KeyKoder Radio Control Systems
Hitchiker Add-on channels to Futaba R/C

Help: **(541) 471-7135**

❑ **KH732** *COMPLETE* **39 Channel System**

❑ **KH716** *COMPLETE* **23 Channel System**

❑ **KH712** *COMPLETE* **19 Channel Aircraft System**

❑ **7 or 8 Proportional Servo Channels for servos or Speed Controls plus....**

❑ **16 or 32 Independent and Simultaneous ON-OFF channels as 0-30V 5A Switches and**

❑ **6 Two Position Servo Command Outputs and 2 Three position Servo Command Outputs**

❑ **Featuring Reliable Futaba PCM1024 Radios**

❑ **Available on 75MHz Surface vehicle frequencies or 72 MHz Aircraft frequencies**

OVERVIEW: The **KH712, KH716** and **KH732** *Hitchiker* Radio Control systems combine Futaba's excellent `PCM1024` radio systems with **VANTEC** KeyKoder technology to add the extra channels and functions needed for Special EFX projects, inspection/sample harvesting vehicles, and tele-operated robots. Great for controlling submarines with their complex plumbing and pumps. Making your dream scale R/C boat fully operational is now easier than ever. Eliminate fussy servo-microswitch kluges. Microprocessor equipped projects have used the *Hitchiker* channels to initiate pre-programmed routines. Available on 72 or 75 MHz frequencies; there is no additional charge to have your transmitter legal. **VANTEC** warrantees the entire system.

The three systems are complete including the Futaba FP7CAP series radio control sets and come with transmitter, receiver, selection of servos, Nicad batteries, charger and the **VANTEC** *Hitchiker* KeyKoder components. The Futaba radio sets are top-of-the-line models using Futaba's `PCM1024` **P**ulse **C**ode **M**odulation method. PCM is a significant improvement over FM because it transmits the servo commands as digital words with special mathematical properties that facilitate accurate reception and calibrated servo positions for **F**ail **S**afe operation. Servo jitters are a thing of the past. The **F/S** meets the criteria for competitive robot safety shut-down. See the side panel for more about the PCM Advantage.

VANTEC fully harnesses Futaba's coding to reliably pack additional controls onto one of the Futaba R/C servo channels. The new controls are independent and operate simultaneously. The remaining conventional channels are not affected. To make a complete *Hitchiker* system **VANTEC** adds two devices to the Futaba set.

The first device is a KeyPad that is added to the transmitter. It mounts onto the base of the Futaba FP-7CAP transmitter. Each new KeyPad channel is actuated by a special toggle switch that can operate momentarily like a push button by pressing *down*; it automatically springs back to center off. Or switch it "On" continuously like a normal toggle switch by flipping it *up*. Any number of switches may be activated at once. The KeyPad switches are labeled 1-16 or 1-32. The KeyPad understands and "speaks" `PCM1024`; it interjects its new data onto one of the regular servo channels through the trainer connector. This means you lose the normal operation of the selected channel; usually the invisible 8th channel of the 7 channel system or the "Retract" channel 5 is sacrificed.

The second device is a Receptor add-on box that plugs into the Futaba R/C receiver like a servo and separates the KeyPad commands back into 12, 16 or 32 individual outputs corresponding to the transmitter KeyPad switches. The Futaba receiver is optically isolated from the workings of the Receptor. The Receptor has terminal blocks and
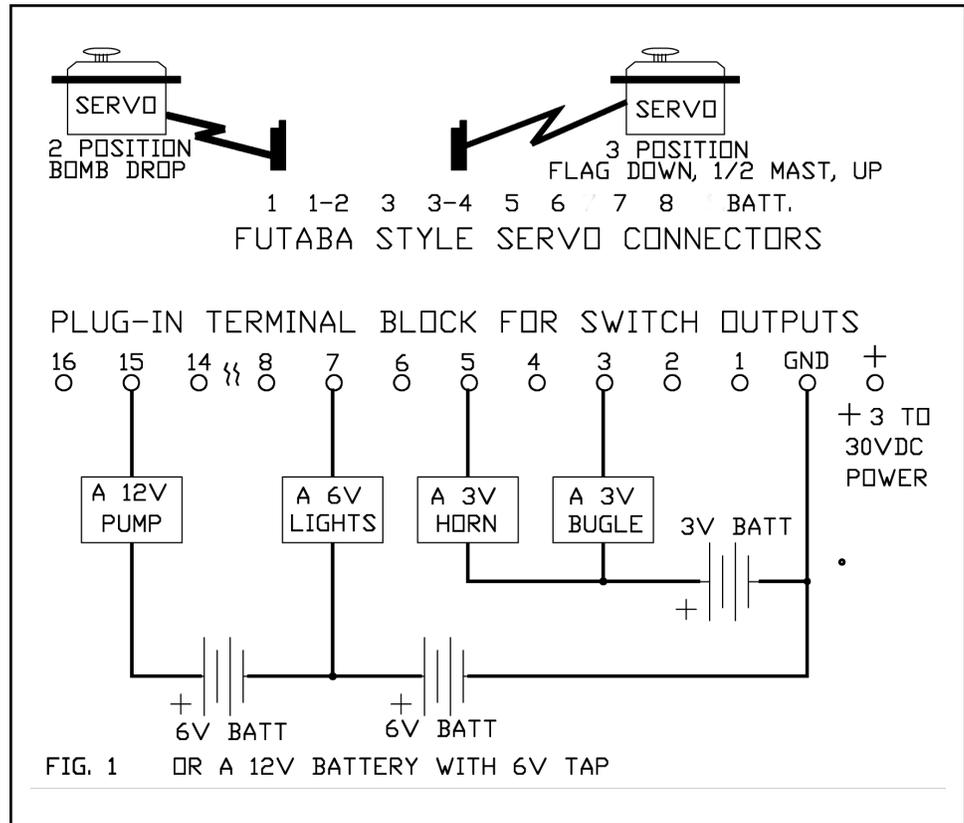
additional servo connectors for the newly added channels. These on-off or two-state outputs manifest themselves several ways depending upon the Receptor model. At 5A capability each the ON-OFF electronic switches can be used *directly* for many functions even with devices operating on an assortment of voltages. And the 8 conventional **S**ervo **C**ommand **P**ulse outputs are a handy and familiar way to implement mechanical functions using conventional servos.

The **KH716** *complete* system has 7 conventional servo channels and 16 independent and simultaneous KeyKoder ON-OFF electronic switch channels for 23 channels total. The first 8 of the 16 KeyKoder channels coincidentally features 2 three-position regular **S**ervo **C**ommand **P**ulse outputs and 6 two-position regular **SCP** command outputs. The **KH716** system consists of: the complete Futaba FP7CAP R/C set with the 7 channel FPR168DP or other equivalent Futaba Brand receiver, **VANTEC KH16T** KeyPad and **KH16R** Receptor and 2 servos. Additional servos available.

The **KH732** complete system has 7 conventional servo channels and 32 independent and simultaneous KeyKoder ON-OFF switch channels to yield 39 channels total. The first 8 of the 16 KeyKoder channels coincidentally feature 2 three-position regular **S**ervo **C**ommand **P**ulse outputs, 6 two-position regular **SCP** outputs. The **KH732** systems consists of: the complete Futaba FP7CAP R/C set, with the 7 channel FPR168DP or equivalent Futaba brand receiver, **VANTEC KH32T** KeyPad and **KH32R** Receptor and 2 servos. Additional servos available.

Generally the '716 & '732 versions are employed in boats and robots. Up to 128 ON-OFF channels can be added to a single Futaba Servo Channel with an array of KeyKoders.

SERVO
2 POSITION BOMB DROP

SERVO
3 POSITION FLAG DOWN, 1/2 MAST, UP

1 1-2 3 3-4 5 6 7 8 BATT.
FUTABA STYLE SERVO CONNECTORS

PLUG-IN TERMINAL BLOCK FOR SWITCH OUTPUTS

16 15 14 ⌇ 8 7 6 5 4 3 2 1 GND +
+3 TO 30VDC POWER

A 12V PUMP   A 6V LIGHTS   A 3V HORN   A 3V BUGLE   3V BATT

6V BATT   6V BATT
FIG. 1   OR A 12V BATTERY WITH 6V TAP

The **KH712** is specifically configured for model aircraft applications. Switches 1 through 8 on the **KH16T** KeyPad generate only **S**ervo **C**ommand **P**ulses and switches 13, 14, 15, and 16 are the only electronic switch outputs on the **KH12R** Receptor. The **KH712** *Hitchiker* is perfect for 1/4 scale R/C model airplanes with 7 conventional servo channels for the normal flying functions and 12 added KeyKoder channels for a total of 19 channels. It's KeyKoder Receptor features 2 three-position regular **S**ervo **C**ommand **P**ulse outputs, 6 two-position regular servo command outputs, and 4 electronic switches. Since the servo command outputs are just like the signals coming from a Futaba receiver you can plug-in up to *8 new* conventional servos for auxiliary functions like bomb bay doors, bomb release, or parachutists. The electronic switches can be used to control engine ignition, starting, lights and camera. The **KH712** **s**ystem consists of Futaba FP7CAP PCM R/C set with an 8 channel receiver, **VANTEC KH16T** KeyPad and **KH12R** Receptor and Servos.

TRANSMITTER / KEYPAD INSTALLATION:
The KeyPad is factory mounted to the Futaba case, a slight modification made to the transmitter. You cannot use the original trainer feature after these modifications.

KH716R & KH732R RECEPTOR INSTALLATION:

Keep all output wiring separated from the Futaba receiver and servo leads. Use the full extended length of the supplied receiver antenna and locate it away from all other wires and metal structures. Plug the Receptor add-on box into the Futaba R/C receiver channel engraved "K", usually Futaba channel 5. FPR168DP and FPR138DP receivers ordered from VANTEC for KeyKoder applications have a small internal modification to supply the needed signal out the "K" marked channel. It is the same as the "C" or "DSC" connector available on other Futaba PCM1024 receivers. Do not plug a servo into this channel as it will disable all channels.

Some receivers like the FP-R129DP come with a "C" or "DSC" output; plug the Receptor into this socket regardless of the Futaba channel sacrificed for the *Hitchiker.*

Receptor **S**ervo **C**ommand **P**ulse outputs work in conjunction with KeyPad channels 1-8. With **KH16R** and **KH32R** receptors these **SCP**ulse outputs operate together coincidentally with ON-OFF outputs 1-8. These **S**ervo **C**ommand **P**ulse outputs are limited to two or three fixed pre-determined positions and can drive regular R/C servos or speed controls. Regular 3 pin plug-in servo connections are provided on the Receptor in three groups, each group accepting 3 servo connectors netting 9 Futaba "J" style connectors in all. The 9th position labeled "Bat", on the far right, is the power input to run the 8 Receptor servos. A separate 4.8V battery pack or suitably robust 5V regulator for this is recommended.

Servo Command Pulse outputs "1-2" and "3-4" are the three position servo outputs. Logically 2 switches on the KeyPad are required to define 3 positions (4th possibility not used). Further, the two and three positions are designed so that a three position servo output shares a transmitter KeyPad switch with a two position servo output. For example: KSw1 controls servo SCP1 which operates as two position actuator. But KSw1 also commands the second SCP2 servo, along with KSw2, for one of three positions. In practical situations either 2 two-position servos OR 1 three position servo would be deployed. The actual servo positions are assigned in groups to provide a variety of combinations as delineated in Fig 5. The three positions are adjustable by three factory set and secured trimming potentiometers.

Receptor ON-OFF Switch outputs are each capable of current sinking to ground 0-30 VDC@ 5 amps. This means they switch to ground to complete the circuit to operate your device. Because they switch to ground they easily accomodate a variety of lights, horns, motors and other loads operating on a variety of voltages up to 30VDC by simply using different batteries or taps on a series connected set of batteries. See Figure 1 above for examples. Total continuous "box" current controlled at any one time should be limited to 20 Amps.

Inductive coil loads like motors and relays inherently generate a potentially damaging voltage spike when they are turned off. We recommend the addition of a Metal-Oxide-Varistor (MOV) across each inductive load to safely suppress this spike. **VANTEC** has supplied a number of MOVs with your *Hitchiker.* They are un-polarized so you may connect them without regard for position or orientation.

Figure 2 shows a simple "lossy" bridge circuit for forward and reverse momentary operation of a small motor such as the zoom and focus motors found in some
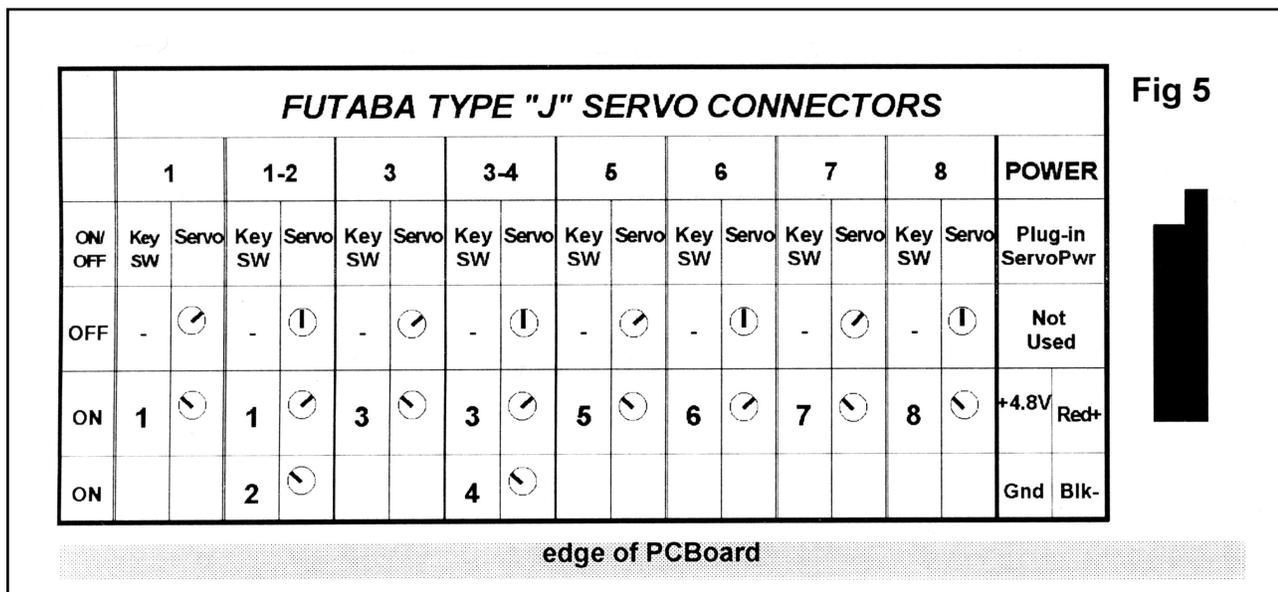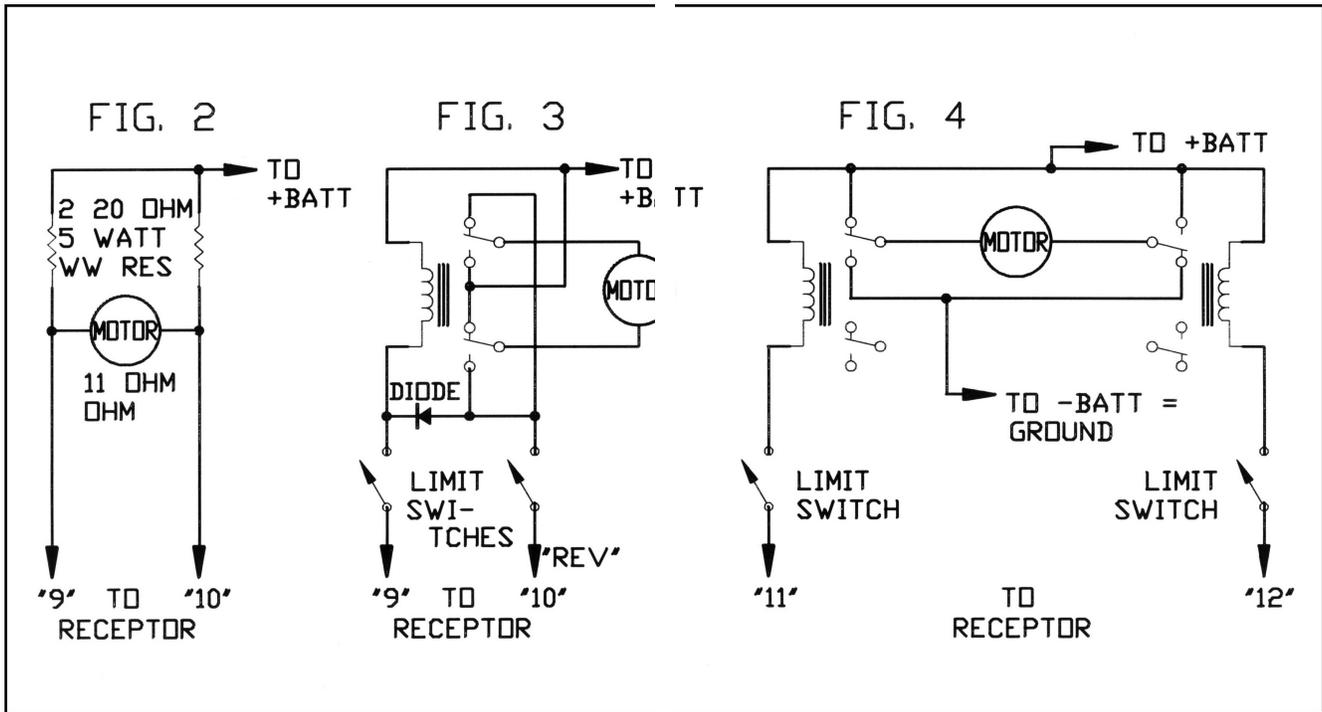
FUTABA TYPE "J" SERVO CONNECTORS — Fig 5

		1		1-2		3		3-4		5		6		7		8		POWER	
		Key SW	Servo	Key SW	Servo	Key SW	Servo	Key SW	Servo	Key SW	Servo	Key SW	Servo	Key SW	Servo	Key SW	Servo	Plug-in ServoPwr	
ON/OFF	OFF	-	⟲	-	⟳	-	⟲	-	⟳	-	⟲	-	⟳	-	⟲	-	⟳	Not Used	
	ON	1	⟲	1	⟲	3	⟲	3	⟲	5	⟲	6	⟲	7	⟲	8	⟲	+4.8V	Red+
	ON			2	⟲			4	⟲									Gnd	Blk-

edge of PCBoard

FIG. 2   FIG. 3   FIG. 4

FIG. 2
TO +BATT

2 20 OHM
5 WATT
WW RES

MOTOR

11 OHM
OHM

'9' TO '10'
RECEPTOR

FIG. 3
TO +BATT

MOTOR

DIODE

LIMIT SWI-TCHES

'9' TO '10'
RECEPTOR   'REV'

FIG. 4
TO +BATT

MOTOR

TO -BATT = GROUND

LIMIT SWITCH   LIMIT SWITCH

'11'   TO   '12'
RECEPTOR

video cameras. The resistors provide automatic current limiting and un-equal resistor values can be used for different forward and reverse speeds. Experimentation is required but for a 12V battery bridge resistors should be greater than 15 ohms; 24V battery - 30 ohms. Put a MOV across the motor brushes.

To maintain satisfactory R/C operation select quality motors whose RFI qualities are known from past R/C applications. Some situations may require RF chokes in series. Don't use toy motors with metal brushes or automobile-type horns because these devices generate horrific RFInterference.

Relays may be used to amplify the current capacity or provide handy operating logic such as reversing high current motors. Use MOVs across their contacts to minimize RFI as well as in parallel across the coil for spike suppression. Additional MOVs are available from **VANTEC** or Radio Shack. Use AC types rated for 30-50 volts such as Panasonic ERZ-V05D390.

Figure 3 shows efficient operation of reversing motors up to 5 amps using a single 5 amp relay and 5 amp diode from Radio Shack. If your application runs into a physical stop use the limit switches shown to prevent dangerous stalled motor operation. For limit switch installations you can have automatic reverse/return by connecting wire "REV" to ground instead of a Receptor output, omit diode, (saves a KeyKoder channel too). Don't forget the MOVs.

Figure 4 shows the use of relays to operate much larger motors, over 4 amps. In this circuit the limit switches need only be capable of handling the relay coil current.

Use MOVs.

If the Receptor fails to receive KeyPad signals it uses the old information for a brief time and then enters a fail safe mode. In the fail safe mode all electronic switches are turned off except KCh14 & 15 which maintain their last state. You could use KCh14 to command lighting since your vehicle could be at rest but illuminated with the transmitter turned off; great for preventing runway collisions at night or dinner flotillas.

KH16R and **KH32R** Receptor power wiring is through the 18 station plug-in terminal block. The ground circuit which supports these electronic switches-to-ground must be substantial since *all* the current for *all* of your loads passes through it; up to 5 Amps for each one. Use a suitable gauge for the ground wire to support your switch loads; AWG#16 for the full capacity. The ideal power supply for the unit is +12VDC connected to the + terminal of the terminal block .+.   The power input range on the + terminal may by 4.8-30VDC.   When power is not supplied to the + terminal block then power and ground for the Receptor will be derived automatically from the 4.8VDC power input for the *Hitchiker* "J" style connector; the 9th one labeled "Bat". This is less desirable due to increased current drain. Power may be supplied to both the terminal block + and "J" style. The "J" style +4.8 will run the servos and the terminal block + will power the internal circuitry.

KH716 or KH732 OPERATION: Extend transmitter antenna fully. Interference from regular servo data sent by other PCM1024, AM or FM transmitters on your frequency, although guarded

against, can occur to the *Hitchiker* channels or regular servo channels. This can be avoided by proper frequency control protocol and turning on your transmitter first, then your model. Reverse procedure for powering down. For secure channels and a truly unique transmitter identification code ask about our industrial strength **Kommander Keykoder** systems.

When purchased as a complete system the KeyKoder comes installed and includes a minor internal modification to the FP7CAP transmitter and sometimes the receiver. If your components require modification VANTEC will do it or supply instructions to a qualified technician in your area. We do not recommend customers modify the equipment.

KH712 system:
The Airplane **KH712** system is configured differently from the 16 and 32 channel boat and robot systems. Although the transmitter still uses the **KH16T** Keypad only 12 switches are effective. Switches 1 through 8 on the **KH16T** KeyPad generate only Servo Command Pulses and switches 13, 14, 15, and 16 are the electronic switch outputs on the Receptor. The KH12R companion Receptor doesn't use an 18 pin plug in terminal block. Instead it uses a pin-post

connector 2 X 5 array, sometimes called a .1" header, labeled as Power/Switch Pairs. Mating connector pairs with pigtail wires are included. The outputs 14, 16, 15 and 13 are the right 4 pairs. Each pair consists of an electronic switch output and it's corresponding ground. Be sure to connect each output ground wire to the negative of the battery used to power that channels device. Usually in aircraft applications the same battery is used for all devices.

The left-most pair of the Power/Switch Pairs is the preferred power input connection for the **KH12R**. The ideal power supply for the **KH12R** is +12VDC connected to this pair's +D pin-post, with the negative connected to the pairs ground pin. The voltage input here may range from 4.8-30VDC. When or if power is not supplied to +D pin post then power and ground for the Receptor will be derived automatically from the 4.8VDC power input for the *Hitchiker* servos "J" style "Bat" connector.

The *Hitchiker* is comes with a limited one year warranty based upon a fixed repair charge for units not tampered with, imersed or electrically or mechanically abused. Call before returning unit for repair. These products are not safety devices nor for use in life-critical or life-support systems. Specifications and prices subject to change without notice. Patents and patent pending may apply. Some trade names and trademarks owned by others.

THE PCM ADVANTAGE

Early R/C transmitted each channels servo position as an analog pulse width that ranged from 1-2 milliseconds. The pulses were transmitted as a continuous Radio Frequency energy carrier with their beginning and end marked by Amplitude Modulating the RF carrier "off" for 0.35 ms. The channels were sent sequentially with the .35ms end mark of one serving as the beginning mark of the next channel. A special long pulse delineated the beginning of the channel series, called a Frame. The receiver used the marks to determine the channels, otherwise the receiver was dumb. Any noise or interference in the "air" was interpreted as a marker pulse and mis-commanded the servos because the receiver couldn't tell the difference. FM versions suffer the same problems.

The Pulse Code Modulation receiver is smart; it contains a microprocessor. By clever structuring of the servo commands using mathematics and precise timing PCM facilitates accurate reception even with severe noise or interference.

It begins in the transmitter by conversion of each joystick position into a 10 bit digital word plus bits to enable the receiver to mathematically verify the word. The next trick of PCM is to compact this data representing 1024 servo positions/channel into the FCC specified radio bandwidth while maintaining responsive "real time" control to fly a helicopter. The PCM data is transmitted synchronously; each bit has a particular position in time, within the Frame. The Frame continuously repeats. A precision crystal controlled clock in the receiver locks onto the transmission to maintain synchronization with the data bit by bit even during major signal drop outs. Thus the receiver can process data immediately after interference instead of waiting for a Framing pulse.

Received data is evaluated channel by channel. When the mathematics indicates an error, previously validated channel data stored in the smart microprocessor is substituted. If an error persists then failsafe servo operations previously specified by the operator are initiated until accurate commands are again received. The microprocessor converts the proper data into pulse widths to command the servos. No more servo jitters!

Futaba's scheme gives 8 channels of 10 bit resolution. Other competitive systems limit the resolution of some channels to 8 bits; 1/4 as accurate.