WARNING

- The human body can generate static electricity which can damage electronic equipment – HANDLE THE TT301 BY THE CIRCUIT BOARD EDGES ONLY!
- For INDOOR use only.
- The TT301 is not suitable for use by children under 14 years of age unless supervised by an adult.

GETTING STARTED

Refer to fig. 1

The TT301 is designed to drive a Traintronics model railway colour-light signal using either *digital command control* (DCC) or "conventional" (AC or DC) power supplies.

Other manufacturers' signals may be used provided that they incorporate *light-emitting diodes* (LEDs) as their "lamps" – see the "Signal Requirements" section (page 11) for more information.

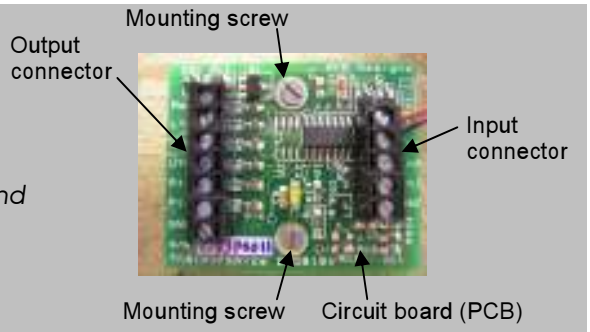


Fig 1: TT301 General Arrangement

Mounting the unit

We recommend mounting the TT301 onto a wooden surface (e.g. underside of baseboard) using two 2.5mm diameter wood screws as shown in fig.1.

WARNING

- The unit MUST NOT make contact with any electrically-conductive parts!
- DO NOT OVERTIGHTEN the mounting screws. **Under no circumstances must the circuit board be flexed or distorted!!**

Wiring

Fig. 2 shows how to make electrical connections to the TT301. For the *input* connections you should use stranded insulated wire with about 6mm of insulation stripped from the end. The *output* connections are made using the fine *enamelled-copper* wires that emerge from the bottom of the signal post – see the Traintronics signal instruction sheet or consult the relevant instructions for other manufacturers' signals. Remove a length of about 20mm of the enamel insulation from the wire end and then "fold" the bared end thus .....

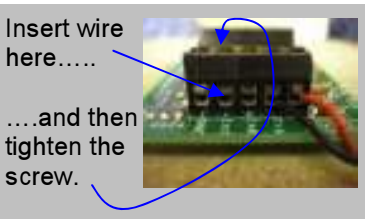


Fig. 2: Making connections

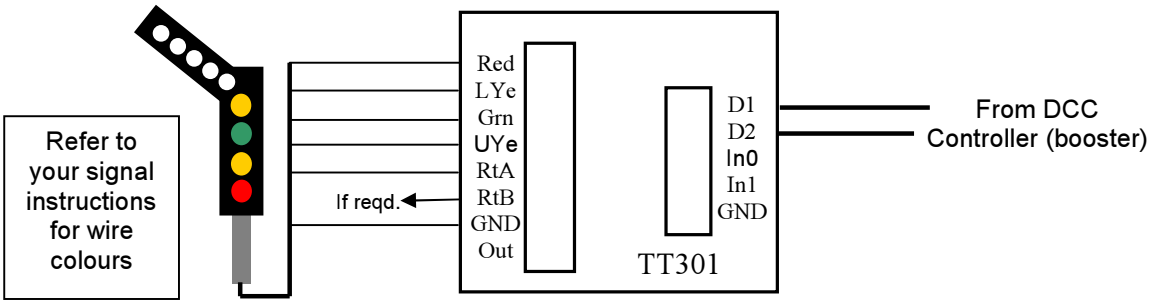
This increases the wire area so that the terminal will clamp it more securely. The enamel may be removed by carefully scraping it with a craft knife but we recommend *tinning* the wire with solder. The enamel insulation will melt and *self-flux* when you apply the soldering iron tip and solder together to the wire end.

The input terminals are:	"D1" & "D2"	- Power, or DCC, inputs
	"In0"	- Override or non-DCC control for aspects
	"In1"	- Override or non-DCC control for routes or flashing
	"GND"	- "Ground" or *common return*
The output terminals are:	"Red"	- Red signal "lamp"
	"LYe"	- Lower yellow signal "lamp"
	"Grn"	- Green signal "lamp"
	"UYe"	- Upper yellow signal "lamp"
	"RtA"	- Route indicator "A" "lamp(s)"
	"RtB"	- Route indicator "B" "lamp(s)"
	"GND"	- "Ground" or *common return*
	"Out"	- "Daisy chaining" output – see the "Advanced Features" section

These are labelled with white printing on the circuit board.

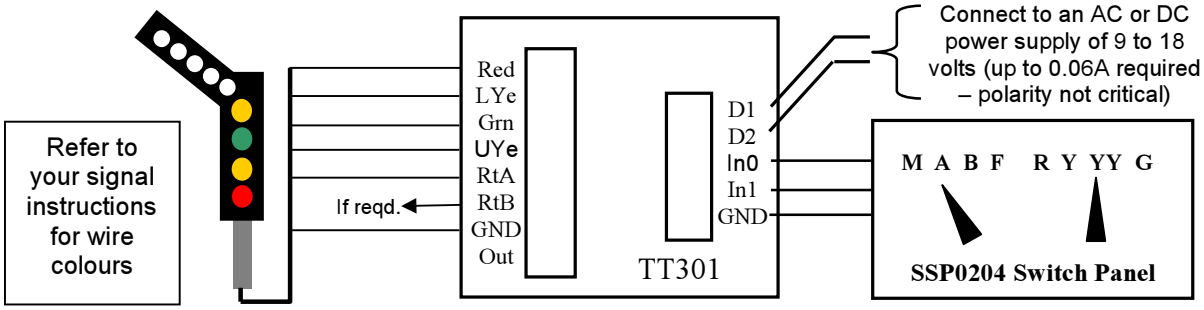
The TT301 will drive a *running signal* of up to four aspects plus up to two *route indicators*. Simply omit any connections that are not required for your chosen signal. TAKE CARE WITH NON-TRAINTRONICS SIGNALS – the lamp outputs (Red, LYe, Grn, UYe, RtA, RtB) provide a POSITIVE current when turned on so the signal LEDs must have their *cathodes* connected together and to the "GND" terminal.

Fig. 3 shows a basic configuration for operation under DCC whilst fig. 4 shows the use of a signal switch panel for control without DCC.



Note: There will be two wires between "GND" and the signal if you are using route indicators.

Fig. 3: Wiring for basic DCC control



See page 11 for details on how to construct your own switch panel.

Fig. 4: Wiring for manual control without DCC

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

Initial testing

With the unit wired as shown in fig. 3, turn on the DCC controller. After a short delay, the signal should indicate a STEADY GREEN aspect. Note, however, that signals without a green lamp (e.g. 2-aspect red/yellow) will be BLANK at this stage.

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 signal should change to RED. Signals without a red lamp (e.g. 2-aspect yellow/green) will go BLANK.

See the "Troubleshooting" section on page 13 if the above indications are not obtained.

Changing the signal address

The TT 301 must be connected to the programming output of your command station.
We suggest you allocate a specific block of numbers to CV1 or register1 for your TT 301s. For example if you have 10 signals make CV1 or register1 in the block 50 to 59 your TT 301 values. Make sure you mark the address next to the TT 301 on the baseboard or keep a note somewhere.
Again, refer to your DCC system manual for details. Your DCC programmer – or the programming output of a combined command station and programmer – should be now be connected to the "D1" and "D2" terminals of the TT 301.

NOTE: Some DCC systems use decoder *registers* rather than *CV numbers*. In this case, the signal address is set in **register 1** and a value between 1 and 255 (inclusive) is allowed.

- Following your command station instructions, program the value of CV1/register1 in the TT 301 with an appropriate value (between 1 and 255)
- Make sure you carry out a CV or register read to verify that you have programmed the correct value.
- You must now program the correct value of CV2 or register 2 to match your signal type in accordance with the following table.

Signal Type	**Red Green**	**Yellow Green**	**Red Yellow**	**Red Yellow Green**	**Yellow Green Yellow**	**Red Yellow Green Yellow**
No of aspects	2	2	2	3	3	4
CV2 value without route indicator	0	1	2	3	4	5
CV2 Value with route indicator	16	17	18	19	20	21

Now connect your TT 301(s) to the normal running track.

In order to change the running signal **aspects**, perform the following actions:-

- Select, on your DCC controller, the *accessory* ("point", "switch" or "turnout") number corresponding to the value programmed into *CV1* (or *register 1*).
- Now repeatedly send "POINT NORMAL" (or "closed/off") commands. The signals should now change in the correct running sequence. If you have a route indicator then the indicator will light when an aspect is shown. If you have blank aspects at this point it is an indication that CV2 has not been set correctly.

In order to change **route indications**, perform the following action:-

- Select, on your DCC controller, the *accessory* ("point", "switch" or "turnout") number corresponding to the value programmed into *CV1* (or *register 1*).
- Send "POINT NORMAL" (or "closed" or "off") commands until you obtain a yellow, yellow-yellow, or green aspect.
- Now repeatedly send "POINT REVERSED" (or "thrown" or "on") commands.

The route indicator should now turn on and off with repeated "POINT REVERSED" button presses

NOTE: In accordance with British signalling practice, a RED aspect on the running signal will prevent illumination of the route indicator(s).

Non-DCC Operation

Provided that the TT301 has not had any settings changed under DCC programming, it will operate on a layout using "traditional" (i.e. *DC* or *analogue*) control as follows:-

Power Supply

As shown in fig. 4, a power supply must be connected to the "D1" and "D2" terminals. It may be an *alternating current* (AC) or *direct current* (DC) type and it may be connected either way round (even if DC). The characteristics of the power supply must be:-

- Voltage between 9 volts to 18 volts. DO NOT EXCEED 18 volts AC, or 25 volts DC, UNDER ANY CIRCUMSTANCES !!
- Available current 0.06amp (60mA) for each TT301 connected to the supply (e.g. sixteen TT301s could be powered from a supply rated at 1 amp).

A few examples of suitable power sources are:-

- "Gaugemaster" transformer, type M1 or T1 or WM1.
- "Hornby" type C990 wall plug transformer or the 16V AC output from the R965 controller (when used with the C990).
- "Maplin Electronics" wall plug supply – stock code GS75S or MG81C.

Signal Control

Use the SSP0204 switch panel, or a home-constructed version as described on page 11, connected as shown in fig. 4. Simply rotate the switches to the desired aspect, route or flashing indication. Note, however, that a RED aspect will not flash and will extinguish both route indicators in accordance with British signalling practice.

See "Advanced Features" for other methods of signal control and see "Troubleshooting" if manual control can not be satisfactorily obtained.

This completes the "getting started" section of this guide.

Comprehensive operation under DCC

The TT301 is a DCC accessory decoder as defined by the NMRA. It obtains power and control information from the DCC booster via the "D1" and "D2" terminals as indicated in fig. 3. As most (if not all) currently-available DCC systems will not specifically control signals, the TT301 is designed to respond to point/turnout control commands.

Operating modes and options

The TT301 will "recognise" a valid DCC signal when supplied to the "D1" and "D2" terminals and will automatically switch to DCC operation. You can select the signal address (between 1 to 2044), and change the exact way in which the signal responds to DCC commands, by setting the configuration variables (CVs) as detailed below. Descriptions of the operating *modes* are as follows:-

"Signal Type"

Configuration variable (CV) **2,** should be changed as described in "CV Setting" below in any of the following circumstances:-

- A two or three-aspect signal is being used.
- The signal has fewer than two route indicators.
- Flashing is to be disabled.

This ensures that the TT301 generates the correct outputs for your particular signal.

"Modeller's Mode"
Modeller's mode allows you to select every possible signal aspect, route indications and flashing aspect from the DCC controller. The mode works, as described in the "Controlling The Signal" section, by sequencing the aspects using "point NORMAL" commands and sequencing the route indications (along with flashing) using "point REVERSED" commands. Upon applying power (DCC) to the TT301 a steady GREEN aspect, with no route indications, is selected.

Modeller's mode enables a basic system to be implemented but control of the signal can be tedious! For this reason, the preferred operating mode is "Signalman's mode".

"Signalman's Mode"

Signalman's mode is intended to simulate "real life" (*prototypical*) operation of colour light signals. It allows you to switch between STOP and PROCEED aspects using your DCC controller but the specific aspect displayed when "proceed" is selected is controlled by the **"In0"** *manual override* input on the TT301. For example, if you are using a four-aspect signal:-

- A point NORMAL (or "closed" or "on") command will turn on the RED lamp (i.e. STOP/DANGER).
- A point REVERSED (or "thrown" or "off") command will turn on the GREEN lamp (i.e. CLEAR).
- YELLOW (CAUTION) and YELLOW-YELLOW (PRELIMINARY CAUTION) aspects are displayed by *loading* the "In0" input and sending a point REVERSED command (simulating *track circuiting* on a full-size railway). This is explained in "Use Of Override Inputs For Semi-automatic Operation" on page 8.

With two or three-aspect signals, the operation is as follows:-

- Two-aspect red/green: NORMAL = RED; REVERSED = GREEN.
- Two-aspect yellow/green: NORMAL = YELLOW; REVERSED = GREEN.
- Two-aspect red/yellow: NORMAL = RED; REVERSED = YELLOW.
- Three-aspect red/yellow/green: NORMAL = RED; REVERSED = GREEN. (REVERSED & In0 loaded = YELLOW)
- Three-aspect yellow/green/yellow: NORMAL = YELLOW; REVERSED = GREEN. (REVERSED & In0 loaded = YELLOW-YELLOW)

Configuration variables (CVs) are special numbers stored within the TT301's memory. The format is defined by the NMRA Recommended Practices. The *address,* operating modes and options of your signal can be changed by setting CVs **1**, **2** and **9** 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 TT301.

Note that the TT301 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 TT301 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 TT301 supports all four techniques. Refer to your DCC system manual to determine the most appropriate method. (The TT301 automatically responds to whichever CV access instructions are received by it).

"Read only" CVs (7 & 8)

The following CVs cannot be changed. They are required by the NMRA recommended practices and they contain data on the TT301.

CV (or REGISTER) NUMBER	VALUE	DATA (meaning of value)
7 (Register 7)	60	Software version (currently V6.0 at 05 Nov 2009)
8 (Register 8)	46	Manufacturer I.D. (GFB Designs – designers)

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

The TT301 may be set to any address between **1** and **2044** inclusive. Note, however, that the TT301 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 recommended by the NMRA.

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

This special CV is factory-set at a value of **192** and should not normally be changed. If, however, your DCC system supports EXTENDED ACCESSORY CONTROL, as defined in the NMRA document RP-9.2.1, then the value of CV29 may be changed to **224** in order to run the TT301 *extended* mode.

(As an example, the NCE "Power Cab" provides extended operations mode CV programming for signals)

Setting Operating Modes And Options (CV2)

As supplied, the TT301 is setup for a 4-aspect signal with 2 route indicators. Flashing aspects are enabled and the unit works in "modellers' mode". Use of a signal with less than 4 aspects, or less than 2 route indicators, will give *blank* indications as you cycle through the *red/yellow/yellow-yellow/green* and *route-A/route-B/flash/main-route* operating sequences.

The value of CV2 (or register 2) can be altered in order to remove "blank" aspects – and/or to change to "signalman's mode". This action will "customise" the TT301, thus matching it to your chosen signal.

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

- Start with a value of **0** (zero).
- Add: **0** for a 2-aspect **red/green** signal
  or: **1** for a 2-aspect **yellow/green** signal
  or: **2** for a 2-aspect **red/yellow** signal
  or: **3** for a 3-aspect **red/yellow/green** signal
  or: **4** for a 3-aspect **yellow/green/yellow** signal
  or: **5** for a 4-aspect **(red/yellow/green/yellow)** signal.
- Now add: **0** for **main route only** (i.e. a basic signal with no route indicators)
  or: **16** for **one route indicator**
  or: **32** for **two route indicators**
  or: **48** for **two route indicators plus flashing** aspects.
- Now add: **0** to select **"modeller's mode"**
  or: **128** to select **"signalman's mode".**
- Set **CV2 (register 2)** to the value you have calculated.

For example:-

The TT301 is supplied with CV2 set to a value of **53** (the *default* value). This configures the decoder to correctly drive…….

a 4-aspect signal **(5)**
with 2 route indicators and flashing **(+ 48 = 53)**
and "modeller's mode" selected **(+ 0 = 53)**

Example 2:-

To setup the TT301 to **signalman's** mode for a **Red/Yellow/Green** signal, with **one route** indicator, the CV2 value is **147**. This is calculated as follows:-

a 3-aspect R/Y/G signal **(3)**
with route indicator **(+ 16 = 19)**
and "signalman's mode" **(+128 = 147)**

The **"In0"** and **"In1"** terminals on the TT301 (see figs.1 & 3) are known as *manual override inputs*. They provide the sole means of controlling the signal under non-DCC operation and they may also be used, as an additional means of control, under DCC operation.

Note that: **"In0"** controls the signal **aspects**.
"In1" controls the **route indicators** and selects **flashing.**

Each manual override input can select one of 4 *states* depending upon the *electrical resistance* between it (the input) and the "GND" terminal. Figs. 5 and 6 show how to activate the manual overrides, for "In0" and "In1" respectively.

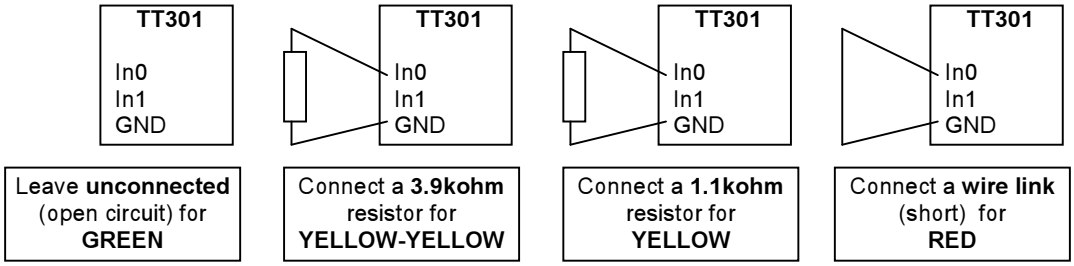
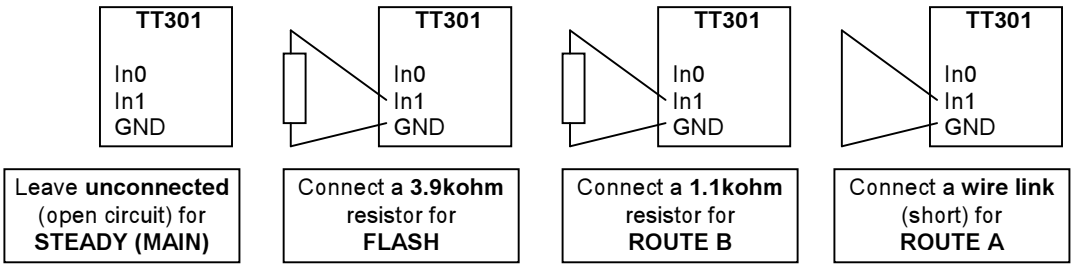


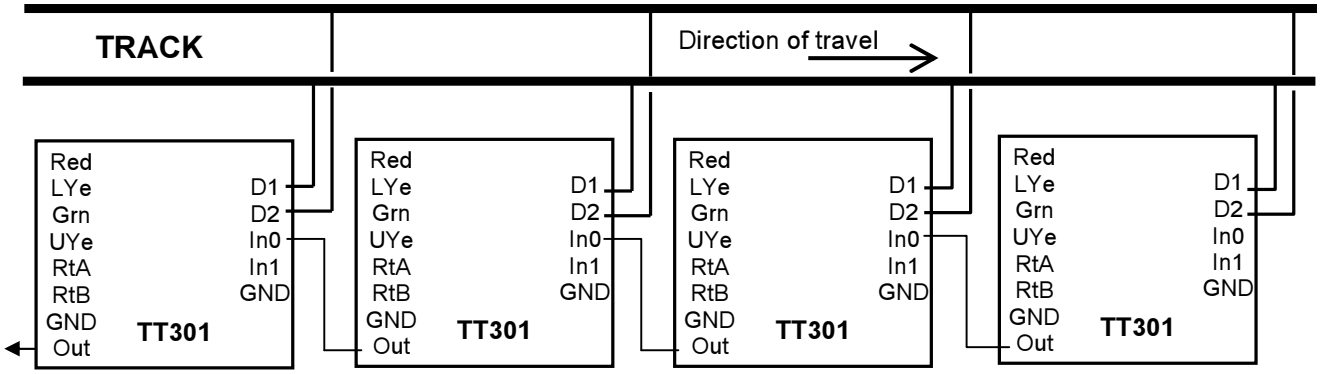
Fig. 5: Manual ASPECT control using "In0"



(You can obtain suitable resistors from Maplin Electronics – order codes are M3K9 for the 3.9kohm part and M1K1 for the 1.1kohm part.)

Fig. 6: Manual ROUTE & FLASH control using "In1"

Fig. 7, below, shows how to "daisy chain" a series of TT301 decoders so that the aspect displayed by a signal depends on the setting of the next signal in *advance* (as on full-size railways).



NOTE: Signals, and connections to them, omitted for clarity.

Fig. 7: Interconnection of TT301s For Semi-automatic Operation

Adding The TT302 Block Occupancy Detector

The TT302 – also manufactured by Traintronics – provides a further method for *semi-automatic* signal control. The device detects the presence of a locomotive within a section (or *block*) of track, by measuring the electrical current drawn through the rails, and activates an electronic switch when the *block section* is *occupied*.

When connected, along with a TT301, as shown in fig. 8, the TT302 will override the signal aspect when a train occupies the relevant block section thus replacing the signal to RED ("danger").
This simulates track circuiting which is extensively employed on full-size railways.

This scheme may be combined with the "TT301 Interconnection" described above. Each signal on your layout can have its own TT302, along with an associated isolated track section, and the TT301s on a particular "road" can be "daisy chained" as shown above in fig. 7.
Each signal will then display RED, YELLOW, YELLOW-YELLOW and GREEN in sequence as a train passes the signal and progresses through the block sections in advance of it.

Any number of TT301s, TT302s and signals may be interconnected in this manner.

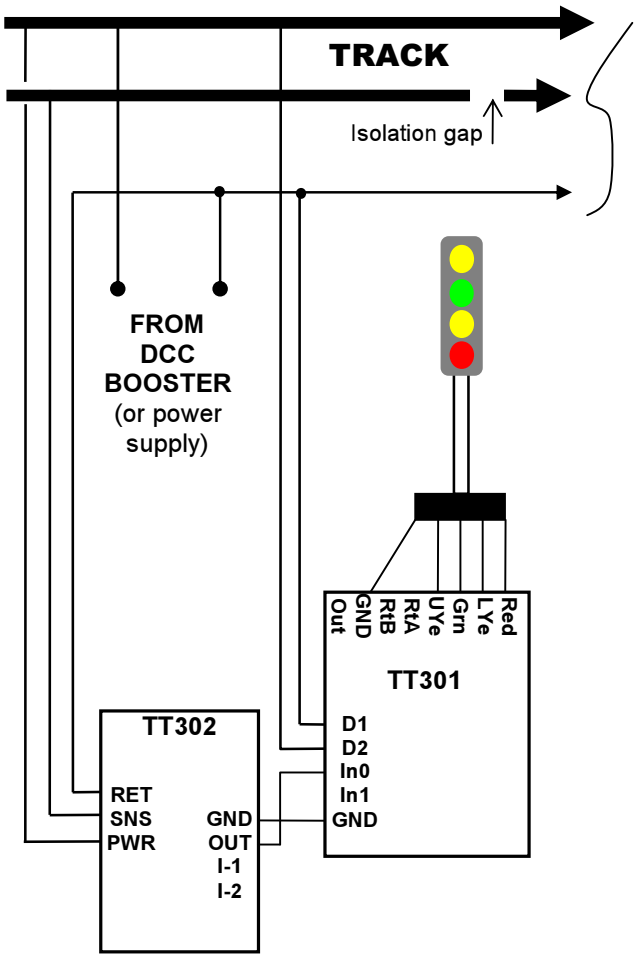


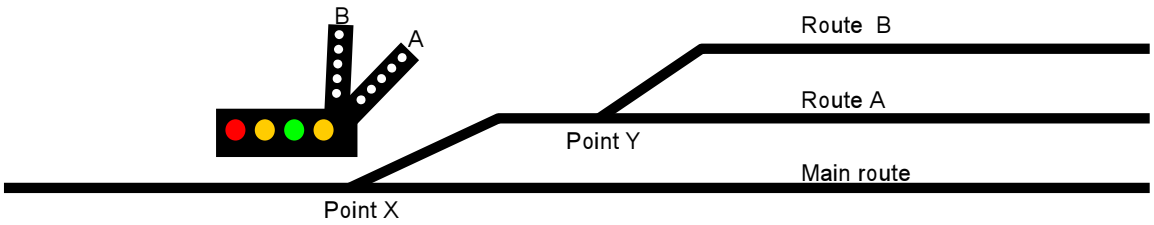
Fig. 8: Connection of a TT302 Block Occupancy Detector

NOTE: It is possible, and indeed advisable, to supply the TT301 "D1" & "D2" inputs from a separate DCC accessory supply rather than from the actual track. Signal operation will then be retained in the event of a short circuit on the track.

SEE THE TT302 USER GUIDE FOR FURTHER DETAILS.

2.4) Automatic Route Indication From Point (turnout) Setting

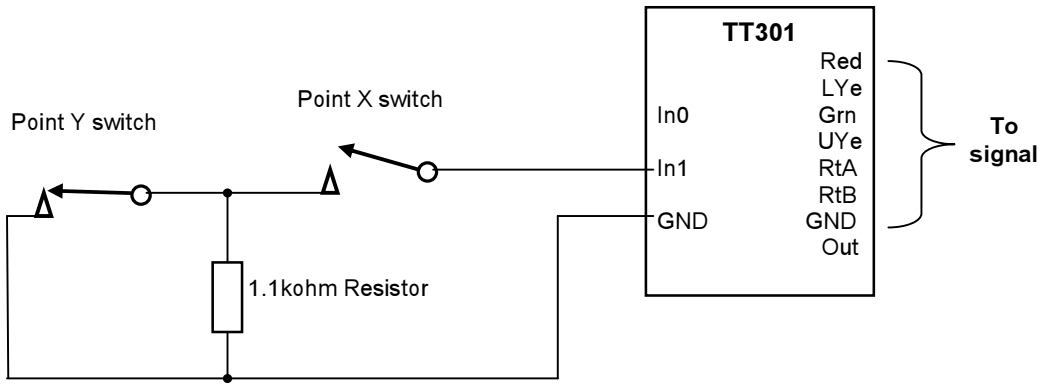
The **"In1"** manual override input can be used (under DCC or non-DCC operation) to automatically switch the signal route indication in accordance with the setting of points.
As an example, suppose you have the following track configuration……..



……

then you can use auxiliary switches, operated from your points, connected to the TT301 as shown below in fig. 9.

NOTE: Switch X should be OFF (i.e. NOT making contact) when its respective point is NORMAL (closed) and ON (making contact) when its point is REVERSED (thrown).
Switch Y should be ON (i.e. making contact) when its respective point is NORMAL (closed) and OFF (NOT making contact) when its point is REVERSED (thrown).



NOTE: Switches are <u>both</u> shown in their "point NORMAL (closed)" states

<u>Fig.9: Automatic route display using auxiliary point switches to drive "In1"</u>

Note that, in the above scheme ……..

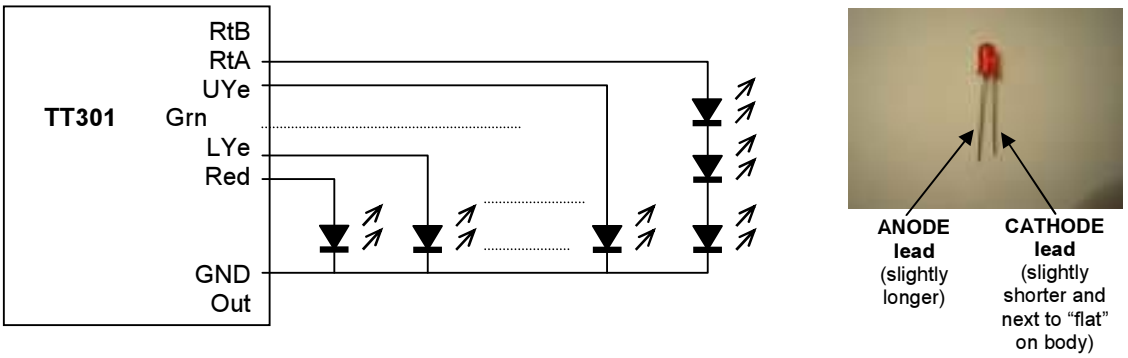
- The signal will (correctly) display MAIN ROUTE (i.e. no route indicators illuminated) <u>whenever</u> POINT X is set to NORMAL (closed) <u>regardless</u> of the setting of POINT Y.
- <u>Both</u> POINTS X AND Y must be REVERSED in order to display ROUTE B.
- The switches must be ISOLATED from – and must not form part of – any other electrical circuit.

There are many ways in which you can use the "In0" and "In1" manual override inputs on the TT301 for semi-automatic signal operation and it is not practical to consider all possibilities here. Using the information contained in this booklet – along with basic electrical knowledge – you should be able to devise a suitable scheme for your layout.

Contact Traintronics (see page 14) if you require any further advice.

If you are NOT using signals from the Traintronics type 100 range, please bear the following points in mind:-

- **The signal "lamps" MUST be *light emitting diodes* (LEDs).** The TT301 does not supply sufficient current for other types of indicators (note, however, that The TT301 provides a "soft" turn on/off characteristic in order to simulate the filament lamps used on most full-size signals).
- LEDs must be connected correctly as they are *polarity-sensitive*. The photograph in fig. 10 below shows how to identify the ANODE and CATHODE leads of a typical LED.
- Each LED must have its *anode* connected to the relevant *output* terminal on the TT301 (i.e. "Red" or "LYe" or "Grn" or "UYe" or "RtA" or "RtB"). The LED *cathodes* must be connected together (i.e. *in common*) and then connected to the TT301 "GND" terminal on the *output connector*. Fig. 10 should make this clear.
- Route indicator(s) – if required – should use white LEDs. You can use up to <u>three</u> white LEDs *in <u>series</u>* for each route indicator.



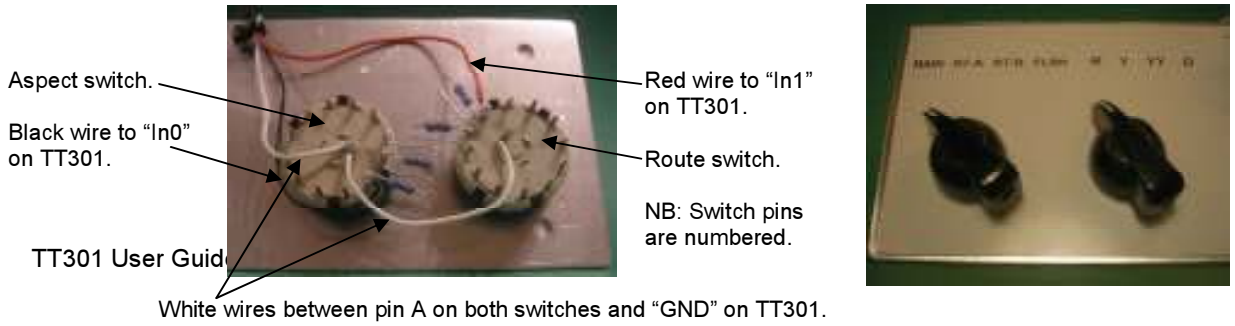
<u>Fig. 10: Connection of light emitting diodes for home-made signals</u>

CONSTRUCTION OF A SWITCH PANEL FOR MANUAL SIGNAL CONTROL

The TT301 may be operated **manually** *without DCC* using a switch panel constructed as shown below:-

Parts List:-

DESCRIPTION	QUANTITY	Maplin Electronics Stock Number	CONNECTIONS	
			ASPECT SWITCH	ROUTE SWITCH
Rotary switch	2	FF73Q	Black wire on pin 1	Red wire on pin 2
Knob	2	RW75S		
1.1kohm Resistor	2	M1K1	Between pins 1 & 2	Between pins 2 & 3
2.7kohm Resistor	2	M2K7	Between pins 2 & 3	Between pins 3 & 4



DO…….

- Read and follow these instructions carefully.
- Handle the unit by the circuit board edges only.
- Mount the unit on an INSULATING surface.
- Tighten the screws on the connector terminal strips firmly (at positions with wires inserted).
- Check all wiring carefully before applying power to the unit.
- Work within any electrical limitations stated in these instructions.
- Contact Traintronics for advice if you are unsure of ANY technical issues.

DON'T…….

- Excessively handle the unit.
- Touch the underside of the circuit board or any components on the upper side.
- Attempt to use the TT301 to drive lamps of a type other than light emitting diodes (LEDs).
- 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 "GND" and the "In0" inputs, or between "GND" and "In1", greater than 5 volts.
- Apply any signal or power to the output connector.
- Connect your signal directly to a power source (LEDs need resistors – these are built in to the TT301).
- Attempt to dismantle or repair the unit yourself.

TT301 Technical Specifications (hardware version 2.0 & software version 6.0)

DESCRIPTION:		A DCC decoder – for model colour light signals (British railway signalling practice) – compliant with applicable parts of the National Model Railroad Association standards and recommended practices S-9.1, S-9.2, RP-9.2.1, RP-9.2.2, RP-9.2.3 and RP-9.2.4.
INPUTS	- "D1" & "D2":	Accept AC (50Hz to 10kHz) or DC (smoothed or full-wave rectified un-smoothed) or DCC (compliant with NMRA S-9.1). **Voltage range: 7.0V to 25.0V peak (abs. max. 27V peak).**
	- "In0" & "In1":	Accept either a resistance to "GND" (any value between short and open circuit) or a voltage **between 0V to +5.0V** (relative to GND).
CURRENT CONSUMPTION:		No greater than 10mA (excluding signal LEDs).
OUTPUTS	- "Red/LYe/Grn/UYe":	Voltage source with 240Ω built-in series resistor. 0V OFF; +4.8V ON (± 0.3V) open circuit (relative to GND).
	- "RtA/RtB":	Current source – 0mA OFF; 8±2mA ON (flowing OUT of RtA/B towards GND – O/C voltage approx. 1.5V less than peak input to "D1/D2" terminals).
DCC ADDRESSING MODES:		BASIC and EXTENDED modes supported (see NMRA RP-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:		46 X 37 X 12mm ± 1mm (overall); weight approximately 12g.

TROUBLESHOOTING

The following table gives guidance on resolving some of the problems that you may encounter when becoming familiar with the TT301. 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.
- All wiring is undamaged.

PROBLEM	PROBABLE CAUSE(ES)	SOLUTION(S)
No signal lamps illuminated.	Power supply, or DCC system, faulty or turned off.	Turn on power supply or DCC! Rectify supply fault (consult DCC manual as appropriate).
	Power supply or DCC system shut down due to fault (e.g. short circuit) elsewhere on layout.	Connect and test TT301 and signal independently from layout. Correct layout fault.
	"Signal type" incorrectly set.	Check and correct setting of CV2 – see page 7.
Some, but not all, signal lamps working.	Non-working signal LED(s) connected wrong way round.	Correct signal wiring error(s).
	Faulty signal LED(s).	Replace faulty LED(s).
	"Signal type" incorrectly set.	Check and correct setting of CV2 – see page 7.
Signal will not respond to DCC commands.	Incorrect address set.	Check and correct setting of CVs 1 & 9 – see page 6.
	Invalid accessory command being sent.	Consult your DCC system manual for the correct operation of accessories.
	Signal being overridden by In0 and/or In1 input(s).	Remove any connections from In0 and In1 terminals and re-test. If the signal now works, check your method for driving In0 and/or In1.
Signal will not respond to In0 input.	"Signal type" incorrectly set.	Check and correct setting of CV2 – see page 7.
	"In0" incorrectly driven.	Check circuitry driving "In0" – see page 8.
Signal will not respond to In1 input.	"Signal type" incorrectly set.	Check and correct setting of CV2 – see page 7.
	"In1" incorrectly driven.	Check circuitry driving "In1" – see page 8.
Green and/or yellow aspects will not flash.	"Signal type" incorrectly set.	Check and correct setting of CV2 – see page 7.
	"In1" incorrectly driven.	Check circuitry driving "In1" – see page 8.
Aspect does not change on signal driven by an inter-connected TT301.	"In0" incorrectly driven.	Check that a SINGLE connection is made from "Out" on the TT301 ***in advance*** of the signal in question to "In0" on the TT301 in question. Ensure that no other circuitry can interfere with this connection – see page 9.
Aspect does not change on signal driven by a TT302 Block Occupancy Detector.	"In0" on TT301 incorrectly driven.	See page 9 *of this manual* in conjunction with the TT302 User Guide. Check all connections and ensure that no additional circuitry can interfere with the TT302/TT301 inter-connection.
	Problem related to the TT302 detector.	
Intermittent false aspects displayed on signal.	Strong electrical interference present.	Ensure that DCC power feed wire-pairs are twisted.
		Try to locate, and eliminate or minimise, the source of interference (e.g. Poorly suppressed electrical tool? Mobile telephone? Nearby radio transmitter?). Ensure that all locomotives have their motor suppression components fitted (as supplied by the manufacturer).
	Dirty track or train wheels with occupancy detectors in use.	Check, and clean, all track and wheels.