Your ICG540 gyro incorporates advanced features not found in any other gyro system. Please read this manual fully before installing and flying.

With their pioneering Heading Lock, Yaw Rate Demand and Flight Mode concepts CSM revolutionised the tail rotor gyro with their ICG360.
This all new ICG540 builds on those ideas and extends gyro technology still further with its Advanced Heading Lock System.

ICG540 key features:-

- **Heading Lock** (as pioneered by CSM)
- **Gyro Flight Modes** (as pioneered by CSM)
- NEW **Auto-setup system** allows rudder trim gyro reversing, Super servo support and servo travel limits to be set FROM YOUR TRANSMITTER.
- NEW selectable **Super Servo support**. **Automatic frame doubling and tripling** gets the optimum from your RC system.
- NEW adjustable* **'Look Ahead'** gain and timeconstant on motion and commands.
- NEW fully adjustable* **'Exponential gain'**.
- NEW fully adjustable* **'Glitch Limiter'**.
- **Yaw Rate Demand** with NEW fully adjustable* linear + exponential Demand Curves for each Flight Mode.
- NEW **Fuzzy logic Drift Compensation**.
- NEW fully adjustable* **'Heading Lock Relaxation Rate'**.
- NEW **High Resolution** pulse measurement and generation systems.
- Two stage power supply regulation - ensures gyro is fully functional down to 2.5 volt supply (even if your radio isn't!)

*Flight mode adjustability is via (optional) PC interface cable/software.

Radio System requirements

The wiring of this gyro is compatible with JR, Futaba, Hi-Tec, Graupner, Robbe and the new style only (Blue Plug) Sanwa/Airtronics radio systems. To use this unit with other makes of radio please check with the service centre in your country or e-mail the CSM service centre (tech@CSM-LTD.CO.UK) The gyro requires an auxiliary channel with travel adjustments to control the gyro mode/gain. It cannot be used with basic RC systems that lack such a channel. We recommend that you use an RC system that also provides travel adjustment on the rudder channel. Most current production computer RC transmitters have these facilities.

Servo choice

Servo speed

Optimum performance from the ICG540 is obtained when it is used in conjunction with a high speed servo (0.12 seconds/60 degrees or better).

Super Servos

The term super servo is used to describe servos capable of running at high data frame rates (6ms per frame or less). Examples of this type of servo are JR 2700G and Futaba FP-S9250. The use of super servos with the ICG540 is highly recommended as they allow the gyro to fully exploit its fast response. When used with this type of servo the "Super Servo" support of the ICG540 should be activated. This can be done during the Auto-setup routine (but may also be accessed via the PC interface if desired).

Warning: Use of the Super Servo facility with servos not designed to accept the high frame rate will result in damage to the servo. The auto setup routine runs the servo in standard mode so it is always possible to access this routine with a standard servo even when the gyro has Super Servo support on.

Standard Servos

With "Super Servo" support off the ICG540 will work with any servo in the Futaba or JR ranges (and many other makes) but as with any gyro system a fast servo with a speed of 0.12 sec/60 deg. or better is to be preferred.

Batteries, power consumption, and wiring

Although the power consumption of the gyro unit itself is very modest, as with all high performance Solid State gyro systems the speed of the gyro response will work the tail rotor servo harder than slower mechanical gyro systems. Especially where a high performance servo is being used the battery drain from the tail rotor servo can be high. **We recommend that you use a good quality battery state monitor and check it carefully before each flight.**

Your receiver battery is a vital part of your tail rotor system. Remember that a battery in a low state of charge or an old battery that has developed a high internal resistance will adversely affect servo performance, especially its acceleration, and may even cause the tail to wag on an otherwise well set up helicopter. You may wish to consider maintaining the charge in your receiver battery between flights by the use of a quality Delta Peak type field charger. In installing the gyro also bear in mind that voltage drops down long servo extension leads will also detract from servo performance. Where the installation requires extensions to be used (either between the receiver and gyro or between the gyro and the servo) avoid using ones that are unnecessarily long.

The ICG540 philosophy
To get the best from this gyro system it is useful to understand how the ICG540 differs from conventional gyros.

Conventional gyro systems
In a conventional gyro the pilot applies a rudder command which is transmitted through the gyro to the servo. As the helicopter responds to the command the gyro detects the movement and opposes the pilot's command and reduces the servo deflection. The yaw rate achieved in such a system depends on the 'gain' of the gyro. The more gain the gyro has the lower the yaw rate that can be achieved. It is common with such systems to have to reduce the gyro gain to achieve the required yaw rate for some manoeuvres (this being accomplished with the gyro gain switch).

The ICG540 system
The ICG540 employs a 'Yaw Rate Demand' philosophy making it a true yaw rate gyro. In this system the rudder command from the pilot is interpreted as a request to the gyro to establish the desired yaw rate. The gyro drives the tail rotor servo as needed to obtain this yaw rate. This means that the ICG540 makes full yaw rate available even at high gain settings. With this system you can use the rudder travel adjustments ('Travel Volume', 'ATV') and rudder rates facilities to set up the desired full-stick yaw rate and the gyro gain switch now becomes a 'Flight Mode Switch' for the gyro. There is no need for so called Pilot Authority Mixing - indeed you should not use pilot authority mixing with this gyro
It is important to realise that with this system the limits to the servo travel are set by the gyro and not by the transmitter's travel adjustment of the rudder channel. The servo travel limits imposed by the gyro are set during the auto-setup sequence as described later in this manual.

The new 'Heading Lock Relaxation Rate' feature makes it possible for the ICG540 to have handling characteristics that are adjustable between full Heading Lock and fully conventional. Using Heading Lock without relaxation gives a helicopter no tendency to weathercock round into wind. The higher the Heading Lock relaxation rate the more the gyro will respond like a conventional type and allow the helicopter to weathercock.

Behaviour on the ground
For those used to conventional gyro systems the behaviour of the ICG540 on the ground may seem unusual.

Unlike conventional systems, it is quite normal for the ICG540 in Standard mode (mode 0) to provide full tail rotor servo movement for rudder commands that are as little as 30% of the full stick movement. This is a consequence of the Yaw rate demand feature, and is why the ICG540 gives such a crisp response.

With the helicopter on the ground and the ICG540 set in Heading Lock mode (mode 1) you will find that even very small movements of the rudder stick or trim will set the servo moving slowly and may, over the course of a few seconds, reach full travel. Your transmitter rudder trim will affect the direction and speed of this movement. This apparently strange behaviour is caused by the stationary helicopter not responding to the heading corrections requested by the gyro. In the absence of a response from the helicopter the gyro continues to increase the servo command in an attempt to get the helicopter to obey. In flight the helicopter will, of course, respond to the tail servo movements and the system will act normally. In order to minimise these movements the trim of the rudder stick needs to be very accurately set. To do this the ICG540, during its auto-setup routine, samples the mid-stick signal to an accuracy much finer than one click of trim. This feature also accommodates the variations in servo pulse standards adopted by RC manufacturers.

Flight Modes
The ICG540 has two flight modes selectable by the transmitter gyro gain switch (or Auxiliary channel switch).
Note: A rotary knob or slider is **not** recommended as it is not possible to accurately and repeatedly set the gain with these.

Factory default flight modes.
Both flight modes are fully configurable via the optional PC interface cable/software, however as supplied from the factory the flight modes are set up as described below.

Mode 0 (Standard Mode)
This mode gives flying characteristics that are similar to conventional gyro systems, but it also incorporates an auto trim that compensates for small inaccuracies in the mechanical adjustment of the tail linkage, variations in engine performance, etc.

Mode 1 (Heading Lock Mode)

This mode provides a much higher resistance to unwanted yawing movements than can be obtained with a conventional gyro system. This mode has great advantages in the following situations:

1) For the beginner, where this mode makes it possible for him/her to almost ignore the tail rotor control in the initial hovering phase, which is made even easier as this mode allows the tail trim to be set before the helicopter leaves the ground. (see 'Trim Adjustment')

2) For cross-wind hovering manoeuvres where the natural tendency of the helicopter to weathercock into wind needs to be resisted.

3) For backwards flight manoeuvres and general "3D" flying.

The Standard mode may be employed for basic forward flight where the natural tendency of the helicopter to weathercock can be helpful, especially to the less experienced pilot.
The graph (Figure 1) shows the way in which the gyro gain channel provides both mode switching and independent gain adjustment of the two modes. If the gyro gain channel pulse is longer than the centre value the gyro is in Mode 0 while with the gain channel pulse shorter than the centre value the gyro is in Mode 1. The travel adjustment (or ATV) settings for the two switch positions of the gain channel provide a convenient way of adjusting (from the transmitter) the gain for the two modes. Increasing the ATV of the gyro gain channel increases the gain for that mode. Please note that it is not possible to use the ICG540 with basic radio systems that lack a suitable channel for controlling the gyro gain.

Gain channel operation
The centre pulse value is set at the factory at 1.51ms however the Auto-setup routine will adjust the gyro centre value to <u>accurately</u> match that of your particular radio system. This accommodates the different pulse length standards adopted by different radio system manufacturers.
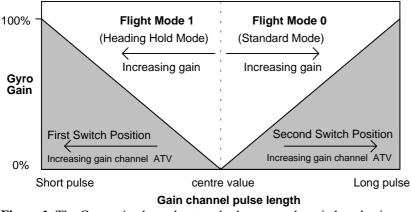

Figure 1. The Gyro gain channel acts as both gyro mode switch and gain control
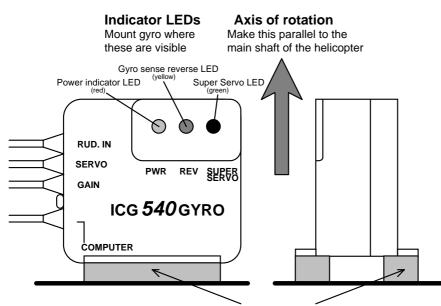
Installation.

Preparing the helicopter mechanics

Attention to the tail control linkage is important to getting the best from this gyro. You should aim for a easy-moving but slop-free linkage between the tail servo and the tail blades. Inspect the bearings/thrust races in the tail hub for smoothness of operation. Check the pitch slider and ball links for slop and replace if needed. Some helicopters that have noticeable 'give' in the tail linkage may benefit from the addition of a rear-mounted tail servo and rigid pushrod. You should also fit a long servo arm (between 15 & 20mm) to the tail servo.

Remember that during aerobatic manoeuvres the combination of a high performance gyro and a fast tail servo can place very high loads on the tail rotor drive train. While you have the helicopter on the bench to install the gyro is a good time to check the condition of tail rotor gears etc. Inspect them regularly to ensure that they are in good condition.

Mounting the gyro

The gyro may be mounted lengthways (longitudinally) or across (transversely) within the model however it should have its axis of rotation (as marked on the back of the gyro case) parallel to the main shaft of the helicopter. For setting up you will need to see the LEDs so mount the gyro where these can readily be seen.

Figure 2. Gyro orientation

The gyro sensor (together with the electronics of the gyro) is anti-vibration mounted inside the gyro case. However, to provide further vibration and shock resistance it is important that the gyro be mounted to the airframe using two of the double sided adhesive foam strips provided. Do not use any other type of mounting foam as this will reduce the performance of your gyro. Replacement strips are available as a CSM spare. For good adhesion, ensure that the surface to which the gyro is attached is smooth, hard and clean. As with all high performance solid state gyro systems, the ICG540 performs best if sited at a point of low vibration in the helicopter airframe. Where possible avoid siting the gyro at the extreme front of the radio tray for example as this area is often subject to high levels of main rotor generated vibration. Also many plastic radio trays are too flexible and better performance can often be gained by mounting the gyro at the rear of the frames.

Radio and tail linkage adjustment.

In our experience most problems with gyro systems arise from incorrect radio setup, incorrect servo arm length, or poor adjustment of the tail control linkage. The following sequence is designed to avoid these snags and ensure a fault-free installation first time. You may need to consult your radio control system manual in order to identify the receiver channels for the rudder and gain inputs to the gyro, however we have included information for some commonly used systems later in this manual.

Radio Setup

First enter the menus of your transmitter and set up the rudder and gain channels as follows:-

• Centre rudder trims and (if fitted) rudder sub trim.

- Set rudder travel adjustment (ATV) to 90%. Most transmitters have separate adjustments for left and right movements and you should make sure you have set the travel adjustment for both directions. At this stage (i.e. before the gyro has been installed) we are using this value to help establish the right servo arm length. Once the gyro has been installed the rudder ATV is used to set the yaw rate demand.

- Ensure that the rudder rates are set to the default value of 100%.

- Set the gain channel travel adjustment to 60% (both ways)

- Ensure that Automatic Tail Stabilisation (ATS) or 'REVO' mixing is INHIBITED.

- Ensure that pilot authority mixing is INHIBITED

- Put the throttle hold switch to the OFF position.

Rudder channel checks
- At this point you should plug rudder servo directly into rudder output of receiver.

- Turn on the radio and open and close the throttle. The rudder servo should not move as the throttle is operated. If it does, then ATS or REVO mixing is still active. **You will need to inhibit it before proceeding** further.

Mid stick trim
- With the rudder stick and trim centred make sure that servo arm is at right angles to tail push rod.

- Now adjust push rod length until the pitch of the tail blades is about 8 degrees with the rudder stick centred. This will correspond approximately to the pitch of the tail in the hover and ensures that the servo will be close to its mid position in the hover.

Servo arm length
- Watch the tail rotor linkage while moving the rudder stick slowly fully left and fully right. If the linkage does not approach either extreme of the pitch linkage travel then increase the servo arm length. Conversely, if the linkage binds at one extreme or the other then slightly reduce the servo arm length. Re-check the mid-stick pitch setup and repeat this test. You are looking to achieve a servo arm length that gives full pitch linkage movement but avoids the linkage binding or the servo stalling. Many helicopters have pitch systems that do not give equal throw about the hover pitch value. The ICG540 has independent servo throw adjustments for left and right which will accommodate this and fine tuning of the servo throw is done later (in the auto-setup routine).

Rudder control sense
- Now we must establish that the sense of the transmitter rudder control is correct (i.e. that the application of a right rudder command causes a change in tail pitch that will rotate the model to the right). **Failure to do this will cause an uncontrollable pirouette on take-off and beginners who are in any doubt on this aspect of the set-up should seek advice** To work out which way the tail rotor will go just remember the leading edge (front) of the tail blades will point in the direction that the tail rotor will go, so for a left stick command you want the tail blades to point to the right (tail swings to the right and the nose goes left). It is vital for this test that you have the tail blades fitted the right way around!

Gain channel checks
- Plug the rudder servo directly into the channel on the receiver you are going to use for the gyro gain/mode control. (This allows us to check for correct gain channel operation).

- Operate the gyro gain switch and observe the servo movement. If there is no movement check that you have correctly identified the gain channel and its switch.

- Now move the rudder stick over its full range and observe the rudder servo. If it moves then pilot authority mixing is still active. Disable it and repeat this test.

Connecting the gyro
- It is now time to connect the gyro into the system. Power down the radio and connect the servo to the gyro output and connect the gyro to rudder and gain inputs to the correct receiver channels.

- Power up, observing that the red gyro power LED comes on and wait 5 seconds while the gyro initialises.

- Move the rudder stick and check that servo swings both ways. If it swings the same way for left and right stick movements you have the rudder and gain inputs of the gyro transposed. Connect rudder and gain inputs correctly and repeat this test .

- We must now identify which gain switch position gives mode 0 and which gives mode 1. The flight modes can be identified by the different way the servo reacts in the two modes. For both gain switch positions hold the rudder stick at full travel for two seconds and release to centre. If the servo returns close to mid position the gyro is in Standard mode (mode 0), while if the servo stays at or near full travel the gyro is in Heading Lock mode (mode 1). For future reference note which switch position corresponds to which mode.

You should now have your gyro installed and have your radio and tail linkage set up correctly and may now proceed with the auto-setup routine as described below.

Leave the "COMPUTER" connector unconnected. (This is for use with the optional PC interface cable/software). If needed however, an extension of not more than 150mm (6 inches) length may be left permanently connected to the gyro's computer connector where this will improve its accessibility (i.e. within a scale body).

The Auto-setup routine.

The unique auto-setup facility of the ICG540 allows the important parameters Rudder trim, Gyro sense, Servo type and Travel limits to be quickly and simply set up from the transmitter. The setup is stored in the gyro's non-volatile memory so the routine will only need repeating if one of these parameters needs to be changed.

Before entering the auto setup routine it is important that:-
- All forms of mixing to the tail rotor channel (i.e. Automatic Tail Stabilisation, or throttle to tail rotor mixing) are inhibited.

- The trim and sub trim of the tail rotor channel are centred.

- The tail rotor servo operating sense has been correctly set in the transmitter. **Failure to do this will cause an uncontrollable pirouette on take-off and beginners who are in any doubt on this aspect of the set-up should seek advice.** The correct operating sense can be established by looking at the tail rotor blades. With a left tail rotor command held on, the leading edge of the tail blades are to the right of their trailing edges (see Figure 3)

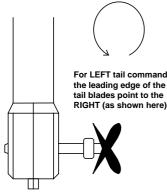**For LEFT tail command the leading edge of the tail blades point to the RIGHT (as shown here)**

Figure 3 Getting tail servo operating sense right.

If the tail blades move in the wrong direction the condition of the servo reversing of the tail rotor channel should be changed and the movement of the tail blades re-checked.

Performing the auto setup

To access the auto setup you toggle the gain switch a couple of times during the gyro boot-up time (this is the first few seconds after the radio system is powering up). The gyro acknowledges this by zipping the servo back and forth a couple of times before parking it in the mid position. The gyro also samples the mid-stick pulse width at this time so you need to have the rudder trim set to centre before entering the auto-setup. **Make sure you do not touch the rudder stick at this time.**

Gyro sense reversing

The first item to be set is the gyro sense reversing. Check that the yellow "REV" LED turns on and off as the rudder stick is moved fully left and right. Now, if the servo operating sense has been set correctly as described previously, simply push the rudder stick to the left and release it back to the middle. This will set the gyro sense to match your system. The servo will travel over to allow the user to check that left tail command is indeed being given and once

this has been checked the gyro sense is 'entered' by toggling the gain switch once (i.e. into mode 0 and back to mode 1) The gyro will 'zip' the servo back and forth in acknowledgement and again park the servo in the middle.

Super servo support
Now set the Super Servo support. By pushing the stick left and right you will observe the green "SUPER SERVO" LED turns on and off. Just select super servo on or off as required (LED ON = SUPER SERVO ACTIVE). Having done so, release the stick to the middle and enter the super servo condition by toggling the gain switch. This will be acknowledged as before by zipping the servo back and forth.

Servo travel limits
Following the acknowledgement the servo travels over to the first travel limit and this can now be adjusted. Hold the stick over in the direction of the servo deflection to increase the limit or hold it over against the deflection to reduce the limit. The servo will move as you change the limit and with its slow movement it is possible to set the limit very accurately. When the correct limit has been found enter this value by toggling the gain switch. Once again an acknowledging 'zip' is given.
Now the servo travels over to the remaining travel limit. Adjustment and entering is the same as the first limit. Once this limit has been entered the auto setup routine is complete. A double acknowledgement is given to show this and the servo will centre, and the gyro will halt with no activity until the power is cycled.

Restart checks
For the setup changes to take effect the gyro must be powered down and powered back up again. In turn on the gyro takes approximately 5 seconds to re-boot. Having re-started the system check the operation of the tail servo for rudder inputs and helicopter movements. Do this for both flight modes. It is important to check the gyro operating sense. To do this simply set the gyro in mode 1 (Heading Lock mode) and rotate the helicopter 90 degrees to the right (clockwise as viewed from above) then look at the tail blades. These should have their leading edges pointing to the right.

Information on popular radio types.
The ICG540 is designed to accept a wide range of radio system parameters (frame rate, servo pulse timings etc.) however it is not possible to provide information as to channel usage and radio setup details for all manufacturers' equipment. The information below covers the popular JR and Futaba systems. If you wish to use this gyro with other types of radio system please consult your radio manual. In case of difficulty please contact your radio manufacturer or the CSM technical department (Email tech@CSM-Ltd.co.uk) for advice.
Connect the gyro to your receiver as indicated in the following table:-

Radio Type	Gyro "RUD IN" connect to	Gyro "GAIN" connect to
JR	"Rudd"	"Gear", "Aux2" or "Aux3"
Futaba	Channel 4	Channel 5 or Channel 7

Connect the "SERVO" output to the tail rotor servo.

JR PCM10S/SX
Setup with 'code 44' disabled
On these radios it is easier to disable the JR 'code 44' (gyro sense adjust) and control the gyro gain by a switch. In this case the gain for the two gyro modes is adjusted by the two travel adjustment values for the gyro channel. Initial values of 60% should be used.
Setup with 'code 44' enabled
If you wish the gyro to switch automatically between mode 0 and mode 1 as the Flight Mode (Idle Up) switch is operated you will need to enable the JR 'code 44' gyro sensing facility.
When using 'code 44' you should remember that the ICG540 gain control works from the centre of the channel outwards. As a consequence an LCD value of 50% (the channel centre) is in reality zero gain (the switchover point between the two gyro modes). Increasing the value above 50% will increase the gain in one flight mode while the other mode is adjusted by decreasing the value below 50%: be aware that this value will be reversed so that an LCD value of 25% will actually be a higher gain value than a LCD value of 30%. Note: if the gyro is adjusted through the JR gyro software, the gyro channel travel adjustments should be set to equal values each way. Initially set them to 100% and only increase them if you run out of gain adjustment with the code 44 parameters. The starting point should be with the code 44 parameters set to 10% and 90%

JR X388S/X3810/X8103
On these radios it is easier to control the gyro gain through the gear channel as it is not always possible to have control over other channels on a 2 position switch. Note: if so desired it is possible to set the gyro up using the JR gyro software on the 3810/8103, see the PCM10 instructions above.

Futaba 9ZHP/ZAP

With this transmitter it is important that, initially, all the flight conditions have the same gyro configuration. To check all the flight conditions you will need to go into the various menus mentioned below and turn throttle hold on and off and then try each of the idle up positions in order to see the status for all the conditions. (see your ZAP/ZHP manual for more detail). First ensure that **in all flight modes** the gyro sense mode is set to INHIBIT. To do this go to the "GYR" entry of the "helicopter condition" menu and for each flight condition press the INH key to select the INHIBIT state. Then press END to exit the gyro sense menu. Now check under the "PMX" entry that no throttle to rudder or rudder to gyro mixing is active in any of the flight conditions. Then check in the "P->R" entry that pitch to rudder mixing is inhibited. Now enter the "ATV" menu. Press "RUD" to select the Rudder channel and for all flight modes make RATE A and RATE B equal to 90%. Then press "GYR" to select the Gyro menu and set RATE A and RATE B to 60% for all flight modes. Press END to exit the ATV menu.

Now press "MDL" to enter the "model menu". Use the "FNC" entry to allocate the gyro control to a switch of your choice. After the auto setup has been done you may wish to return to the ATV menu to set the rudder ATVs to 60% until you are familiar with the gyro's handling characteristics.

Flying the gyro
Turn-on sequence
1. Turn on your transmitter
2. With the model stationary on the ground turn on your receiver.
3. Wait for about **5 seconds keeping the model still** while the gyro goes through its self test/boot up sequence.
4. Move the rudder stick fully in both directions and ensure that the tail rotor servo responds to stick movements. (Do not move the gain switch until the boot up is complete unless you wish to enter the auto setup routine.)
5. Your ICG540 is now ready for flight.
!! Make sure the model is not moved during the gyro self test period. !!

Initial flight trials.
We suggest that you **reduce the rudder travel adjustments in your transmitter to 60% for the first few flights until you get used to the response of the gyro system**.
First select flight mode 1 (Heading Lock mode) and hover the helicopter. Use short small 'stabs' of rudder control to disturb the helicopter in yaw and observe. If some tendency to oscillate is seen, slightly reduce the gyro gain. Conversely if no tendency to oscillate is seen try increasing the gain. You are looking at this stage for the highest gain that gives no sign of oscillation when the tail is disturbed by sudden changes in tail command. Observe any trim offset in the tail and correct this with the transmitter rudder trim.

Now switch to Flight mode 0 (Standard mode) and repeat the exercise above. If the mechanical trim adjustment of the tail linkage is within a reasonable range of the correct setting the auto-trim built into this mode should compensate for the residual trim error and the trim state of mode 0 should match that of mode 1. If however you observe a trim difference between the modes this means that the mechanical trim of the tail is outside the limits of the auto trim system. **Do not move the trim on the transmitter** but observe the direction of the trim error in mode 0 and adjust the mechanical trim of the tail linkage to correct it. If the trim error in mode 0 causes the helicopter to rotate anticlockwise (a leftward trim error) adjust the length of the pitch linkage to put more right tail pitch on and vice versa.

Once this has been done you may wish to check for tail wagging in fast forward flight. Should this be observed, you should lower the gyro gain slightly. Caution should be exercised over the use of the Heading Lock mode in flying circuits or other general flying until you are familiar with the very special handling characteristics that Heading Lock gives.

Adjusting the stick response
After initial setting use the rudder ATV, Rates, and Exponential facilities of the transmitter to tailor the control response as required. **Beware that the ICG540 makes high rates of yaw available (at all gain settings).** If an increase in available yaw rate is required increase the rudder travel on your transmitter **gradually** until the desired response is obtained. Remember that increasing the rudder travel adjustment will not increase the overall tail servo throw as this is set by the gyro's own travel limiters.

The ICG540 has built-in exponential. You may find the following graph of yaw rate against rudder command useful in deciding on the setting of rudder rates and rudder ATV. Remember that the ATV and rates facilities work together so that setting the rudder ATV to 80% in both directions and also setting a rudder rate of 60% will give a total rudder throw of $0.8 \times 0.6 = 0.48 = 48\%$
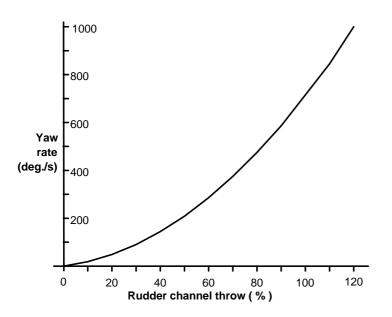
Figure 3. Factory default Yaw Rate Demand curve built in to the ICG540.

Changing the gyro's internal demand curves
If the default yaw rate demand curve shown above does not suit your requirements it is possible to customise the demand curve by use of the optional PC interface cable/software. The two flight modes have completely independent demand curves allowing the stick response to be changed with the gyro gain switch.

Automatic Tail Stabilisation (ATS)
This should not be used with the ICG540 gyro

Pilot Authority Mixing
This should **not** be used with the ICG540 gyro.

Tail rotor dynamics
To realise the full benefit of the ICG540 it is important to have a basic understanding of the dynamics of the tail rotor system. It is a common misbelief that the higher the electronic gyro gain is, the better the system will work. Whilst this is generally true, the electronic gain is only one part of the tail rotor system and of equal importance is the amount of tail pitch range available, and the tail rotor disk size. The disk size is also related to the tail rotor speed. Of course there are other influences on the tail system but these are the most important and can be grouped together as mechanical gain.
If the mechanical gain is not correct, then the gyro will not be able to function to its best ability. For this reason it is important to select the correct size servo arm that will give maximum tail pitch movement without stalling the servo. In most helicopters this will be an arm of between 15 and 20 mm radius. Note: As the servo travel limits are set during the auto setup routine, increasing the rudder travel adjustment will not increase the servo throw as this is limited electronically in the gyro. The rudder travel adjustment is used instead to adjust the rotation rate.

Tail blade size
The correct length of tail blade can only be selected by flight testing. There are 2 types of test to ascertain the correct size:
1) With the model in the hover at its normal flight rpm, making sure the gyro is in Heading Lock mode, make a rapid vertical climb for 50 to 60 feet: there should be no discernible rotation of the model. If the tail does not maintain its position this is a good indication that the diameter is too small. Note: if the model is over pitched and there is a noticeable drop in rotor rpm during the climbout, then this will invalidate the test as the tail would probably not be able to cope with this situation regardless of the setup.

2) This test is only really necessary for those who wish to do advanced aerobatics/3D flying and should only be carried out those who are confident to do so. With the model at a safe height fly the model sideways, starting slowly and building up speed until it reaches its maximum possible speed:
 a)If the tail manages to hold its position then the blade length is OK.
 b)If the tail starts to lag behind, then either more pitch is needed (if the mechanical limits haven't already been reached) or longer tail blades.
 c) If the tail swings round suddenly and cannot return to the correct position then the tail rotor is stalling and longer tail blades are needed.

Maximising Performance for Advanced 3D/Aerobatic Flight - by Bob Johnston

To get the maximum performance from this or any piezo gyro it is essential to minimise the vibration reaching the gyro sensor. Apart from the obvious balance checks, make sure that the canopy, fins, tuned pipe or muffler are not too loosely mounted, especially if the gyro is being used with a fast servo, as it is possible for a resonance to build up which shows as a very fast shake, visible in the canopy and tail.
If you feel confident to do so, try slowly tumbling the model while checking for any visible vibration, a small amount is almost inevitable, but try to dampen any large vibrations present. Alternatively tumble or roll the model at a safe height and if the gyro can be made to wag through the manoeuvre this is a good indication that a component is resonating.
To set the maximum gain permissible for aerobatic flight, either a) fly the model as fast as possible in a straight line and twitch the rudder stick a small amount: if this causes the gyro to wag, lower the gain and repeat the test until the tail cannot be made to wag anymore. Obviously if the model cannot be made to wag initially, keep increasing the gain until it does, and then reduce the gain a few percent. Setting the gyro this way should prove sufficient for all flying except in very windy turbulent conditions where the gain may have to be lowered by a few percent. b) Alternatively, if you feel confident enough in your ability and your models reliability, put the model in a vertical dive for 3 or 4 hundred feet (90 to 120 metres) with the main rotor pitch at zero. Once terminal velocity has been reached, pull the model out in a smooth arc, and if the model does not wag under these conditions it is unlikely to do so under any conditions.

WARNING: Only attempt to carry out these flight tests if you are 100% confident in your own flying ability, and the structural integrity of your equipment.

Boom supports

Tests have shown that the use of boom supports significantly increase the rigidity of the tail boom and so allow a higher gyro gain to be used. Generally the longer the boom supports the better they will work. Note: A loose/cracked boom support or a loose/cracked boom support clamp can have a significant effect on the gyro gain. Even a slightly loose boom clamp or support will have a dramatic effect on the amount of gain that can be used. Stand on the skids of the model and try to flex the end of the boom from side to side while holding a finger against the joint to feel any movement.

Humidity

Under conditions of extremely high humidity it is possible for condensation to form on the piezo sensor. This can adversely affect gyro performance. Where it is not possible to avoid subjecting the gyro to such humidity levels it is advisable to leave the model standing for a few minutes with the radio switched on so that the internal heating of the gyro helps disperse the condensation. Always protect the gyro from ingress of water (e.g. rain).

PC interfacing

Your ICG540 is equipped with a 'COMPUTER' port which is provided for the experienced pilot wishing to optimise the internal settings of the ICG540's two flight modes to their helicopter and flying style. An optional Interface cable and software disk is available for use with this port. The interface/software is compatible with any IBM PC compatible with a parallel (printer) port and VGA graphics. Comprehensive additional instructions on the use of the PC interface are supplied with the software. Connection to the 'COMPUTER' port of the ICG540 must only be made via the correct optional interface cable.
No other form of connection to this port should be made as mis-use of this facility may damage the gyro unit.

DOs and DON'Ts

DOs:

Do mount the gyro with its axis of rotation parallel to the helicopter main shaft.
Do mount the gyro on two of the supplied self-adhesive foam strips.
Do mount the gyro to a hard, smooth clean surface.
Do use the rudder ATV and rates to tailor required stick response.
Do check the sense of the gyro operation **before flight**.

Do use a battery state monitor and check it before each flight.
Do remove slop and stiffness from tail control linkage.
Do inspect tail gears etc. for wear.
Do explore the performance limits of this gyro with care.

DON'Ts:
Don't subject the gyro to mechanical shock.
Don't mount the gyro where it will be subjected to high vibration levels.
Don't use Super Servo support with standard servos.
Don't use Pilot Authority Mixing.
Don't use Automatic Tail Stabilisation (ATS) or Throttle-Tail mixing.
Don't use unnecessarily long servo extension leads with the gyro.
Don't move the model during gyro self-test time.

Trouble shooting

Model pirouettes violently as soon as it starts to lift off.
Gyro sense has been set incorrectly. Repeat the rudder control sense checks and the auto setup routine to rectify

Model tail wags from side to side in the hover.
Reduce the gyro gain (using the gain channel travel adjustment)

Model flies OK in one gyro mode but wags when switched to the other mode.
You have too much gain in just the one mode. Reduce the gain channel travel adjustment for the mode that wags.

Tail response is not crisp.
Too little gyro gain. Gradually increase travel adjustment of the gain channel until tail shows some tendency to wag and then reduce it back until wag just stops.

Model wags even when the gain is very low.
Possible causes: Slop in pitch linkage. Friction in pitch linkage. Tail hub bearings locking up under load. Servo is very slow. Short servo arm with excessive servo travel.

Model hovers steadily in mode 1 but starts to rotate when switched to mode 0.
The mechanical tail pitch trim is outside the auto trim range. Adjust the length of the tail push rod to correct this.

Model flies OK on first few flights of the day but tail starts to wag on later flights.
Servo consumption with fast gyros is high, and falling battery voltage reduces servo performance making the tail system less stable. Cycle receiver battery and check its capacity. Also consider using a fast Delta -peak charger to top up battery between flights.

Model was OK last season but after the winter in store the tail now wags.
Check the tail control linkage for free movement. Pay special attention to the pitch slider and the tail hub bearings. Receiver battery may have developed a high internal resistance. Cycle the battery and check its capacity. It may show a normal capacity at low discharge rates, but a much reduced capacity when measured at say 3 amps discharge rate indicating a high internal resistance.

Ratings
Weight: 40g

Dimensions :   42.5mm High x 26.5mm Wide x 46.5mm Long
(excluding cables and mounting ears)

Supply voltage range: 2.5v to 7.2v**
** Warning: Check your RC system voltage limits as these may be more restrictive.

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ICG540 PC INTERFACE MANUAL

INTRODUCTION
The ICG540 gyro is equipped with a 'computer' port that allows the internal settings of the gyro to be adjusted to the users' requirements. Although for most users the default settings of the ICG540 (with which it is supplied pre-loaded) will be satisfactory, with careful experimentation, it may be possible to tailor the operation of the gyro to match more closely the particular model, radio equipment, and flying style of the pilot. Should you be unsuccessful in finding a better set-up, the PC software includes a facility for returning the gyro back to the factory default settings.

INSTALLING THE INTERFACE SOFTWARE ON YOUR PC
The installation program may be run under DOS or windows. The following description is for DOS. To install the gyro interface software onto a hard drive, insert the distribution disk in drive A (or B) and at the DOS prompt type:-
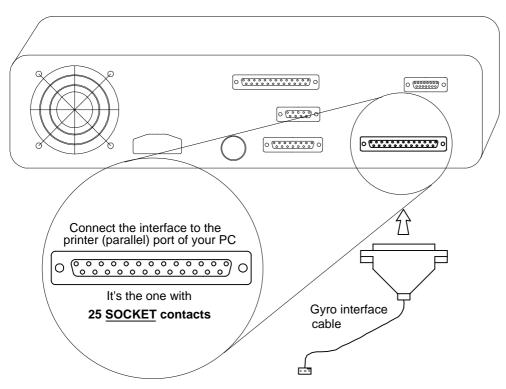   **A:**   (Enter)   {or B: if appropriate}
    INSTALL   (Enter)
You will be asked which hard drive you want the software installed onto (e.g. "C"), and the floppy drive from which the software will be installed ("A" or "B"). Once the selection of drives has been confirmed, a directory called **'ICG540'** will then be created on the appropriate drive, and the required files transferred. If the install program finds a previously installed version it will ask if you wish to overwrite it.

RUNNING THE INTERFACE SOFTWARE
Once the software has been installed on your PC follow these steps to connect to your gyro.

1. CONNECT THE GYRO INTERFACE CABLE TO YOUR PC

Connect the interface to the
printer (parallel) port of your PC

It's the one with
25 <u>SOCKET</u> contacts

Gyro interface
cable

Locate the Parallel (Printer) port of your PC. This is a 25 pin 'D' connector with **socket contacts.** If you have a printer attached to your PC it may already be connected to the desired port. If so, disconnect it and connect the gyro interface cable in its place. If your PC has multiple parallel ports you can install the interface on LPT1, LPT2 or LPT3. You will be able to select the port in use when running the interface program.

<center>

<u>! DO NOT CONNECT YOUR PC TO THE GYRO YET !</u>

</center>

2. START THE INTERFACE SOFTWARE
Do this by typing at the DOS prompt:-

       GYRO (Enter)

3. SELECT THE LPT PORT IN USE

At the first menu screen select the printer (LPT) port to which you have the gyro interface cable connected. If you are unsure of your LPT port's address you will need to try each option in turn until a successful connection to the gyro is achieved. (some PC manufacturers use non-standard port addressing, ie. 278 for LPT1)

4. TURN RECEIVER ON.
This will power up the gyro. Check that the power indicator LED "PWR" is on.

5. CONNECT INTERFACE LEAD TO "COMPUTER" PORT OF GYRO
This lead is easily identified as the only white/red/black ribbon cable emerging from the gyro.

6. PRESS ANY KEY TO INITIATE LINK-UP

When you have finished making changes to the gyro's internal settings disconnect the interface cable from the gyro and cycle the power in order to let changes take effect.

TROUBLE SHOOTING
During the initial stages of the link up the integrity of the PC-gyro communications is checked and any problems will be reported. Failure to establish a link-up is usually due to the selection of the wrong LPT port address. As an aid the software automatically highlights your last port selection on being run.

THE MAIN MENU
Once you have successfully connected to the gyro you will be presented with the main menu.
This offers the following options:-

> **Set up general gyro parameters**
> **Set up Flight Mode 0**
> **Set up Flight Mode 1**
> **Set up Anti Drift system**
> **Return gyro to factory settings**

If you are familiar with using your ICG540 with its factory default settings then Flight Mode 0 is the so called 'Standard' mode while Flight Mode 1 is the 'Heading Lock' mode.
However, with the aid of this PC interface both Flight Modes are fully configurable and you could, if desired, set up both modes to have Heading Lock capability. To do this simply copy the Factory Default values for Flight Mode 1 to Flight Mode 0.

The general gyro parameters menu
The parameters under this menu influence the overall operation of the gyro and are common to both the flight modes.

Mid Stick pulse length
This must correspond to the channel output pulse width of your radio system with a channel set to its centre position. It is used to set the zero yaw rate point and also the switchover point for the mode 0 to mode 1 switching. The factory default is 1.5100ms but this value is automatically adjusted to the value for your radio system as part of the Auto-setup routine, so it is not normally necessary to adjust its value via the PC interface.
Throw limit 1 and Throw Limit 2
These are the servo throw limits set by the gyro and are expressed as a percentage of the normal full travel of the servo. These values are set as part of the Auto-setup routine and so will not normally need adjustment via the PC interface. However, it is useful to see the actual values as they can help to trace problems with the setup of the tail linkage. If, for example, the limits are both greater than 100% it suggests that a better setup could be obtained if a longer servo arm were fitted and the throw limits reduced correspondingly. If the values for the two directions are very different this could simply indicate that the helicopter has a very asymmetric linkage, but it may also point to an incorrect tail centre pitch value.

Gyro sense reversed
This is also a parameter that is set in the Auto-setup routine and should not normally need changing via the PC interface. However, if you do change it please check that the gyro is operating in the correct sense before the gyro is next flown.

Super Servo in use
This is also set in the Auto-setup routine, but for convenience is also included in this menu. Care should be exercised in turning this facility ON as standard servos that are not able to handle the high data rates will be damaged by being used with the ICG540 in Super Servo mode. If in doubt leave this parameter OFF

Look-ahead time
The look ahead facility of the ICG540 enables it to anticipate the required servo movements and contributes to the gyros clean stop capability. This parameter allows the look-ahead time to be adjusted. The default value is 'SHORT' but in large helicopters (especially scale types) it may be useful to change this to 'LONG'. Changing this parameter will also affect the required values of look-ahead gain used in the two flight modes, with lower values normally being needed when the look-ahead time is set to LONG.

Look-ahead on motion/stick
You have the option of letting the gyro anticipate just the motion of the helicopter or to have the gyro attempt to anticipate both the motion and the stick movements. The default state is with the look-ahead on the motion only. Enabling look-ahead on the stick can crispen stick responses but demands a smooth touch on the rudder. Where look-ahead on stick is used the Glitch Window facility can be used to mask rough stick movements, though if used to excess this will largely defeat the crispening effect of the stick look-ahead feature.

Glitch Limiter Window
This facility is used to 'filter' the rudder command data coming into the gyro. It may be used for several reasons. It may simply be used to limit the effect that radio glitches have on the gyro response. Since the ICG540 yaw rate demand feature acts to give the helicopter a very agile tail it follows that unwanted glitches in the rudder command data will be more noticeable than with less agile conventional systems. Alternatively, it can be used to smooth out rough handling of the rudder stick. It may also be used to artificially slow the tail response of the helicopter for example in scale models where slower handling responses may assist your scale flying technique.

Flight Mode menus
The two Flight Mode setting sub-menus are identical and provide control over the following parameters which have independent values for each of the modes.

Look-Ahead gain
This parameter sets the degree to which the look-ahead feature influences servo position. The right amount of look ahead gain helps clean up the gyro 'stop' and will allow an increase in the overall gain to be achieved. Too much look-ahead gain can smear the stop or cause a short-lived 'shudder' as the pirouette stops.

Conventional gain
This sets the degree of rate damping provided by the gyro, and is like the gain on an ordinary gyro.

Exponential gain
This feature improves the speed of tail response to large yaw rate changes and should be used to help reduce the stop time from fast pirouetting manoeuvres. Excessive values will tend to degrade the clean nature of the stop.

Heading Lock gain
This sets the degree of resistance the gyro provides to unrequested heading changes. **If you want a 'standard' (non Heading Lock) mode set the Heading Lock <u>Range</u> to zero.**

Direct (stick to servo) coupling
This provides the gain independent servo movement linked directly to the demanded yaw rate from the stick position. The setting of this parameter is discussed later.

Heading Lock range
This limit sets the range of headings over which the Heading Lock gain applies. It can, if desired, be used in conjunction with the Heading Lock Gain to limit the maximum power of the Heading Lock. **<u>Important: Set this parameter to zero for a 'standard' (non Heading Lock) mode.</u>**

Heading Lock relaxation rate
The new 'Heading Lock Relaxation Rate' feature makes it possible for the ICG540 to have handling characteristics that are adjustable between full Heading Lock and fully conventional. Using Heading Lock without relaxation gives a helicopter no tendency to weathercock round into wind. The higher the Heading Lock relaxation rate the more the gyro will respond like a conventional type and allow the helicopter to weathercock. Thus, this feature allows you to create a full range of handling characteristics between full Heading Lock and fully conventional. Small values (say less than 4%) give flying characteristics indistinguishable from full Heading Lock but allow the servo to gradually

centre when the model is on the ground for a period, and this is recommended for eliminating any 'swing' on take-off.

Stick linear sensitivity
The yaw rate demand curve for each flight mode can be fully and independently adjusted to give exactly the stick 'feel' you want. This linear sensitivity has most influence on the feel near mid-stick. If the model feels too 'dead' around mid-stick then increase this value. Conversely, reduce this value to reduce the sensitivity to small stick deflections. The graphical display at the right of the Flight-mode edit screen allows you to see the shape of the demand curve you are creating.

Stick exponential
This has little effect near to mid-stick but has a big effect towards full-stick deflection.
Use this in conjunction with the stick linear sensitivity and the graphical display to the right of the flight mode edit screen to get the stick response you want.

Max yaw acceleration of helicopter
This parameter helps the gyro match its operation to the actual agility of the helicopter in yaw. The value relates to the maximum achievable rate of acceleration and deceleration of the helicopter in yaw. Helicopters with large yaw inertia (i.e. those with scale bodies), small diameter tail rotors, or slow tail rotor speeds will generally have lower yaw acceleration than, say pod-and-boom designs set up for aerobatics. Setting a value that is higher than the helicopter can achieve will mis-match the gyro to the helicopter and degrade the quality of the start/stop transients.

Set up Anti Drift system
This menu has four options:-
> **Optimise for low vibration environment**
> **Optimise for medium vibration environment**
> **Optimise for high vibration environment**
> **Exit without changing optimisation**

The Fuzzy Logic anti-drift system is largely self -adjusting and for the majority of cases the default setting (optimised for low vibration environment) is best. However you may wish to select the medium or high vibration environment options if you are fitting the gyro into a petrol (gas) powered helicopter especially if this is to be run at high engine RPM.

General remarks
We strongly recommend that before entering into adjustments of the internal parameters of the gyro you first get your model performing well with the factory default settings. In our experience this is always possible and if you have major handling problems with your model you should look for the cause in your radio setup, tail linkage adjustment, friction or slop, tail blade length, etc. Trying to cure such defects by internal adjustments of the gyro will be a frustrating waste of time.

Once you have your model responding well to the default settings, probably the first parameters you will want to adjust are the Stick Linear sensitivity and Stick Exponential. These determine the shape of the Yaw Rate Demand curves for each flight mode and in so doing determine the 'feel' of the stick. The factory default setup for the ICG540 gives both flight modes the same shape of demand curve. By adjusting these parameters you can build exactly the stick feel you want for each mode separately and have the feel switch with the gyro mode. The Glitch Limiter window (with or without the use of the Look-Ahead on Stick option) may also help tailor the stick response of the model to your liking.

The remaining parameters determine the detailed dynamics of the gyro system and given the number of these variables as well as the many aspects of the helicopter (tail blade size, engine performance, servo speed, etc.) that influence the characteristics of the helicopter in yaw it is not possible to give a simple recipe for further optimising the gyro for your model. The parameters have complex interactions so that the optimum value of say Look-Ahead gain is affected by a change in the Heading Lock gain. So, before attempting this it is vital that you have the model in perfect mechanical condition and performing well with the factory default settings. You should then try making small adjustments to the default settings and observe their effects.
In arriving at the factory default settings we found it useful to set the two modes to nearly identical settings differing only in, say, the value of the Look-Ahead gain value. By switching between the two modes we were able to see quite small changes and 'home in' on the optimum. Careful note-taking is vital to prevent confusion in this process! An observer taking notes on a clip board is very useful. Once you have used this technique to get one good mode you can then apply the same method to optimise your second flight mode.

Adjustment of the Direct (stick to servo) Coupling can be left until other aspects of your Flight Modes have been set. The other parameters can be adjusted with the Direct Coupling set to the factory default value. Adjustment of the Direct Coupling is done by observing the effect of gyro gain changes on the maximum yaw rate. If you find that reducing the gyro gain causes the maximum yaw rate to decrease then more Direct Coupling is needed. Conversely, an increased maximum yaw rate at reduced gyro gain means that too much Direct Coupling is being used.