Sig-naTrak®
Model railway electronics

IMP DIGITAL SERVO CONTROLLER

(Part no: DSI1001)

FULL USER GUIDE

GFB Designs - WE put YOU in control!

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WARNING

- The human body can generate static electricity which can damage electronic equipment – AVOID TOUCHING THE PINS OF THE *IMP*'S CONNECTORS!
- For INDOOR use only.
- The *IMP* is not suitable for use by children under 14 years of age unless supervised by an adult.

1) GETTING STARTED - FAMILIARISATION

Refer to Fig. 1

The *IMP* operates a model control *servo*, between two preset *endpoints*, using either *digital command control* (DCC), or "analogue" operation using a DC supply. The *transit speed*, to each endpoint, can also be set and semaphore signal "bounce" can also be simulated.

Servos – originally designed for model radio control systems – provide mechanical motion in the form of a rotating *output arm*. This arm rotates, through a total angle of around 90 degrees, in response to a series of electrical pulses with the exact position of the servo's output arm being determined by the width of the pulses. Layout accessories - such as semaphore signals or level crossing gates – can, therefore, be controlled by electrical means using a servo.

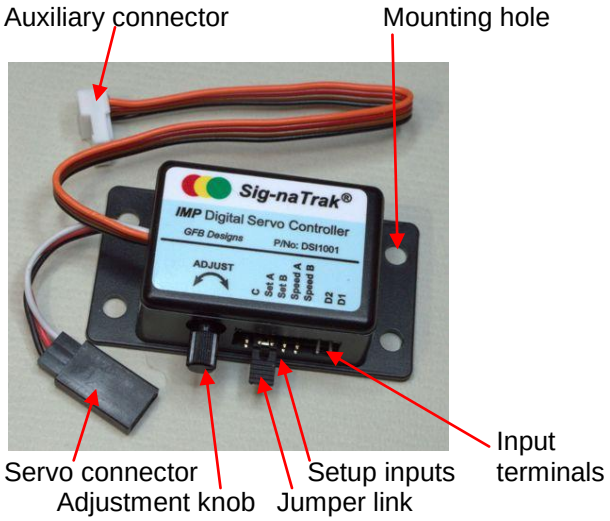


Fig.1: *IMP* Overall View

The complexity with servo control arises with the generation of the electrical pulses because a dedicated piece of electronic circuitry is usually required. The *IMP* takes care of this process whilst providing power to the servo.

Many modellers also use servos for point (turnout) operation and the IMP/servo combination can be used in this application. However, it is probably worth considering the use of a dedicated point (turnout) motor for this purpose and we would recommend our GEM Digital Point Actuator (part no: DPD2001) if slow motion operation is not required.

1.1) Wiring and Connector Information – see Fig. 1

The *input* terminals are on the 2-pin connector at the right-hand end of the slot in the case side, as follows:-

	"D1"	- **Power**, or **DCC**, input
	"D2"	- **Power**, or **DCC**, input

The *setup* inputs are on the 5x2-pin connector in the slot in the case side, as follows:-

Top row, left-to-right -	"C"	- **Control** input for manual override or *In-Situ Setup*
	"Set A"	- Connect this pin to *ground* to set **endpoint A**
	"Set B"	- Connect this pin to *ground* to set **endpoint B**
	"Speed A"	- Connect to *ground* to set the transit **speed** to endpoint **A**
	"Speed B"	- Connect to *ground* to set the transit **speed** to endpoint **B**
Bottom row -	"G" (x5)	- **Grounds** or *common returns* for the "C" input and setup inputs

Servo outputs are on the shorter, 3-wire, lead and are:-

"S"	- **Signal**, or pulse train, to drive the servo
"5"	- **+5volts** power
"G"	- **Ground** or 0V

Auxiliary outputs are on the longer, 4-wire, lead and are:-

"5"	- **+5volts** power output
"A"	- Output indicating "endpoint **A** reached"
"B"	- Output indicating "endpoint **B** reached"
"G"	- **Ground** or *common return* for "A" and "B"

The current that the *IMP* draws from your layout varies but it will be no more than **20mA** (0.02A) when *idling.* Operating current – i.e. when moving the servo between endpoints – will depend upon the type of servo used and upon the mechanical load placed on the servo. The IMP can supply a maximum of **1A** (amp) to the servo.

1.2) Connecting Power

The IMP is connected to your power supply, or DCC system, via the "D1" and "D2" terminals on the *input connector*.

WARNING

- **TURN OFF power to the *IMP* before making or modifying any electrical connections!**
- DO NOT make any electrical connections other than those specified in this manual (or otherwise recommended by *GFB Designs*)!

We have aimed to minimise the amount of soldering required, when wiring the *IMP* within your layout, by supplying an *insulation displacement* (IDC) connector. Blades in this connector automatically pierce the outer sheath of a wire when it is pressed into the connector shell and, therefore, no soldering or wire stripping is required. HOWEVER, you must use the correct size of wire which is stranded ***7/0.2mm*** type. This is commonly supplied by most model retailers and is available from *GFB Designs* – part number: EW007215 (black) or EW207214 (red - see our website for other colours).

If you are using DCC, and you have a number of *IMP*s on your layout, you can run a pair of 7/0.2mm wires around your layout and press multiple IDC connectors onto the wires as/where required. This is known as a "bus" arrangement and is shown in fig.2a below. Otherwise, each IMP may be supplied from its own short pair of 7/0.2mm wires which are then connected to either a main "bus" or the track. Figs. 2b and 2c show these alternative schemes.

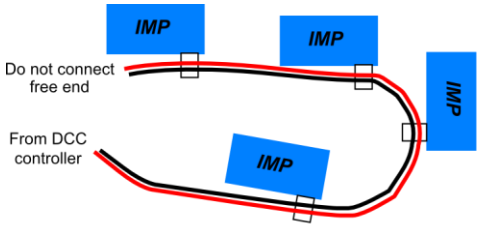


Fig. 2a: Accessory bus connection

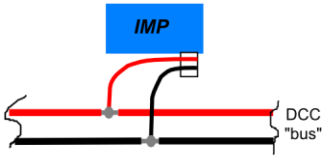


Fig. 2b: Main DCC bus connection

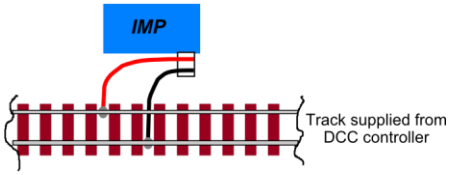


Fig. 2c: DCC power from track

Fitting the IDC Connector

Carefully press two wires into the connector as shown in fig. 3. Press repeatedly in all 6 positions until both wires are fully and evenly seated. A blunt tool - e.g. Allen key - no larger than 1mm dia., should be used taking care not to damage the metal blades in the connector. Alternatively a special tool, part number HT110031, is available.

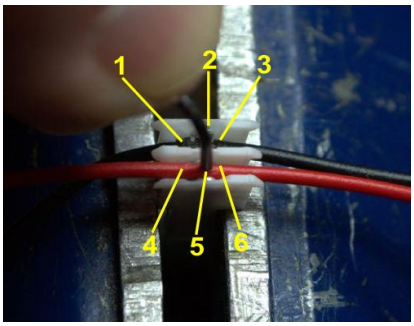


Fig. 3: Fitting the IDC connector

1.3) Connecting the Servo

Servos are supplied with a 3-way socket which mates with the servo connector on the IMP (at the end of the 3-wire, shorter lead). We recommend the use of our RCS0009 servo as this unit is compact and inexpensive. Also, although it is manufactured in the Far East, it complies with the relevant European regulations.

Servos other than the RCS0009 may be used with the IMP, provided that they draw less than 1amp of current, but be aware that some servos "glitch" severely when power is first applied. This could cause problems if you are controlling a delicate accessory – for example a "scratch-built" semaphore signal.

NOTE that the RCS0009 servo does not have a polarising key on its socket and it can be inserted into the IMP's servo connector either way round. Fig. 4 shows the correct orientation. (Incorrect orientation will not cause damage but the servo will not operate)

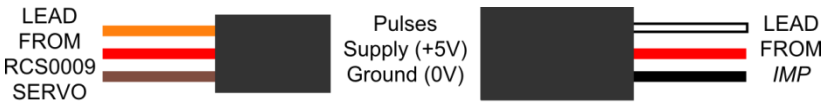


Fig. 4: Servo connector orientation

The wire colours may vary with other servos but the ground, or 0V, wire will usually be black or brown. Some servos have a polarising key on their sockets which mates correctly with a notch on the IMP's connector.

1.4) Using DC ("analogue") Power

The IMP automatically senses its power source so it will operate from a direct current (DC) power supply with the addition of a switch to control the servo position (provided that configuration variable *CV2* has not been changed under DCC programming – see page 14).

As shown in figs. 5&6, a power supply must be connected to the "D1" and "D2" terminals through a *double-pole-double-throw* (DPDT) switch. The requirements of the power supply are:-

- It must produce **smooth** *direct current* (DC).
- Normal voltage between 9 to 18 volts.
- DO NOT EXCEED 25 VOLTS UNDER ANY CIRCUMSTANCES !!
- Available current 0.25amp (250mA) for each IMP and servo supplied.

Model train controllers or older transformers are NOT suitable - we recommend one of the following "wall plug" styles:-

- GFB Designs - part no: PS115017
- Rapid Electronics - stock no: 85-2903
- Maplin Electronics - stock no: L48BL

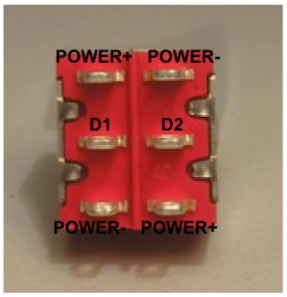


Fig.5: Rear view of a typical DPDT toggle switch (and power connections for the IMP)

The supplies listed above will power up to 4 IMP/servo combinations, depending upon the type of servo used.

Examples of suitable switches are:-

- GFB Designs - part no: SW122031
- Maplin Electronics - stock code FH04E
- Rapid Electronics - stock code 75-0097
- Gaugemaster - stock code GM506

Wiring for DC

Fig.6 shows the overall wiring. The servo position is determined by the *polarity* of the DC power supply – if the "D2" terminal is *positive*, the IMP will drive the servo to endpoint "A". If "D2" is *negative*, it will drive the servo to endpoint "B".

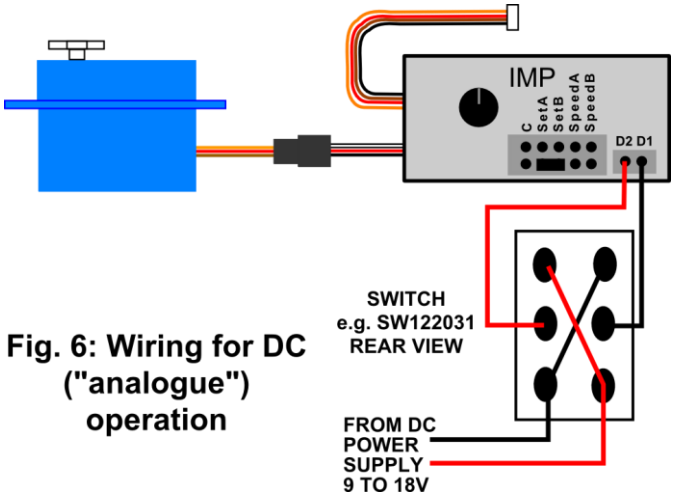


Fig. 6: Wiring for DC ("analogue") operation

Testing with DC

With the unit wired as shown in fig. 6, turn on the power supply. If this is the first time you have applied power to the IMP the servo will, after a short delay, drive to the centre of its travel and then to one of its endpoints (depending upon the setting of the switch).

The IMP "remembers" which endpoint it has commanded the servo to. This means that, on subsequent applications of power, the servo should stay in its previous position PROVIDED THAT:-

- Power was not removed whilst the servo was moving.
- The (DPDT) switch position has not been changed whilst the IMP is not powered.

To operate the IMP…….

Simply change the setting of the switch and the servo will drive to its opposite endpoint. You can reverse the "D1"/"D2" connections from the switch, or change the orientation of the switch in your control panel, if you need to reverse the operating sense.

Consult the "Troubleshooting" section of this guide on page 20 if control can not be satisfactorily obtained.

1.5) Using Digital Command Control (DCC)

This section assumes that you have a DCC system – including a *command station* and *booster* (often combined in one unit) – which is fully compliant with the *National Model Railroad Association* (NMRA) DCC Standards. As all DCC systems vary in their exact operating methods, please read the following instructions in conjunction with your DCC system manual.

DCC Wiring

Fig. 7 shows a basic configuration for operation under DCC where the servo arm position (i.e. endpoint "A" or "B") is selected by sending *accessory* instructions from your DCC *command station*.

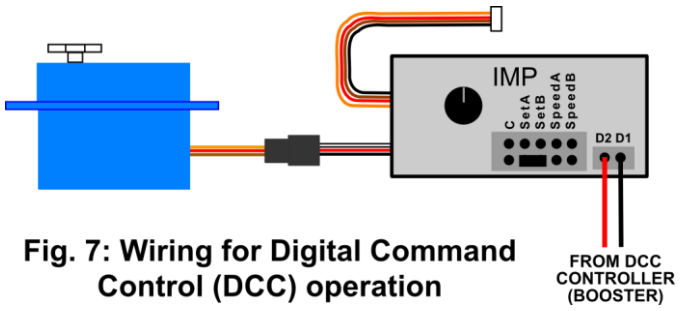


Fig. 7: Wiring for Digital Command Control (DCC) operation

Testing with DCC

With the unit wired as shown in fig. 7, turn on your DCC controller. Upon initial application of power, the servo's output arm should move rapidly to the centre of its range and then stop. (On subsequent applications of power, the servo will maintain its previously-commanded endpoint.)

Refer to your DCC system manual and perform the following actions:-

- Select *accessory* ("point", "switch" or "turnout") NUMBER 1 on the controller.
- Send a single "POINT NORMAL" (or "turnout/switch" "closed/on") command.

The IMP should drive the servo anti-clockwise to endpoint "A" – which is preset at the fully anti clockwise position - and then stop. You will notice that the transit speed, in this direction, is approximately 8 degrees per second.

- Now send a single "POINT REVERSED" (or "turnout/switch" "thrown/off") command.

The servo should drive clockwise to endpoint "B" – which is preset at the fully clockwise position – at about 10 degrees per second.

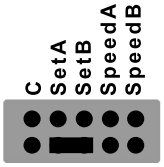
See the "Troubleshooting" section on page 20 if the above actions do not occur.

2) SETTING UP THE *IMP*

The procedures described in the following paragraph, (2.1), work with either DC or DCC power. They are part of the "*In-Situ Setup*" (ISS) process which is described in more detail later.

2.1) Servo Settings

In-Situ Setup utilises the *jumper link* - shown here in its *inactive* position:



By placing the link in one of the following positions, the servo is no longer controlled by DCC commands or the "C" input or the DC power polarity. Instead, the *IMP* runs in *In-Situ Setup mode* and the ADJUST knob can be used to alter the position of either endpoint or the transit speeds, as selected.

The IMP "learns" the setting when the link is removed.

Endpoint "A"

To set endpoint A, move the link to the position shown here:

The servo will follow the movement of the ADJUST knob and its instantaneous position will be stored as "endpoint A" when the jumper link is removed.

Endpoint "B"

To set endpoint B, move the link to the position shown here:

The servo will follow the movement of the ADJUST knob and its instantaneous position will be stored as "endpoint B" when the jumper link is removed.

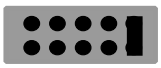
Speed "to A"

To set the transit speed to endpoint A, place the link as shown here:

The speed ("to A") can now be set on the ADJUST knob, between approximately 2 to 500 degrees per second. The servo will not move during speed setting but the ADJUST knob has a thin *index line* moulded into its end (as shown in Figs.6&7) to allow you to estimate the set speed.

Speed "to B"

To set the transit speed to endpoint B, place the link as shown here:



The speed ("to B") can now be set on the ADJUST knob, between approximately 2 to 500 degrees per second. The servo will not move during speed setting.

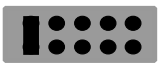
Replace the jumper link to its *inactive* position once you have made the required settings.

"Signal Bounce"

Either: rotate the ADJUST knob fully CLOCKWISE to turn bounce ON.

Or: rotate the ADJUST knob fully ANTI-CLOCKWISE to turn bounce OFF.

Now move the link to the "C" pins as shown here:



Wait for 3 to 4 seconds, then move the link back to its *inactive* position.

(NOTE – the signal bounce feature is available on IMPs with software version 2.1 or later – see page 13)

2.2) Configuring for DCC using “In-Situ Setup”

The National Model Railroad Association defines methods for setting up DCC decoders, by programming *configuration variables* (CVs) in *service mode*. This involves the use of a DCC programmer (usually incorporated within a *command station*) and the technique is not particularly convenient when the IMP is installed on a layout.

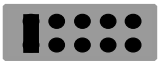
In common with other manufacturers, *GFB Designs* has adopted a simpler approach which is part of the *“In-Situ Setup” (ISS)* mode.

i) **“Signal Bounce” Feature**

This is turned on or off in *ISS* mode.

To turn bounce ON, rotate the ADJUST knob fully CLOCKWISE prior to stage (ii) below.
To turn bounce OFF, rotate the ADJUST knob fully ANTI-CLOCKWISE prior to stage (ii) below.

ii) To enter ISS mode, ensure that the IMP is connected to the “MAIN” (or “TRACK” or “RAIL”) output of your DCC controller – NOT the “programming” output. Turn on your controller and place the jumper link in the “C” position as shown here:



iii) Wait for 3 to 4 seconds. If you wish to change the IMP’s DCC address, proceed to stage (iv) below. Otherwise remove the jumper link and place it back to its *inactive* position.

Address

iv) Send an “accessory” (or “point”/”turnout”/”switch”) command **to the address that you wish the IMP to adopt.**

v) Remove the jumper link and place it back to its *inactive* position. At this point, the IMP stores the DCC address that you used in step (ii) above. Subsequent DCC accessory commands, **to this address**, will operate the servo connected to the IMP in accordance with your chosen endpoint and speed settings.

Operating sense

The operating sense determines in which direction the servo moves for a given command.

In the ***original*** (as supplied) operating sense, a **NORMAL** (or “closed”/”on”) accessory command will drive the servo to endpoint **“A”** and a **REVERSED** (or “thrown”/”off”) command will drive it to endpoint **“B”**.

In the ***alternative*** operating sense, a **NORMAL** (or “closed”/”on”) accessory command will drive the servo to endpoint **“B”** and a **REVERSED** (or “thrown”/”off”) command will drive it to endpoint **“A”**.

vi) To select original operating sense using In-situ Setup, you need to send a NORMAL command in step (ii) above. To select the alternative operating sense, you must send a REVERSED command at step (ii).

3) OPERATING LAYOUT ACCESSORIES

3.1) Example – Semaphore signal

Servos can operate almost any mechanically-moving object on a model railway layout but we have chosen a semaphore signal as an example as this is a popular use for them. The following guidelines should be appropriate for most applications. Fig.8a shows the overall (suggested) setup whilst figs.8b, 8c and 8d focus on the details.

Fig.8a: Semaphore signal operation.

Fig.8b: Servo mounting detail

Mounting the servo

The servo should usually be mounted under the baseboard, out of sight. As we need vertical motion to operate the signal, the servo needs to be mounted on its side and one method – shown in fig.8b – uses a sheet aluminium frame screwed to the baseboard. Simple wooden blocks could also be used.

We recommend that *pilot holes* are drilled into any wooden surface before inserting screws to prevent the wood splitting and so that the screws are accurately located and do not "wander" with the wood grain.

Linkage (to the signal)

"Piano wire" is available from most model retailers and it is used here to mechanically link the servo output arm to the signal mechanism.

This example uses 22gauge (SWG) wire as this can be easily bent into shape using pliers. This type and diameter of wire also exhibits some flexibility which prevents damage to the signal in the case of any "over-travel" on the servo.

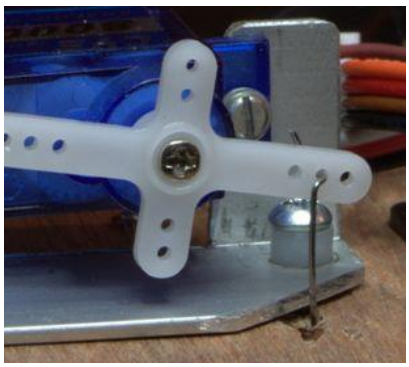


Fig.8c: Linkage to the signal

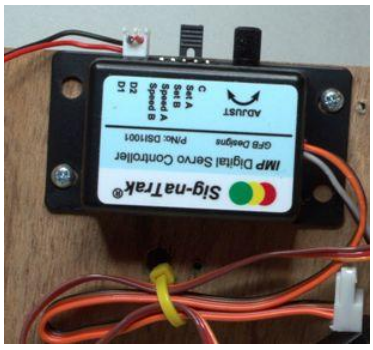


Fig.8d: *IMP* mounting detail

Mounting the *IMP*

The mounting of the *IMP* module is the least critical part of the operation. Ideally, the unit should be positioned near the edge of your baseboard so that the setting-up connector, and adjustment knob, are easily accessible.

Servo extension leads are available, if required (*GFB Designs* part no: WL10300).

WARNING

- **DO NOT** over-tighten the mounting screws as this may crack the plastic case!!

4) GENERAL ADDITIONAL FEATURES (DCC and non-DCC modes)

The IMP incorporates a DCC accessory decoder as defined by the NMRA. It obtains power and control information from your DCC booster via the "D1" and "D2" terminals as indicated in fig. 7. Most DCC accessory decoders will drive up to four devices but, as the IMP is a completely self-contained unit, its internal decoder is dedicated to a single servo.

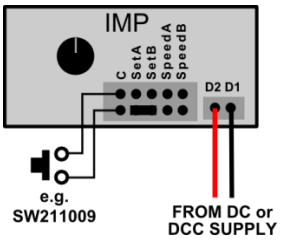
The IMP will "recognise" a valid DCC signal when supplied to the "D1" and "D2" terminals and will run under DCC commands. ***Non-DCC*** mode is automatically entered when the unit is supplied with direct current (DC) and the operation is then as described on page 7. However, non-DCC mode can be disabled as explained in the section on CV2 setting (page 14).

The following features of the IMP work in both DCC and non-DCC modes whilst those in section (5) are applicable to DCC operation only.

4.1) Remote control ("C") input

The "C" input on the setup connector can be used to remotely operate the IMP independently from DCC commands, or as an alternative means of control with a DC supply. Fig.9 below shows how to connect a *normally-open* push-button switch, between "C" and "G", in order to achieve this.

Pressing and releasing the push-button switch will override the last DCC command sent – or the DC input polarity - and will change the servo position to its opposite endpoint.



Suitable switches:-

GFB Designs part no:	SW211009
Maplin stock no:	FH59P
Rapid stock no:	78-0030
Gaugemaster no:	GM516

Fig.9: Adding a push-button switch for remote point operation

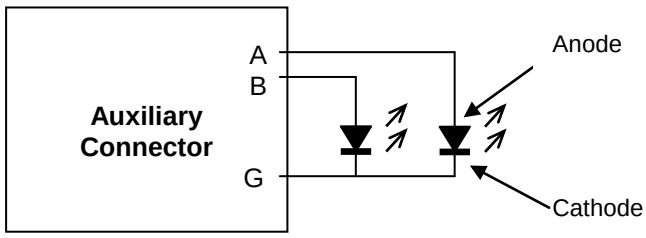
NOTE:-

- DO NOT INTERCONNECT THE "G" TERMINALS BETWEEN TWO OR MORE IMPs.
- The switch must be a ***momentary, normally-open*** type (i.e. spring-loaded to the OFF position).
- Operation from the "C" input can be disabled by changing ***CV2*** – see "CV2 Setting" on page 14.

4.2) Auxiliary ("A" & "B") outputs

Position indication using LEDs

The "A" and "B" outputs will drive *light emitting diode* (LED) indicators which can be mounted on a control panel or track diagram in order to indicate the position of your accessory. Fig.10 shows the required wiring.



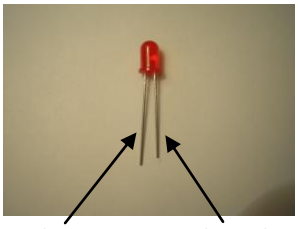


Fig.10a: Connection of LEDs for positon indication.

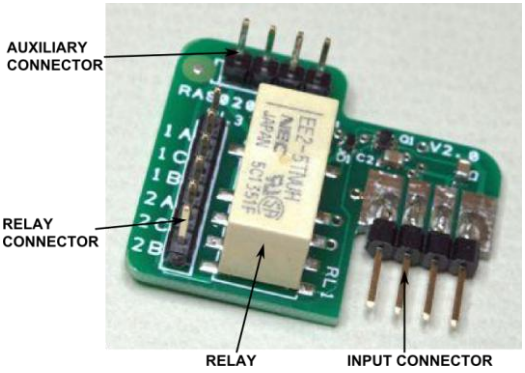
Fig.10b: A typical LED.

NOTE:-

- The “A” and “B” outputs will only supply a limited current (around 8mA).
- The current limiting resistors required for LEDs are built in to the IMP.
- DO NOT INTERCONNECT THE “G” TERMINALS BETWEEN TWO OR MORE IMPs.

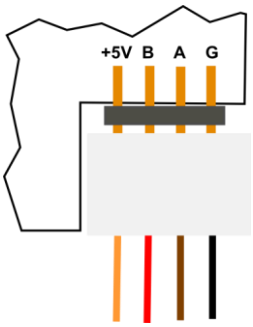
The “A” LED turns on when endpoint A is reached and the “B” LED turns on when endpoint B is reached. Both LEDs are off whilst the servo is moving.

Adding the RAS1202 accessory switch



The RAS1202 uses a *relay* to switch electrical power between two pairs of circuits in accordance with the setting of two low-current inputs. It can be plugged into the *IMP* so that power is automatically switched when the state of the servo is changed. Example applications are:-

- “Live frog” polarity switching on points
- Track power isolation when point or signal is changed
- Automatic signal operation according to point state



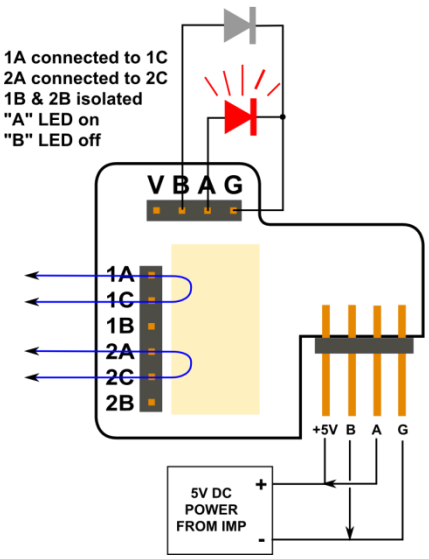
The RAS1202’s *input connector* plugs into the *auxiliary lead* of the *IMP*, as shown opposite.

The RAS1202 can be secured to your baseboard with a double-sided self-adhesive pad.

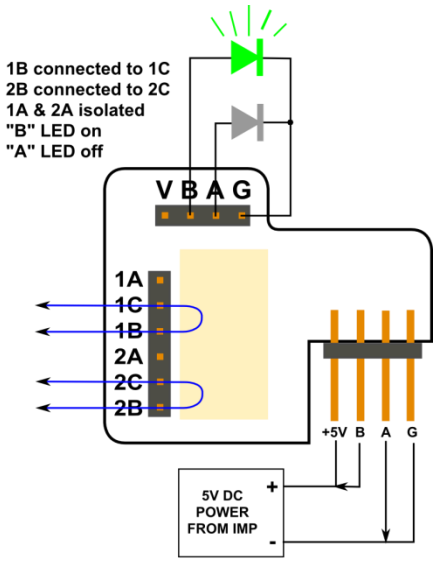
Operation

- The RAS1202 needs a supply of 5volts dc onto the *input connector*. This is supplied from the *IMP*.
- Optional *light-emitting diodes* (LEDs) can be added to the *auxiliary connector* so as to indicate which circuit is active (and, hence, the position of the servo).

Selection of circuit(s) “A”



Selection of circuit(s) “B”



Please see the User Guide supplied with the RAS1202 for further information on how the unit works.

5) ADVANCED DCC OPERATION

5.1) Programming Configuration Variables (CVs)

Configuration variables (CVs) are special numbers stored within the *IMP*'s memory. The format is defined by the National Model Railroad Association (NMRA) Standards. The *address,* operating modes and options of your servo controller can be changed by setting CVs **1 to 6**, **9 and 33 to 80** with the values indicated below – refer to your DCC system manual for details on how to program CVs. Once programmed, a CV will retain its value even when power is removed from the *IMP*.

Note that the *IMP* will normally have CVs changed in *service mode*. This means that its "D1" and "D2" terminals should be connected to the *programming track* output of your DCC controller (or programmer). CVs can also be changed in *operations mode*, with the IMP connected in your layout, BUT only if you have a DCC controller that is capable of sending *operations mode accessory programming* instructions. Currently most DCC systems cannot do this (their *operations mode CV access* capability is restricted to locomotives).

The NMRA has defined four methods of changing CVs in service mode: i.e. *address only, register, paged and direct.* You do not need to understand how these work – you simply need to be aware that the IMP supports all four techniques. Refer to your DCC system manual to determine the most appropriate method. (The *IMP* automatically responds to whichever CV access instructions are received by it).

"Read only" CVs (5, 7 & 8)

The following CVs cannot be changed. They are required by the NMRA Standards and they contain data on the IMP.

CV (or REGISTER) NUMBER	VALUE	DATA (meaning of value)
29 (Register 5)	192	ACCESSORY decoder – OUTPUT address method (single servo) – BASIC addressing ("simple" accessory control) – no bi-directional communication
7 (Register 7)	21	Software version (currently V2.1 at 27 July 2015)
8 (Register 8)	46	Manufacturer I.D. (GFB Designs)

Changing The Accessory *Address* (CVs 1 & 9)

The *IMP* may be set to any address between **1** and **2044** inclusive. Note, however, that the *IMP* will ALWAYS respond to addresses 2041, 2042, 2043 and 2044 regardless of the values set in CVs 1 and 9. These special addresses are known as *broadcast addresses* as required by the NMRA standards.

To set the address between 1 and 255 inclusive (recommended for simplicity):-

- Ensure that **CV9** is set to **0** (as supplied – *default* value).
- Set **CV1 (register 1)** to the **required address**.

Example: For address 78 - CV9 = 0; CV1 = 78

To set the address between 256 and 2044 inclusive (more complex – NOTE: the register method can not be used to set addresses in this range):-

- Working in WHOLE NUMBERS, divide your required address by **256**.
- Set **CV9** to the **whole number result** of the division.
- Set **CV1** to the **remainder** from the division.

Examples:
For address 256 - 256 / 256 = 1 remainder 0 so…. CV9 = 1; CV1 = 0
For address 257 - 257 / 256 = 1 remainder 1 so…. CV9 = 1; CV1 = 1
For address 511 - 511 / 256 = 1 remainder 255 so…. CV9 = 1; CV1 = 255
For address 1453 - 1453 / 256 = 5 remainder 173 so…. CV9 = 5; CV1 = 173
For address 1792 - 1792 / 256 = 7 remainder 0 so…. CV9 = 7; CV1 = 0

Setting Operating Modes And Options (CV2)

To set the value of CV2 (register 2), perform the following calculation:-

- Start with a value of **0** (zero).
- Add: **0** to **disable** the **"C"** input
  or: **1** to **enable** the **"C"** input
- Now add: **0** to **disable non-DCC** mode
  or: **2** to **enable non-DCC** mode
- Now add: **0** to **disable signal bounce**
  or: **32** to **enable signal bounce**
- Now add: **0** to select **original operating sense** – i.e. a NORMAL command drives to endpoint "A"
  or: **128** to select **alternative sense** – i.e. a NORMAL command drives to endpoint "B"
- Set **CV2 (register 2)** to the value you have calculated.

Example - the *IMP* is supplied with CV2 set to a value of **3** (*default* value). This configures the unit as follows:-

Control "C" input enabled	**(1)**
Non-DCC mode enabled	**(+ 2 = 3)**
Signal bounce disabled	**(+ 0 = 3)**
Original operating sense	**(+ 0 = 3)**

Now suppose that you wish to change to **alternative** operating sense, enable signal bounce and **disable** remote control from the "C" input. CV2 needs to have a value of **162** so that:-

Control "C" input disabled	**(0)**
Non-DCC mode enabled	**(+ 2 = 2)**
Signal bounce enabled	**(+ 32 = 34)**
Alternative operating sense	**(+ 128 = 162)**

Setting Servo Endpoints (CVs 3 & 4)

The output arm on the recommended RCS0009 servo has a total *throw* of around 90 degrees when driven by the IMP. Each endpoint (B or A) can be set anywhere within this 90 degree range by changing the values of CVs 3 and 4, within a range of 0 to 250, as follows:-

CV3 sets the position of endpoint **B** and **CV4** sets the position of endpoint **A**.

For each CV, a value of **0** (zero) corresponds to the fully **anti-clockwise** position of the servo's output arm and a value of **250** corresponds to the fully **clockwise** position.

Setting Servo Transit Speeds (CVs 5 & 6)

The transit speed of the servo can be set by changing the values of CVs 5 and 6 within a range of 0 to 255.

CV5 sets the speed of transit in the **A-to-B** direction and **CV6** sets the speed of transit in the **B-to-A** direction.

For each CV, a value of **0** (zero) corresponds to a speed of approximately **2 degrees per second** and a value of **250** corresponds to around **500 degrees per second**.

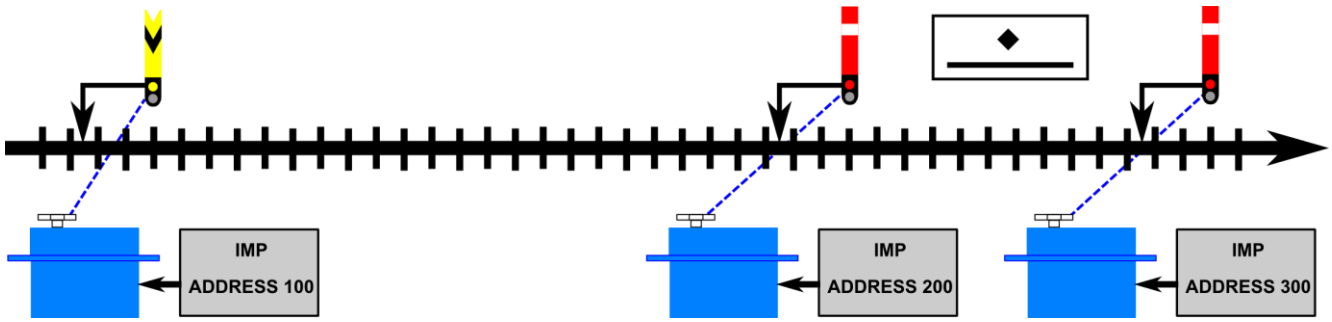
NOTE – At lower speeds, the movement of the servo's arm may not be entirely smooth. This is a characteristic of the servo (known as *dead band*) and is not a fault with the *IMP*.

The maximum transit speed may be limited by the type of servo used. The maximum programmable speed, of 500 degrees per second, may not therefore be achievable.

5.2) Grouped Operation Using Secondary Addresses (CVs 33 to 80)

Consider the track configuration shown below with three *IMP*s, each driving a semaphore signal (via a servo, of course!). We will consider a simple example, based on a traditional *block section*, with a signal box controlling a section of main line. The signals are – left to right – distant, home and starting which are driven by *IMP*s having DCC addresses 100, 200 and 300 respectively.

Assume that when the *IMP*s drive their respective servo to ***endpoint A*** its associated signal is **"ON"** (caution/stop/danger). Assume also that ***original*** operating sense is set for all three *IMP*s – therefore, a **NORMAL** DCC accessory command to address 100 or 200 or 300 will place the relevant signal **"ON"**.



Now – in addition to the above illustration - showing all signals "ON" - the following scenarios can be set:-

Scenario 2 – Train not accepted into next block (but allowed within "station limits"):-

For this setup, the *IMP* states must be: **100 to A;200 to B;300 to A**.

Scenario 3 – Train allowed into next section (previously held at signal box):-

For this setup, the *IMP* states must be: **100 to A;200 to A;300 to B**.

Scenario 4 – Train cleared into next section after passing the distant signal:-

For this setup, the IMP states must be: **100 to A;200 to B;300 to B**.

Scenario 5 – Train offered and immediately accepted by our signal box and box in advance:-

For this setup, the *IMP* states must be: **100 to B;200 to B;300 to B**.

We can set each of the scenarios 2 to 5 above with a SINGLE DCC COMMAND, by programming the IMPs' CVs as follows:-

Unit 100:-	Unit 200:-	Unit 300:-	
CV1 = 100	CV1 = 200	CV1 = 44	
CV2 = 3	CV2 = 3	CV2 = 3	
CV9 = 0	CV9 = 0	CV9 = 1	
CV33 = 10	CV33 = 10	CV33 = 10	(Scenario 1 - address 10)
CV34 = 148	CV34 = 20	CV34 = 148	(Scenario 2 - address 20)
CV35 = 158	CV35 = 158	CV35 = 30	(Scenario 3 - address 30)
CV36 = 168	CV36 = 40	CV36 = 40	(Scenario 4 - address 40)
CV37 = 50	CV37 = 50	CV37 = 50	(Scenario 5 - address 50)
CV38 = 0	CV38 = 0	CV38 = 0	

(All CVs 39 to 80 will be set to zero unless previously programmed for additional grouping)

With these settings:-

- Each signal will respond INDIVIDUALLY to its OWN primary address (100 or 200 or 300).
- The values of CV2 ensure that NORMAL commands correctly set signals "ON".
- To set ALL signals "ON", send a NORMAL command to address 10.
- To set any other scenario, send a REVERSED command to the address of the relevant scenario – i.e. 20, 30, 40 or 50.

How it works…….

The *IMP* will not only respond to the ***primary address***, set in CV1 and CV9, but also to any ***secondary address*** set in CVs 33 to 80. Up to 48 secondary addresses may be set and EACH secondary address has its own *operating sense* assigned to it.

- Secondary addresses can have a value of between **1 and 124**.
- A value between 1 and 124 (set in any of the CVs 33-80) will set the **original** operating sense for *that particular address.*
- To set the **alternative** operating sense for a particular secondary address, the value of that address is **increased by 128**.

For example:-

Suppose the *IMP* needs to respond to addresses **10, 32 and 119** in addition to its primary address. Suppose also that we require the **original** operating sense for address **32** and the **alternative** operating sense for addresses **10 and 119**.CVs 33 to 36 should be set as follows:-

CV33 = 138 (10 + 128)
CV34 = 32
CV35 = 247 (119 + 128)
CV36 = 0

When the IMP receives a valid *accessory* instruction it compares the *received* address with its *own primary* address, stored in CVs 1 and 9. The instruction will be executed if these addresses match, otherwise a search is performed on the *secondary* addresses, CVs 33 to 80, in order (33, 34, 35, …….. , 79, 80).

The search through CVs 33 to 80 stops in any of the following circumstances:-

- A match is found between the received address and a stored secondary address (the instruction will be executed).
- As soon as a value of 0 (zero) is found in any of the CVs 33 to 80 (instruction will be ignored).
- All 48 secondary addresses (i.e. all CVs 33 to 80 inclusive) have been checked (instruction ignored).

THEREFORE, A SERIES OF SECONDARY ADDRESSES SHOULD ALWAYS BE PROGRAMMED, WITHOUT GAPS, STARTING WITH CV33 AND ENDING WITH A VALUE OF ZERO.

Note that the IMP is supplied with CVs 33 to 80 all set to zero.

5.3) "In-Situ Setup" (ISS) In Detail

The configuration of DCC accessories is normally performed in *service mode* where ALL decoders will respond to programming commands, irrespective of their current address. This means that ANY decoder connected to the DCC source would be re-configured along with the particular unit being "targeted"! The *IMP* can be programmed in *operations mode*, which avoids this problem, BUT only if your DCC controller supports operations mode *accessory* programming (most systems only allow ops mode programming for locomotives).

In-Situ Setup overcomes this inconvenience by providing a means of selecting/changing primary and secondary addresses - along with setting the operating sense for each address - without using a DCC programmer and without having to disconnect or remove the *IMP* from your layout.

To enter *In-Situ Setup* mode, the **"C" and the "G"** terminals must be connected together for more than **two seconds** and the unit will stay in the mode whilst "C" and "G" are interconnected. Once the connection is broken between "C" and "G", the *IMP* will revert to normal operating mode.

If you are using accessory state indication, as described on page 11, then the LEDs connected to the "A" and "B" auxiliary outputs provide valuable "status" indication during *In-Situ Setup*. The process can still be performed without the indicators, however, but no acknowledgement of each stage of the process will be provided.

Once in *In-Situ Setup* mode, the addresses and operating senses are set by issuing standard DCC accessory **operating** commands from your controller. The "D1" and "D2" terminals, therefore, need to be supplied from the "main" or "track" output from your DCC controller – ISS mode will not work from a "programming" output.

The *In-Situ Setup* process works as follows:-

i) Set the ADJUST knob fully ANTI-CLOCKWISE for no signal bounce, or fully CLOCKWISE to turn signal bounce on.
ii) Connect "C" to "G"
iii) After 2 seconds, the "A" and "B" LEDs will start flashing rapidly – the *IMP* is now in ISS mode.
iv) All secondary addresses (CVs 33-80) are automatically reset to zero.

v) The *IMP* is now waiting to program its **primary** address. Using your DCC controller, send an **accessory** (or "point/turnout/switch") command to the address that you wish to set as the primary address. The *operating sense* for this address is set according to whether a normal (closed/on) or a reversed (thrown/off) command is sent.

Example 1: To set the primary address to **10**, with the **original** operating sense, send a point **normal (closed/on)** command to address **10**.

The **"B"** LED will go OFF for about one second to acknowledge the programming.

Example 2: To set the primary address to **1789**, with the **alternative** operating sense, send a point **reversed (thrown/off)** command to address **1789**.

The **"A"** LED will go OFF for about one second to acknowledge the programming.

This operation automatically sets CVs 1, 9 and 2 accordingly and both LEDs then continue flashing.

vi) The *IMP* is now waiting to program its first **secondary** address (i.e. CV33). This is performed in the same manner to the primary address – i.e. send a "point change" command to the address **(between 1 and 124)** that you wish to set as a secondary. The operating sense, *for this specific address*, is set according whether a normal (closed/on) or a reversed (thrown/off) command is sent.

Acknowledgement of the programming is indicated, again, by a brief extinguishing of either the "A" or the "B" LED (according to whether a normal or reversed instruction was sent). CV33 is now set.

vii) Repeat the operation (v) for each subsequent secondary address (up to a further 47) that you wish to program. CVs 34, 35, 36, ……. etc. will be set in turn, until you stop sending point instructions.

viii) Finally, remove the "C"-"G" connection. The LEDs will stop flashing, indicating that the IMP is back in normal operating mode.

6) BASIC DOs AND DON'Ts

DO……

- Read and follow these instructions carefully.
- Check all wiring carefully before applying power to the unit.
- Work within any electrical limitations stated in these instructions.
- Contact *GFB Designs* for advice if you are unsure of ANY technical issues.

DON'T…….

- Excessively handle the unit.
- Touch the connector pins.
- Attempt to use the *IMP* where moisture is present.
- Over-tighten the mounting screws.
- Crush or over-stress any wires (e.g. by stapling them to your baseboard).
- Apply a voltage between the "D1" and "D2" inputs greater than 24 volts.
- Apply a voltage between the "G" and the "C" inputs greater than 5 volts.
- Apply any power source to the "A" or "B" output(s).
- Attempt to dismantle or repair the unit yourself.

7) IMP TECHNICAL SPECIFICATIONS

(hardware version 2.1 & software version 1.1)

DESCRIPTION:	A fully integrated model control servo controller, incorporating a DCC decoder – compliant with applicable parts of the National Model Railroad Association Standards S-9.1, S-9.2, S-9.2.1, S-9.2.2, S-9.2.3 and S-9.2.4.
CURRENT CONSUMPTION:	No greater than 20mA idling max. 1.0A operating.
INPUTS - "D1" & "D2":	Accept DCC (compliant with NMRA S-9.1) or DC. **Voltage range: 7.0V to 24.0V peak (abs. max. 25V peak).**
- "Set A", - "Set B", - "Speed A" & - "Speed B":	"Active low" logic inputs. Require "potential-free" contacts to "G" which must sink at least 1mA (Attain +4.5V relative to "G" when open-circuit)
- "C":	"Active low" logic input. Requires a "potential-free" switch to "G" which must sink at least 1mA (Attains +4.5V relative to "G" when open-circuit)
OUTPUTS - "A" & "B":	Voltage source with 330ohm series resistor. 0V relative to "G" when OFF; +4.5V (open circuit) relative to "G" when ON (approx. 14mA short-circuit).
DCC ADDRESSING MODES:	BASIC mode only – OUTPUT address method (see NMRA S-9.2.1).
CV PROGRAMMING MODES:	SERVICE and OPERATIONS MODES supported. In service mode ADDRESS ONLY, REGISTER, PAGED and DIRECT methods may be used.
SIZE & WEIGHT:	82 X 32 X 42mm ± 1mm (overall, exc. drive pin). Weight approx. 50gram.

8) TROUBLESHOOTING

The following table gives guidance on resolving some of the problems that you may encounter when becoming familiar with the *IMP*. Before using this table, please ensure that:-

- You have followed all the above instructions that are relevant (i.e. for DCC or non-DCC operation).
- The unit is wired exactly as shown in these instructions, as appropriate for your application.
- All electrical connections are sound. Ensure that wires are firmly seated in the insulation displacement connectors (where used) and that you are using stranded 7/0.2mm wire in these connectors.
- All wiring is undamaged.
- Your DCC controller, or DC power supply, (as applicable) is functioning correctly.

PROBLEM	PROBABLE CAUSE(ES)	SOLUTION(S)
No response to DCC commands.	Incorrect address set.	Check and correct setting of CVs.
	Invalid accessory command being sent.	Consult your DCC system manual for the correct operation of accessories.
	Jumper link not in its *inactive* position.	Remove the jumper link and replace in its inactive position (see page 8)
No response to “C” input.	Manual override disabled.	Check and correct setting of CV2. Consult *GFB Designs* if you are not using DCC.
No response to DC supply.	Non-DCC mode disabled.	Check and correct setting of CV2. Consult *GFB Designs* if you are not using DCC.
	Wrong type of power supply.	Ensure that you are using a SMOOTH DC supply of between 9 to 18 volts.
	Power supply polarity not being reversed.	Check that you are using the correct type of switch (see Fig.5) and that it is wired correctly (see Fig.6).
Problem(s) with “In-Situ Setup”.	Jumper link incorrectly positioned.	Carefully check the jumper link placement. Try removing the link and then replacing it in the appropriate setting position (see pages 8 & 9).
	Internal fault.	Contact *GFB Designs* for advice.
Servo does not respond to ADJUST knob when setting endpoints.	Jumper link incorrectly positioned.	Carefully check the jumper link placement (see page 8).
	Internal fault.	Contact *GFB Designs* for advice.
Position indication LEDs will not illuminate.	LED(s) not connected correctly.	Ensure that the “A” LED is connected between “A” and “G” and the “B” LED is connected between “B” and “G”.
	LED polarity incorrect.	Check that the LED *anode* is connected to “A” or “B” and that its *cathode* is connected to “G”.
Unable to turn “signal bounce” on or off.	*In-Situ Setup* not correctly entered or cancelled.	i) Ensure that power is applied – do not use a DCC programming output. ii) Check jumper link in INACTIVE position. iii) Set ADJUST knob (see page 8 or 9). iv) Connect “C” & “G” pins. v) Wait 3-4 seconds. vi) Put link back to inactive position.

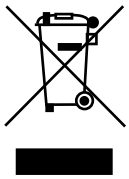
CONSULT *GFB DESIGNS* IF THE ABOVE SUGGESTIONS DO NOT HELP.

9) IMPORTANT INFORMATION

WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT

European law requires that household waste from electrical and electronic equipment is collected separately from normal domestic waste and then properly recycled.

The *IMP* is marked with the crossed out wheeled bin symbol (shown opposite), in accordance with the European directive 2002/96/EC, which means that you must return any damaged or “end-of-life” units to your local authorised collection centre. *GFB Designs* will provide advice and assistance regarding the correct disposal procedures.



WARRANTY

All *GFB Designs* products are guaranteed against defects in materials and workmanship for a period of 24 months from the date of purchase. Should a defect arise within this period, the product will be repaired or replaced free of charge PROVIDED:-

- The product has been used and maintained in accordance with the manufacturer’s instructions and (where applicable) any electrical ratings.
- No accidental physical damage has occurred whilst the product is in the customer’s possession.
- The fault has not been caused by any other form of misuse or neglect on the part of the customer.

This guarantee is in addition to, and does not diminish, your statutory rights – for further information please contact your local Trading Standards Authority.

DECLARATION OF CONFORMITY

The undersigned declares that the *IMP* Digital Servo Controller - manufactured by *GFB Designs* (contact details below) - is, where applicable, in accordance with the European directives 93/68/CEE (CE marking), 2004/108/EC and 2014/30/EU (electromagnetic compatibility). Relevant parts of the following standards have been used to demonstrate electromagnetic compatibility:-

BS EN 61000-6-1:2007
BS EN 61000-6-3:2007+A1:2011

CE

(George Fraser Black, Proprietor)

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