

Introduction

The **Timpdon Electronics** GigaRad model railway radio control system represents a radical departure from the more conventional form of model radio control. GigaRad is a complete, integrated control system comprising radio transmitter, radio receiver and a range of controllers to suit almost any type of application.

It has been developed from the earlier, successful UltraRad radio control system, which has now been available for a number of years.

The main differences between GigaRad and conventional radio control are:

- J It operates in the 2.4 GHz radio controlled model frequency band for licence exempt devices and complies with all UK legislation for licence free operation. Note, however that licence free operation in this band may not be legal in other countries.
- J The use of the 2.4 GHz band gives a number of advantages. It permits a greater transmitter power, giving increased range and a higher data transfer rate resulting in lower latency and faster performance.
- J It uses advanced data transmission and modulation systems, with in-built error checking to provide reliable and error free transmission. An operating range of up to 100 metres can be reliably achieved in a normal model or garden railway environment.
- J It uses a single type of transmitter, operating on a single frequency, with a very low duty cycle and an average latency of 25 ms.
- J All transmitters and receivers are identical. All calibrations are performed from the transmitter and calibration data is stored within the receiver/controller, permitting any vehicle to be controlled by any transmitter without adjustment or calibration.
- J Each transmitter controls one analogue speed channel, a digital forward/reverse/stop channel and four digital auxiliary channels for the control, for example, of horns, sound cards and lights.
- J All transmitters have a one or more unique ID numbers, and a controller will respond only to a single transmitter to whose ID number it is bound. Any controller can be bound to any transmitter at any time by the user, from the transmitter, without any need for access to the vehicle.
- J Multiple transmitters can be operated in close proximity at the same time without interference or loss of performance.
- J Control information is transmitted as a serial, encoded binary data stream including speed setting, direction control and auxiliary control information, together with synchronising, data validation and transmitter serial number information. This data is decoded by the receiver/controller and used to control the vehicle either via an external electronic speed controller, in the case of battery electric controllers, or via conventional radio control servos in the case of live steam controllers.

This technical note describes, in outline, some of the technical features of the GigaRad system. For more detailed information on individual system components, reference should be made to the user manuals for each component.

System Components

At present, the GigaRad range comprises the following components:

GigaRad Vehicle Speed Control System

Radio Transmitter	Model GTX1	For battery electric and live steam vehicles
Multi-Channel Radio Transmitter	Model GTX2	For battery electric vehicles only
Radio Receiver/Controller	Model GRX1	For battery electric vehicles
Radio Receiver/Controller	Model GRX2	For live steam vehicles fitted with separate servos for regulator and reverser
Radio Receiver/Controller	Model GRX3	For live steam vehicles fitted with a single servo for both regulator and reverser
Radio Point Controller	Model GRX4	Single point controller, using standard RC servo as point motor, controlled by any transmitter Auxiliary switch
Radio Servo Controller	Model GRX5	Single servo controller, using standard RC servo as point motor, controlled by any transmitter Auxiliary switch, primarily for control crossing gates, barriers and semaphore signals.
High Frequency [20 kHz] PWM Speed Controller	Model GSC2	20 kHz ESC for battery electric vehicles Suitable for coreless motors.
Frequency [20 kHz] PWM Speed Controller	Model GSC3	20 kHz ESC for battery electric vehicles Suitable for coreless motors. Automatic Directional Lighting Outputs. Supply voltages up to 24 V.
Auxiliary Controller	Model GAC1	Optional additional unit for the control of High lights, horns, sound cards or other switched auxiliaries

Radio Transmissions

In the GigaRad system, radio control data is transmitted as a binary serial data packet comprising a total of 3 bytes. These are formatted as

1 byte	Speed Setting Data
1 byte	Reverser Setting Data
1 byte	Serial Auxiliary Setting Data

The transmitter is energised only for the duration of transmission of each data packet.

The length of an individual data packet transmission is just under 0.5 ms, and data packet transmission is repeated 40 times per second, giving a total transmission duty cycle of approximately 2%, thus permitting operation by a number of transmitters on the same frequency at the same time without mutual interference.

Receiver/Controller Data Decoding

Each data packet received is initially validated for Transmitter ID, and data integrity. Only valid data packets from the transmitter to which the receiver is bound are accepted and passed to the controller.

Within the controller, the received data is decoded and converted to the output format required for the individual controller type. In addition to speed and reverser outputs, which vary depending upon whether the controller is designed for battery electric or live steam vehicles, all controllers also have an additional serial data output which re-transmits all speed, reverser and auxiliary data received from the transmitter.

This output is used by any optional auxiliary controller fitted to the system for the control of, for example, lights, horns and sound cards, and is also available for future system expansion.

Transmitter Binding

As described above, a GigaRad controller will respond only to transmissions from a GigaRad transmitter with a single serial number to which it has been bound. All GigaRad transmitter ID numbers are unique, and are embedded during manufacture.

Binding is performed from the transmitter only, and no access to the receiver/controller is required. The user may rebind a receiver/controller to a different transmitter at any time using a simple procedure.

Once bound to a particular transmitter, the receiver/controller will remain bound to that transmitter, until re-bound to another.

Multiple Transmitter Operation

All GigaRad transmitters operate on the same frequency. However, because data is transmitted in short packets at relatively long intervals, multiple GigaRad systems can be operated in close proximity, at the same time, without mutual interference, because:

-) Each controller will react only to transmissions from the transmitter to which it has been locked.
-) Each transmitter operates at a maximum duty cycle of less than 2%. Thus there are ample gaps for other transmitters to occupy.
-) In addition a random jitter of up to +/- 2 ms is applied to the average transmission interval of 25 ms to ensure that even if two transmitters conflict on one data packet, resulting is loss of packet detection, they will not on the subsequent packet.

Fail Safe

As data transmission in the GigaRad system is not continuous, normally a controller will not change its output until a new valid data packet is received. This has safety implications, however, in the event of loss of radio transmission and could result, for example, in a vehicle running at full speed with no means of stopping it.

To protect against this condition, all GigaRad controllers are equipped with a fail safe mechanism. If, at any time, a period of 10 seconds elapses with no valid transmitted data packet being received by the controller, the output of the controller is automatically set to zero speed, to bring the vehicle to a halt. This condition will only be over-ridden when radio communication is re-established and a new valid data packet is detected.

At special request and to special order, Timpdon Electronics can supply all GigaRad receiver/controller models with the fail safe disabled, to accommodate users who wish their vehicles to continue in normal operation in the absence of a valid radio transmission. Please note, however, that such removal of a safety system is entirely at the user's own risk and Timpdon Electronics will not accept liability for any consequences.

Interference from Non-GigaRad Radio Systems

The 2.4 GHz band used by the GigaRad system is not a dedicated model radio control band. It is used in addition by many other short range radio systems, including WiFi and many computer peripherals.

Because of the coded nature of GigaRad transmissions, there is no possibility of unsafe operation of a vehicle from some other transmission. At worst, interference will prevent valid data being received by an GigaRad controller which will result only in the vehicle being stopped.

The frequency used in the GigaRad system has been deliberately chosen to be as far as possible from other common interference sources within the 2.4 GHz band.

Extensive tests in typical model railway environments have shown no evidence of interference from other users of this band, although you should be aware that, if your system is used in close proximity to other high power equipment operating at the same frequency, problems may be encountered occasionally.