Introduction to Garden Railway

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1 What is meant by Garden Railway?

It simply means running a model railway in garden (outdoor). Although the definition is self-explanatory, this does differ *significantly* from an indoor model railway.

The *garden* part is quite important here. Because it is outdoor it will be subjected to same weathering conditions as in real railway! You need to plan how to lay tracks and effect of sun, snow, rain, trees, animals, heaving of ground etc.

An LGB starter set (with track *Stainz* loco – powered by track electric)

Typical G gauge (45 mm) track (made of brass)

An RC battery loco with directional light and sound – from Playmobil 5258 set (shown on Playmobil plastic track)

An Aristocraft SD45 diesel/electric track powered/battery locomotive – standard gauge

1.1 What is the size/gauge?

The gauge is the inside width of tracks. This is typically 45 mm for Garden Railway. This gauge is also known as G scale. Mind you, scale and gauge are different although they are often used synonymously. Scale is a measure of how much smaller the objects are compared to real world counterparts. G scale is 1:22.5 (for narrow gauge) or 1:29 (for standard gauge). This means, narrow gauge trains are bit larger (by proportion) than standard gauge trains. But standard gauge trains are usually longer and have multiple bogies/trucks.

Narrow gauge trains are comparatively cheaper and suitable where available garden space is limited.

Some folks run 32 mm gauge in garden. Some (but not all) locos and rolling stocks are capable of running in both 45 mm and 32 mm gauges. If you have no idea whether to go for 32/45/anything else, I shall advise to stick with 45 mm gauge then as wider gauges are easier to lay in garden and 45 mm gauge is very popular and thus you can get lots of readymade trains for them. You also need to decide whether you want to start with narrow or standard gauge. Mixing up different gauges of rolling stock may look disproportionate when placed side by side.

You also need to consider whether you want to consider your track width as standard gauge or narrow gauge. Compared to standard gauge rolling stocks (= loco + wagons), narrow gauge rolling stocks will be larger and shorter and cheaper.

You *can* run smaller HO (16 mm gauge, 1:87 scale) or OO (16 mm gauge, 1:76 scale) in garden but those are more suitable for indoors.

1.2 How much will it cost?

It will cost you a considerable amount of money! This is by no means a cheap hobby.

A typical starter set costs £250 (contains 1 loco, 2-3 rolling stocks and a 4-ft circular track).
Roughly each foot (12 inches or 30 cm) of track costs £5.

Some locos will cost over £1000 and up to £3000.

Even used items are not very cheap. But obviously, you can start small and grow with time. The initial layout of tracks will require good amount of time as well. But once tracks are laid, other maintenance work is minimal.

1.3 How do you power the trains?

The options are:

1. Track power
   - Analog (up to 24 V DC)
     - You change voltage via controller which affects the speed of loco. You control the track voltage only and not individual loco. Thus, if 2 locos are on same track, they will both move.
   - Digital (up to 24 V pulse modulated wave DC)
     - Voltage is sent to track all the time. A chip inside each loco interprets your signal from controller. You can individually control each loco on same track.
2. Battery power
   Loco contains 6-24 V on board batteries and RC circuit, Loco is controlled via handset transmitter

3. Live steam
   Gas or coal fired locos
   Controlled manually or via radio control

Most ready-to-buy trains are powered by track power. Cheaper locos are powered by DC. You have a transformer which will step down your 110/220 V main AC to 12-25 V DC. Then you control the speed of loco via a controller. However, if you place 2 locos on same track (ie. powered by same source) both will start moving! That is a disadvantage of traditional DC power (although such locos are cheapest).

Expensive locos often equipped with DCC. In this mode, transformer feeds the track with 12-24 V AC. Each DCC loco has its own electronics *brain* which *listens* to central controller (i.e. one which you will hold) for commands. Thus, you can control each loco individually.

Your track is independent of whether you use AC or DC. However, you should not mix locos (i.e. run DC loco on AC track and vice versa). Also you should be careful not to create a reverse loop directly as it would lead to short circuit.

For best result, good quality brass tracks are recommended.

You can have electricity via catenaries too but this will add more to expense and can become a trip hazard.

If you use battery power, then loco will carry its own battery (either inside loco or in a tender). You will control the loco via remote controller (RC). This is a very convenient mechanism to control trains. However, such locos are in serious short supply! At present only battery operated G scale loco you can buy is *Playmobil 5258* (for ~£100, although it is more like toy than hobby item but nevertheless still a good loco to start with). There are other battery locos available but they are often kit built and cost over £500.

You may ask why battery locos are not so easily available. There are several reasons behind it. Firstly, battery power only improved lately. Model railroad is an old hobby and traditionally only track powered locos were powerful enough to haul long trains. So, manufacturers did not invest much in battery locos. Also, releasing battery locos may cannibalize sales of their track powered locos or DCC equipments so they may be reluctant to release one. It is possible to convert a track powered loco to battery operated one (and vice versa) but that is not an easy job and you have to do that yourself.

Last option is live steam. A boiler is heated via butane gas and steam propels the loco. On downside, such locos are horrendously expensive (around £1000) and they do require regular maintenance. However, I guess you will want them one day.

Whatever way you power your train, do not forget about track maintenance. You need to clear debris from tracks to prevent derailment. Running steam/battery power requires lower maintenance than track power but still some maintenance is required. If you set up your system in such a way that

you can run track powered locos (even though you don't actually run them), you can run steam/battery loco on them without problem. Then later if you wish, you can still run track powered locos.

1.4 Battery vs Track power

Parameter	Track Power	Battery Power
Power source	DC or AC low voltage (0-22 V). Power cable must be connected to track.	Battery (usually rechargeable) inside locomotive. Usually 9-21 V depending on configuration of loco. Batteries can be typical AA or built in.
Speed control	Usually by wired controller via variation of track voltage.	Remote control
Overall Cost	Depends. Some track power locos are cheaper but there are very expensive track powered locos. Brass/stainless steel tracks are more expensive than plastic tracks.	Battery locos are few and far between. They tend to be expensive although Playmobil battery locos are cheap. Rechargeable batteries may need to be replaced after certain intervals. Battery locos can reduce cost by running on cheap tracks though.
Track maintenance	Tracks must be able to conduct electricity. This means they should consist of brass and should be well connected via fish plates. Generally, track power requires comparatively more track maintenance.	Tracks don't need to conduct electricity although good brass track is recommended for durability and in case track power is used in future. Plastic track can be used. Generally, battery power requires comparatively less track maintenance.
Switch/point operation	Short wheelbase locos may stall due to lack of pickups over plastic frog section.	No such problem.
Charging time	Not applicable. Trains can be run anytime as long as electricity is available. Running at short notice is easy.	Can take several hours to charge. Running at short notice is difficult.
Continuous operation	Track power locos can run continuously for several hours or even days!	Batteries usually run out of charge in 1.5-2 hours time.
Multiple loco control	Difficult with analog DC. Requires more expensive DCC for this.	Each loco can be individually controlled via individual remotes.
Hauling power against time	Does not change because track power is continuous.	As batteries lose charge, the voltage drops and locos become slower or stall.
Loco hesitation	Possible due to track power discontinuity. Can be overcome via proper connectivity or adding capacitor based power buffer to loco. This can be expensive and difficult to implement for novice.	Not applicable.
Resemblance with prototype	Real trains don't carry their own power plant. Electric locos usually pick up power from overhead wire. Installing overhead wire in garden railways is very expensive (typically £20/foot).	More like real prototype - at least for diesel locos!

Weather proofing	Depends on loco design. Nothing to do whether track or battery powered.	Depends on loco design. Nothing to do whether track or battery powered.
Wiring	The track needs to be wired to carry electricity from indoor to outdoor. Some wiring is thus required.	Not applicable.
Loco availability	Plenty of readymade locos.	Still only few in numbers for off the shelf locos.
Metal wheels	If carriages have metal wheels, those must be insulated to prevent short circuiting.	No such issue.

1.5 Where do you buy trains from?

There are several manufactures but here I shall list only the most common/popular ones.

Here is a list of manufactures. Please note this is a just a basic guide for beginners and not an exhaustive list!

Manufacturer	Country	Locomotive			Rolling Stock	Track 45 mm brass	Accessories	Comment
		Track powered	Battery	Live Steam				
LGB	Germany	Y	N	N	Y	Y	Y	Pioneer of garden railway
Playmobil	Germany	N	Y	N	Y	N	Y	Closely linked with LGB
Piko	Germany	Y	Y	N	Y	Y	Y	
Accucraft	Britain	N	Y	Y	Y	N	N	
Roundhouse	Britain	N	Y	Y	Y	N	N	
Peco	Britain	N	N	N	N	Y	N	
Aristocraft	USA	Y	Y	N	Y	Y	Y	
Bachmann /Liliput	USA	Y	Y	N	Y	Y	Y	
TrainLine45	Germany	Y	N	N	Y	Y	N	
OcCre	Spain	Y	N	N	N	N	N	Makes track powered trams – assembly required

For best result (i.e. conductivity, strength, longevity etc.) use code 332 tracks if using track power.

Some tracks are incompatible with other brands' tracks!

European stocks use LGB's hook & loop style coupling. American stocks use knuckle style coupling.

1.6 How do I lay tracks in garden?

Unless you have a completely flat garden, you can't simply lay tracks and start running your trains (big difference from indoor model railroad). You need to lay the tracks properly. Take a note of the ***gradient*** in your proposed area of tracks. Ideally, track should be completely level. However, if you can't do it try to minimize the gradient. Aim for having only 1% gradient if necessary. As a thumb rule, each % of gradient reduces pulling power of locomotive by 50%. You should use a spirit level (or relevant Smartphone app) to measure gradient. If you discover that your garden has gradient much higher than this, then you either find a way to level the garden (parts where you intend to lay tracks) or have to buy a rack locomotive! Remember, gradient/slope is bad for your railway! If you must introduce grades, then note that straight tracks offer lower resistance to locos compared to curve tracks due to higher friction in flanges at grades. You need to decide on your curve radius too. On G scale, usually the minimum track radius is of 4 feet diameter (or 2 feet radius). Not all locos (especially the longer multi-bogie ones or standard gauge locos) will be able to run on this minimum curve radius tracks! If you plan to run larger locos later, then it is better to use a wider curve (like 8 feet or more) radius. Such tracks, obviously, will require more space to set up.

There are different ways of laying tracks. Start lurking in Garden Rail forums for ideas and look up on the web.

Here are some high level guidelines but in no way consider this as gospel
because I don't consider myself as an expert on this

- Lay trenches few inches deep. Fill them up with ballast (e.g. 6 mm granite stones) and then lay tracks on them. Make sure there is sufficient of drainage of rain water. This is a semi-permanent way of laying tracks.
- Create a permanent way using concrete. Lay tracks on top of them.
- Lay wooden planks, make them level, lay tracks on top of them.

You can check some videos on YouTube and elsewhere.

1.7 Track laying best practice

1. Use good quality tracks (e.g. brass track if using track power).
2. Tracks must be level. Even slight grade like 1% can greatly impact how much a loco can haul.
3. User larger radius curves as much as possible. However, because of space constraint, you may be forced to use R1 curves. Larger locos will require larger curves. Also, larger curves provide less resistance to trains - so longer trains can be hauled using same loco.
4. S curves provide high rolling resistance. If you use S curves with R1 radius tracks, loco may struggle at those points. If possible, add a straight section (longer than longest rolling stock) between the S curves.
5. Take car about the joints in fish plates. Use plastic clips to keep them together. Make sure there are no abrupt edges which may derail a train.
6. If tracks are joined using plastic clips, don't try to lift a section of track! It may cause fish plates to bend and render tracks as unusable!
7. Tracks need to be checked from time to time. Especially if you lay them on soft grounds like soil. Environmental factors may cause track to heave, move sideways etc. which may cause train derailment.

1.8 Hauling best practice

1. Do not overload the locomotives! Check how much they can pull. Add carriages to a point when they stall and then remove one or two carriages so that it can pull comfortably. Your track layout will have an impact on how many carriages each loco can pull.
2. If you push your train (i.e. loco at back), then trains can derail if lighter carriages are at the front. This is due to the fact that lighter carriages may climb over the rails at curves due to their low weight.
3. If you replace plastic wheels with metal wheels, it will lower center of gravity of carriages and will provide lower resistance and thus improve running of trains. However, metal wheels are expensive to fit retrospectively. Metal wheels keep the track cleaner too.
4. Locos may behave differently while stalling. For example, LGB track powered locos will spin their wheels where as Playmobil battery locos may simply stall.

2 Beginners Guide

So you are ready to take a plunge in the Garden Railway. Great!

Before you carry forward yourself in joy, here are few things you need to plan (if you fail to plan, you plan to fail).

Any hobby needs following consideration.

- Time
- Money
- Space

G scale is big! You need good amount of space. You will also need good amount of money (yes, it is relative but Garden Railway is an expensive hobby) and time as well (to lay tracks, run trains, researching on internet, browsing forums etc.)

Get some executive sponsorship from your spouse. Well, don't laugh. You will be spending a lot of money and time on this hobby so it is best to keep your spouse's expectation at the beginning.

In a very high level, you need to follow just 2 steps.

- Lay tracks
- Run trains

But reality is somewhat more complex (as with most cases in life).

You need to make a decision how you want to power your trains. In fact, this would be one of the most important decisions in your garden railroading.

For absolute beginners I recommend to start with:

- Any one of LGB starter sets (comes with 12 R1 curves making a 4 ft diameter circle)
- Playmobil 5258 (battery RC loco)
- Some more straight tracks (like LGB 300 mm, LGB 600 mm etc.)

This will create a basic loop. You can add bits later to extend it.

Wait 3-6 months (or a full year) to see how your railways cope with different seasons and then decide how to expand.

The advantage with this option:

- Cheapest to start with. You can buy a starter set that comes with analog controller and loco.
- If you wish to move to digital control/battery/live steam later, you don't need to change tracks.
- If you discover track power is good for you then you can expand your layout with track power. If track power does not suit you, then you can move to RC battery without any further investment in track power. If you are having problem with track power, these are likely to manifest within few months.

Why not start with RC battery in the first place?

Definitely you can (in fact I do advise you to start with Playmobil RC loco). It is your railroad and you are free to do anything as you like. If you start with battery loco, you can use any type of track (brass, aluminium, wood, plastic) you want. However, if you ever decide to use track power, unless you have laid conductive (e.g. brass) tracks, your tracks would be wasted. Also, battery locomotives are lot more expensive (unless you buy Playmobil) to buy (live steam locos are horrendously expensive). It is cheaper to convert a track powered loco to RC battery powered yourself. However, you may not want to do this without running trains first for few weeks/months.

What are the problems with track power?

- In track power, the tracks are fed with DC power supply. The track power to work, you must have clean rail heads and tight connections between joins (fish plates). Environmental factors (tree sap, leaves, dirt/muck/gunk etc.) often prevent train wheels/skates from having a good contact with rail heads. Even if you can see no dirt over railheads by naked eye, microscopic level of gunk can still cause locos to stall/sputtering. Things can be improved by frequent cleaning of railhead with mildly abrasive pads. Some people claim that digital track power less susceptible to unclean track (as they always send highest 20-22 V across the track and higher voltage can jump over microscopic thickness of dirt) but that is debatable.
- During fall season, leaves may fall over track and once loco rides over a leaf, the contact with rail head will b e lost - resulting no power to loco.
- Resulting vibration from trains running (G scale trains are heavy) and other environmental factors (e.g. pet movement, strong wind, accidental damage by humans like children playing etc.) can cause fish plates to become loose and thus causing dead sections in track due to break in conductivity. Veteran track power users use rail clamps to overcome this problem. But this works extra effort.
- Some track configuration (e.g. reverse loop) is far simpler when not using track power.

Should I buy new or used?

For the very first start, I recommend buying new loco and tracks. Used tracks may have loose fish plates which would cause problem with track power. Also, if your loco does not work (unlikely) then you can revert back to manufacturer. Once you are experienced in the hobby, then buying used make sense.

3 Dummies Guide to convert a track powered G scale locomotive to RC battery powered

As of now, some of the RC battery locomotives you can buy off the shelf are:

Manufacturer	Model names	Price £
Playmobil	5258	100
Roundhouse	Harlech Castle	900
Roundhouse	Little John	550

Playmobil is entirely made of plastic and intended be to children's toys rather than adult hobby items. However, Playmobil RC locos are still very popular among garden railway enthusiasts.

In fact, I do recommend that you get one if you don't have any already.

I have nothing but all good things to say about Playmobil 5258 loco.

However, if you want something better (i.e. heavier hauling capability, metal wheels etc.) then there is not much option in the market as of now. The Roundhouse locomotives are while very good have following issues:

- Very expensive
- Not enough details (compared to LGB/Piko/USA trains etc.)

Solution

To have a good quality RC battery powered loco, the only available option is to buy a reasonably priced track powered locomotive and convert it to RC battery power yourself.

If you adopt this route, then your total cost would be, cost of loco + £100 to £150, which is considerably cheaper than buying Roundhouse RC loco for £900-£1000.

If you are not confident (*although I believe you will become confident after reading this article*) you can ask some experts to convert it for you for you (at an agreed cost if it is offered as a service).

Conversion steps

Step 1 - Find a suitable locomotive for conversion

You need a locomotive first! You can use your existing track powered loco if you have it. But the loco needs to satisfy following attributes before you plan conversion.

1. Enough space inside to keep battery pack (at least 8-10 AA size batteries). If you don't have enough space inside of loco to place battery pack, you can always put stuff in a separate wagon/tender. However, then you always need to pull the RC wagon whenever

you want to run your loco. The loco should have a socket for connecting wire at the back (many LGB locos will have this connection but not all of them). This may also affect aesthetics of your train as reverse running may look awkward with a leading wagon. The RC receiver circuit boards are usually small - so as long as you can fit battery pack inside, the circuit board should not be a big problem.

2. One motor (if you can convert locos with 2 motors once you are experienced but I would not advise as a first project)
3. The procurement cost is reasonable (if the cost of loco + RC equipment costs in the region of of-the-shelf RC locos except Playmobil then not much point in conversion unless you want to do it for fun)

Step 2 - Open the Locomotive

Note: If you are planning to put RC equipment in a trailing wagon/tender, you can skip this step.

As a beginner, you may find it most daunting step. How to open your loco depends on your loco type. You need to download an exploded diagram of components of loco from manufacturer's website and observe which screws need to be removed to open up the loco.

Some screws may be difficult to access unless you remove the motor block as well. If you do so, you need to be able to re-assemble the loco afterwards.

You are most likely to need following types of screw drivers (usually for LGB locos) - PH0, PH1, PZ1.

It is up to you whether you want to remove all track pickup components. Removing pick up skates may improve hauling power of loco slightly (as it causes some drag). If you are not confident removing all track pick up components, you can leave them as it is.

However, what you must to is to make access to motor terminals. In most LGB locos (if not all) the motor block has 4 pins. The inner 2 pins are for carrying power from track to control board. The outer 2 pins are for carrying power from control board to motors. You should isolate the inner 2 pins. You can leave the pins protruded from motor block but make sure you don't connect anything to these pins.

Leave your loco open (i.e. don't attach screws again until you have converted it to RC battery power).

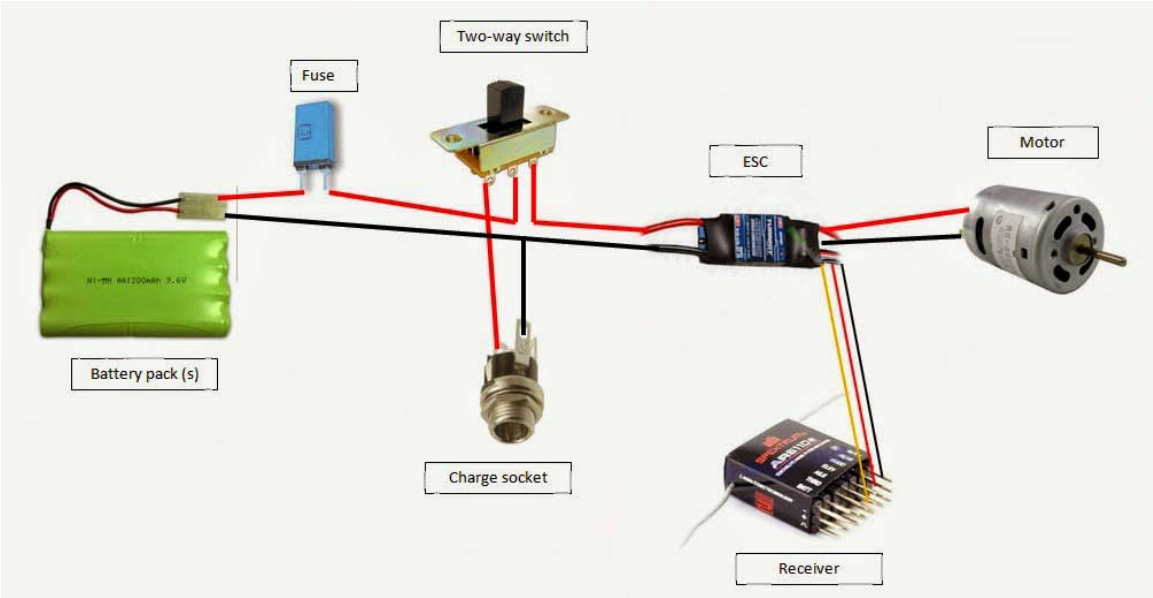
Step 3 - Choose your remote control electronics

Step 3a - Understanding the circuit

At a very high level, you need something to control the input voltage to motor so that loco speed (and direction) can be controlled. You will issue command from a handset (also known as RC transmitter) which will tell the RC receiver (inside loco) to adjust the voltage.

Strictly speaking, you need at least 2 items inside the loco - the RC receiver and electronic speed controller (ESC). The receiver receives the signal from transmitter and ESC controls the speed. The good news is that many circuit boards have built in receiver and ESC inside them.

This can be diagrammatically represented using following image.



Please note following points:

- Receiver + ESC can often be combined in single circuit board (if you choose in that fashion)
- Switch + Charing Socket can be dispensed with if you use standard rechargeable AA batteries

This will make your circuit very simple! All you need to do is to connect 2 wires from battery pack to circuit board (maintain polarity) and 2 wires from motor (polarity does not matter) to circuit board.

Step 3b - Procuring the RC equipment

You need to buy RC electronics components from market. There are several options and I list only few of them. Depending on where you leave in the world, some options may not be available to you.

This is not an exhaustive list in any way.

Also be aware that while buying these components, if you more likely to deal with individual persons rather than large corporations. So, adjust your expectation (purchase process, communication, payment, warranty etc.) accordingly.

Maker	Receiver	Transmitter	Input Voltage DC	Max Current Ampere	URL	Comment
Deltang	Rx65	Tx20 or Tx21	3-18	3	http://deltang.co.uk/	You can buy from several resellers
Cliff Barker	Custom	Custom			http://www.cliffbarker.talktalk.net/SpeedControl	

					ler.html	
Peter Spoerer	Viper 10	User's choice	6-12	10	http://www.peterspoererrmodelengineers.com/	Only sells complete package
Brian Jones	MacFive LA	User's choice	6-18	1	http://www.brianjonesmodels.co.uk/page3.html	
Crest Electronics	Revolution Receiver	Revolution Train Engineer		5-8	http://www.crest-electronics.net/	Most sophisticated control
Chuffed 2 Bits	Deltang derivation	Tx			http://www.chuffed2bits.com/page2.html	
Railboss	Railboss transmitter	User's choice e.g. Spectrum	7-25	5	www.gscalegraphics.net	
RCS	DSM2	Tx	6-18	1-3	www.rcs-rc.com	

Step 4 - Actual conversion process

Connect relevant terminals of receiver with battery and motor.

Depending on what type of equipment you are using, you can connect wires by

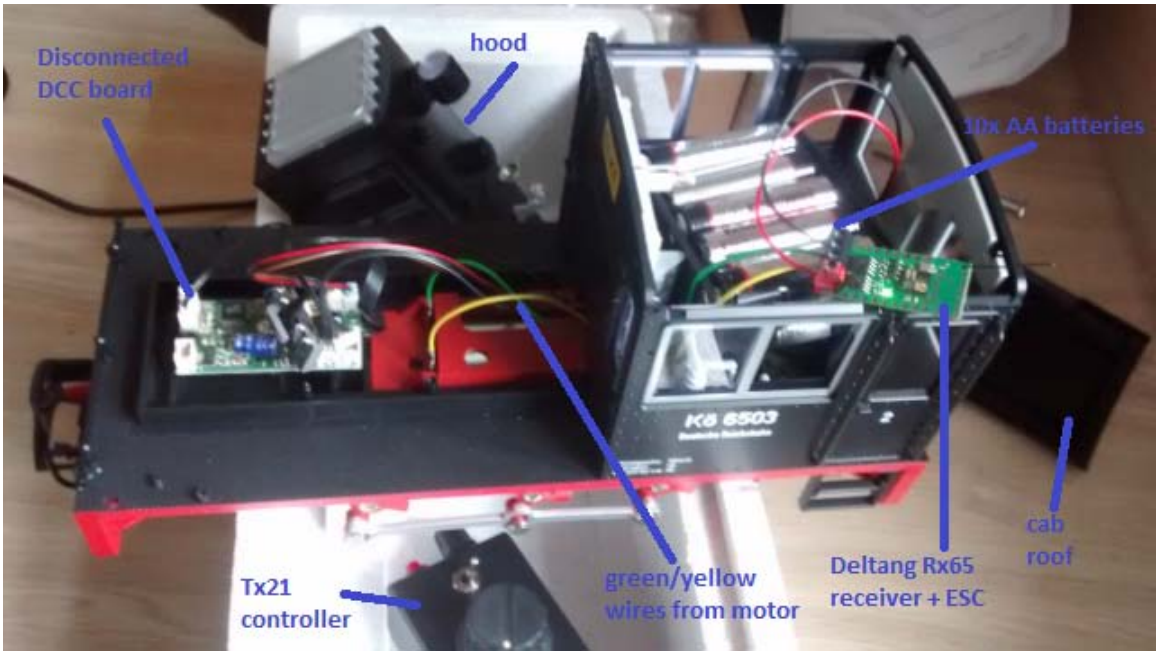
- Soldering
- JST/Tamiya/BEC connectors
- Screw terminals
- Wago connectors or similar

Usually you need to *bind* receiver and transmitter. For how to do that, refer to your circuit board maker's instruction manual.

Transmitter needs some batteries to power it. Depending on model chosen, it could be via 9 V PP3 or AA/AAA batteries.

Once you have tested the loco for RC, put screws back and enjoy your newly converted RC battery loco.

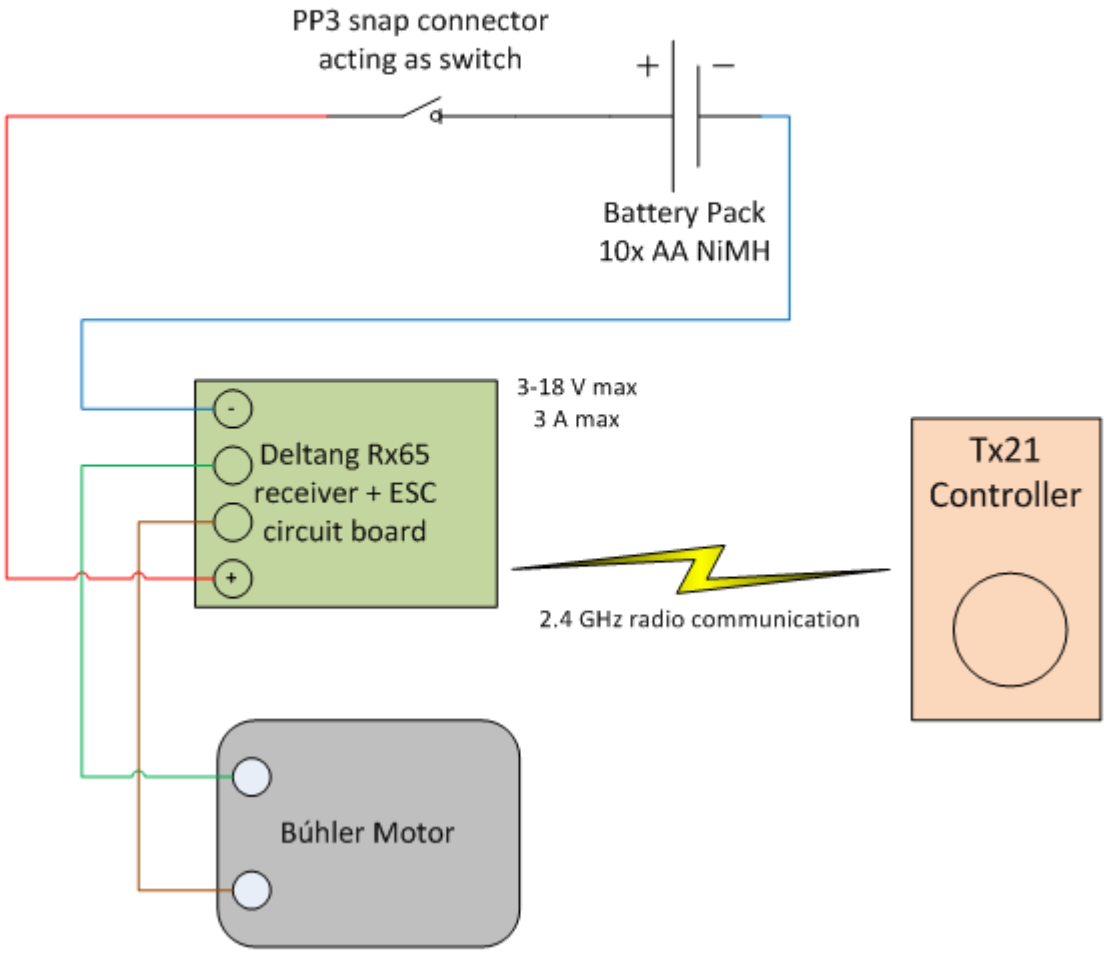
There is an example image of the conversion.



Locomotive: LGB 22620 Kof diesel 0-6-0
Receiver: Deltang Rx65
Transmitter: Tx21
Power source: 10x NiMH AA rechargeable batteries

The batteries are connected to receiver circuit board by a PP3 snap connector (red/black wires) which is screwed to circuit board. The green/yellow wires are connected to motor at one end (via crimp connectors) and to circuit board via screws.

Most basic circuit diagram
for RC battery conversion



Above diagram demonstrates the basic circuit. Please note that it does not show fuses but you advised to add them. One fuse should be just after snap connector and another one just before motor.

4 Reference

4.1 Computer modelling of track layout

www.scarm.info

4.2 Online reference

There are loads of garden railway related websites. Here only few of the forums are listed.

www.mylargescale.com
www.gscalecentral.net