Reverser Operation

The reverser relay will change state only when the required direction of travel is changed from **forward** to **reverse**, and vice versa. It will not change state when the speed demand is reduced to **zero** in either direction.

The relay state will only be changed when the motor output voltage has been set at **zero** [**Stop**] for a period of at least one second. If a direction change is requested directly from **forward** to **reverse**, or vice versa, the motor voltage will be immediately set to **zero**. After a 1 second delay, to permit the motor current to die away and for the motor to stop [hopefully], the relay state will be changed, and the motor voltage then ramped up to the new demanded level, set by the transmitter speed control.

Warning:

There is no protection against reversing motor direction other than this 1 second delay, and the **rate limit** function described below, as it is not possible to determine whether the vehicle has actually stopped.

On a vehicle with high inertia, caution must be exercised when changing direction to ensure that it has first come to a standstill, as applying high reverse voltage to a motor that is still rotating may result in very high motor currents. The residual motor back e.m.f., proportional to its rotational speed, will no longer be opposing the applied motor voltage, but adding to it, possibly leading to motor currents significantly higher than rated motor stall current.

Under worst case conditions, this could result in catastrophic damage to both the ***GSC4*** and the motor itself.

Rate Limit

To minimise physical stress on the motor and vehicle drive system, motor voltage changes for **increasing** speed are automatically rate limited to a maximum increase of 2% of full motor voltage every 20 ms.

This corresponds to a minimum period to reach full motor voltage, for a step change in demand from **zero** to **full speed**, of 1 second in both **forward** and **reverse**.

For a **reduction** in speed demand, there is no rate limit, and output voltage changes will follow the demanded level immediately.

Timpdon Electronics

24 V High Frequency Speed Controller Model *GSC4*

Speed Controller Model ***GSC4*** is a miniature 20 kHz, high frequency PWM motor speed controller for battery electric vehicles, designed to be used with any standard radio control system.

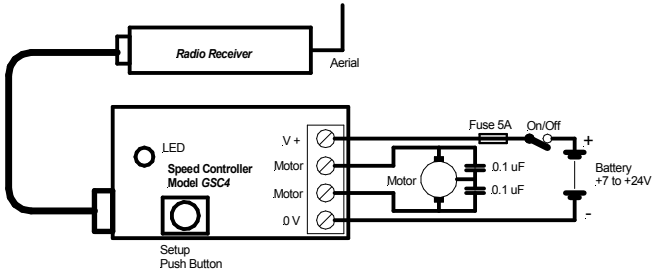
It is suitable for use with modern coreless motors.

It is suitable for use with battery supplies up to 24 V, nominal.

Features

- 20 KHz, bi-directional PWM motor speed controller. High frequency eliminates motor whine.
- Suitable for control of any permanent magnet d.c. motor type, including coreless motors.
- Connects directly to any standard radio control receiver.
- Ideal for use with *Timpdon Electronics* ***GigaRad*** radio system.
- Battery voltage range — 7 to 24 V nominal, d.c.
- 2 A maximum continuous motor current.
- Incorporates 250 mA BEC to provide power to radio receiver and auxiliaries.
- Screw terminals for external motor and battery connections. Flying lead for connection to radio receiver.
- Speed control calibration facility, to match any RC transmitter.
- Three user selectable operating modes, Standard and two shunt modes, for precise low speed shunting control.
- Small Size: 45mm x 23mm x 11 mm

Installation and Wiring



Notes

1 Connect the **V+** terminal to the **battery positive** and the **0V** terminal to the **battery negative**. Connect the two **motor** terminals to the motor. Keep the motor leads as short as possible and ideally twist them together, to minimise electrical interference.

If, on testing, the direction of travel is opposite to that you expected, reverse the **motor** connections at the terminal block.

2 **Take care with the battery polarity**. The ***GSC4*** is **not** protected against reverse supply polarity.

Reversed polarity will result in very high currents and may damage the ***GSC4*** and the radio receiver. You are recommended to fit a 5A fuse in the positive battery lead for protection.

3 Fit a power **on/off** switch in the **battery positive** supply lead. Remember the ***GSC4*** and the radio receiver use power even when the speed is set to zero. The quiescent current is approximately 20 mA plus an additional 25 mA when the reverser is set to the **reverse** position.

4 Plug the flying lead into the required channel of your radio receiver. Make sure that the polarity is correct. The **black** wire is the 0V connection. With a standard radio transmitter, you are recommended to use a channel with a spring loaded, centre off joystick.

5 Two 0.1 µF motor suppression capacitors are supplied loose with the ***GSC4***. These capacitors should be connected **directly** to the motor terminals to suppress electrical noise generated by the motor. Connect one capacitor between each motor terminal and the metal body of the motor.

Calibration Procedure

continued

7 Provided that you have set valid joystick positions for each of the three calibration stages, the ***GSC4*** will now automatically compute the new calibration settings and save them to non-volatile memory. The ***GSC4*** will then restart automatically, as if power had just been applied, with the new settings operational.

8 If you have attempted to set an invalid value in any of the three calibration stages, then after **Step 3**, the ***GSC4*** will automatically return to **Step 1**. Once in **Transmitter Speed Setting Calibration** mode, there is no exit until a valid calibration has been performed, except power off. If you power off whilst in calibration mode, no changes to the original calibration will be made.

To Change the Operating Mode

The Operating Mode settings can only be changed during normal operation, with the speed set to **zero**. The **LED** will be flashing in groups of **one**, **two** or **three** pulses to indicate the current selection:

- Single Pulse **Standard Mode**
- Two Pulses **Shunt [1] Mode**
- Three Pulses **Shunt [2] Mode**

Procedure

1 Ensure that the speed is set to **zero**, and that the **LED** is flashing as described above.

2 **Press** and **hold** the **setup push button** for 3 seconds, until the **LED** state changes from **flashing** to **fully on**.

3 Then release the **setup push button**. The Operating Mode will change to the next mode, and the **LED** Flash sequence will indicate the new mode. After **Shunt [2]** mode, the mode will revert to **Standard**.

4 Repeat steps **2** and **3**, if necessary, to achieve the required mode.

Once selected, the current Operating Mode is stored in non-volatile memory and will remain valid until changed again.

To Program the Transmitter Speed Calibration Settings

The transmitter speed calibration settings can only be changed immediately following power up of the ***GSC4***. Once set, the calibration is retained in permanent memory within the ***GSC4*** and should not need changing again for the same transmitter.

Calibration Procedure

1 Power up the transmitter.

2 Then power up the receiver and ***GSC4***. The ***GSC4*** **LED** will flash for 3 seconds. During this period, press and release the **setup push button** on the ***GSC4***. The **LED** will go **off**.

3 If necessary, wait until the transmitter has bound to the receiver.

As soon as the transmitter has bound, the ***GSC4*** will enter **Calibration Step 1**, and the **LED** will begin to flash.

Calibration Step 1— Stop Setting

The **LED** will flash slowly, with an **On:Off ratio = 1:1**

4 Set the transmitter joystick to its **Zero Speed** position.

Then **press** and **release** the **setup push button**.

Calibration Step 2— Full Forward Setting

The **LED** will flash slowly, with an **On:Of ratio = 7:1**

5 Set the transmitter joystick to its **Full Forward** position.

Then **press** and **release** the **setup push button**.

Calibration Step 3— Full Reverse Setting

The **LED** will flash slowly, with an **On:Of ratio = 1:7**

6 Set the transmitter joystick to its **Full Reverse** position.

Then **press** and **release** the **setup push button**.

Operation

1 Ideally, energise the transmitter first.

2 Then energise the ***GSC4*** and receiver.

3 The **LED** on the ***GSC4*** will flash rapidly for three seconds. During this period **only**, you can enter **Transmitter Setup mode**, to calibrate transmitter speed control settings, by pressing and releasing the **setup push button**. See below for details.

4 After three seconds, the **LED** will go **off**, indicating that the ***GSC4*** is ready for normal operation. However, if you are using standard 2.4 GHz radio equipment, you will need to wait until your radio receiver has bound to the transmitter before normal operation is possible. This may take up to ten seconds.

5 For safety, on power up, the motor can not be energised until the transmitter speed setting control has first been set to **zero** speed. This feature is designed to prevent the loco taking off unexpectedly on power up.

6 The ***GSC4*** incorporates **three** user selectable operating modes to permit the relationship between the setting of the transmitter speed control and the motor output voltage to be selected to match the operational requirements of your vehicle, particularly in providing more precise control of low speed shunting.

The current operating mode is indicated by the **LED**, at **zero** speed only, which will flash in groups of **one, two or three pulses** to indicate the current mode:

- ♦ Single Pulse Standard Mode
- ♦ Two Pulses Shunt [1] Mode
- ♦ Three Pulses Shunt [2] Mode

See below for details of the characteristics of each operating mode, and how to change the current mode.

7 Whenever the motor output is at 100% [full battery voltage], in either **forward** or **reverse**, the **LED** will illuminate continuously.

Operation continued

8 The action of the ***GSC4*** if radio communication is lost will depend on the radio system you are using:

- If loss of radio communication results in the loss of control pulses from the receiver, as is common with 27 MHz and 40 MHz radio systems, the ***GSC4*** will maintain the motor speed at the last valid received setting indefinitely.

- If loss of radio communication does not result in the loss of control pulses from the receiver, as is common on 2.4 GHz radio systems, the action of the ***GSC4*** is governed by the radio system in use. The motor speed may be maintained indefinitely at the last valid received setting, or an automatic fail safe system within the radio system may set the motor speed to a default fail safe level after a delay. Refer to the instructions for your radio system.

- If you are using the ***GSC4*** with a *Timpdon Electronics* ***GigaRad*** system, the motor speed will be set to zero if radio communication is lost for a continuous period of 10 seconds. Until that time, it will maintain the last valid received setting.

User Programmable Functions

The ***GSC4*** has two separate functions which are individually programmable by the user:

- Transmitter Speed Calibration Setting
- Operating Mode Selection

Transmitter Speed Calibration Settings

When shipped from the factory, the ***SC2A*** is calibrated to the following standard speed channel servo pulse width settings:

- **Full Reverse** 1.00 ms
- **Zero speed** 1.50 ms
- **Full forward** 2.00 ms

These values can be changed by the user to compensate for difference in the outputs of a particular transmitter, both to set the **zero** speed output and to set the **maximum** speed in both **forward** and **reverse** to correspond to 100% of battery voltage.

When used with a *Timpdon Electronics* ***GigaRad*** radio system, you should not need to change this setting, as the ***GigaRad*** transmitter and receiver are accurately calibrated to nominal values during manufacture.

Operating Mode

The Operating mode of the ***GSC4*** can be changed by the user to match the operational requirements of the vehicle in use, particularly with respect to its low speed shunting performance.

Any one of three modes can be selected, shown graphically below:

Standard Linear control of motor voltage between **zero** and 100% of battery voltage as the transmitter speed control is moved from **zero** to **maximum**.

Shunt [1] Non-linear control of motor voltage between **zero** and 100% of battery voltage as the transmitter speed control is moved from **zero** to **maximum**, with reduced output at lower speed settings. The first 50% movement of the transmitter speed control gives an output motor voltage of up to 25% of battery voltage.

Shunt [2] Linear control of motor voltage between **zero** and 50% of battery voltage as the transmitter speed control is moved from **zero** to **maximum**.

The ***GSC4*** is shipped from the factory set to **Standard** mode.