# Bees and P2P Food

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## 1 The governance of community gardens

Both Annemie and Peter are setting up a community garden. Annemie is opening the fantastic rooftop garden that she built over the past years to other people in the neighbourhood. Peter is discussing with the local authorities of La Plaine Commune, in La Plaine St Denis, to start a new community garden. Both Annemie and Peter are wondering what rules should be put into place to assure to good functioning of the garden.

### Collective/private parcels

One of the first questions is whether each participant can have its own piece of "land", whether the available space should remain collective, or whether some intermediate form is best.

In the collective gardens in Paris, Michka observer several models regarding the "collectivity" or mutualisation of growing space. On one hand, some gardens were reproducing the "allotment" scheme, with "private" planters assigned to one or two gardeners. On the other hand, some gardens prefered a global collective growing space were anyone is allowed to plant and gather anywhere - and members put a label when they seed to make sure no one seeds something else right after you.

In my opinion, what should drive the choice for one model or the other is the personal motivation of the gardeners in the garden. Do the gardeners participates in the garden to grow vegetables and expects to harvest these vegetables ? Are they interested in planting some rare vegetable they cannot find on the market ? If so, a collective garden in which everyone takes what she wants, might be frustrating. If on the other hand the goal of the participants is to socialise and cultivate a green space, whatever the harvest, then a collective garden may be okay.

An intermediate solution would be that some part is reserved for private usage, and some parts are free for experimenting and collective usage.

In both situation (private/collective spaces), how to make the best of companion planting ?

A possibility is that a member can have a private space only if she uses it to perform agricultural experiments which cannot be properly managed in the collective space.

## Legal structure

In most of the cases of collective gardening, an association is set up at the start, in order to facilitate the communication with the land owner and also to have a basic insurance covering.

The agreements with owners will be different following the status of the owner : a government agency e.g. the city council or a private owner or a company. In some of the cases it can be good to start an NGO or another (legal) form of association. Probably a legal form will give more confidence towards the owners of the land.

In each country, the steps to create a non-for-profit organisation will be different :

- In France : association loi 1901
- In Belgium : VZW

## Meetings/mediation

How should meetings be organised ? Open meetings are often controlled by those who speak loudest/fastest. It is important however that eveyone can express their opinion in a open atmosphere.

How can the collection of propositions be uncoupled from the debate and decision taking ? How to provide a safe space for everyone to make propositions and share their opinion ? How to fight against unconstructive leadership in the group dynamics ? We can use writing online tools to collect propositions, but will people take the time to participate ?

There is probably the need for a mediator (or conciliator) to guide the discussions. He can increase the time efficiency, and the collection, constructive discussion and distribution of propositions. There is extensive literature on how to mediate. The “sociocratie” mouvement also has develop alternative work methods. For example, at the start of the meetings a mediator is chosen from those present through anonymous election without anyone explicitely presenting as candidate. Online tools could also be used. For example, in a first phase, opinions and propositions are collected through email, online submission forms, or over the phone. In a second phase, each of the ideas are debated. This gives some space to everyone to provide input into the discussion outside of the social arena.

VELT, the Flemish, community gardens association, has a list of pitfalls and good practices when creating a new garden.

## Create a physical link between the garden and the platform

Connect the real-world space and the virtual space. The two spaces have to be integrated as much as possible. This is also important to integrate non-technological-friendly profiles.

## Membership

Both initiators (later also the moderators ?) choose yet possible group members, depending on different factors : - for Paris : family, local, neighborhood, self sufficiency, biodiversity - for Brussels : experimental, self-sufficiency, biodiversity, health (zen), herbals, preparations A later admission to the group can be made on several criteria : - waiting list - godfather - financial contribution

- What rules to become a member ? Use the collective plot as a test bed to integrate anyone motivated, and test its real implication before integration as a member and getting her a private space.
- Members should come from the neighborhood.
- New members could be proposed by existing members (parrainage/godfather).
- Financial contribution : A symbolic pecuniary participation (10 a year) has to be paid to become a ”full member”. This payment can be a small barrier to entry but increase the member’s commitment. Other ways of financial contributions to the group should be researched : equal shares ? more input is more output ? local currencies ?
- How to deal with the fact that there will not be room for everyone ? If

some people are frustrated not to be able to be part of your collective garden, provide your experience to help others in setting up their own.

- How to make sure it is a place for everyone in the neighborhood, and not only for a specific social community ? Organize social events in the garden, opened to everyone, like the "Season Soup" in le Jardin Nomade.
- How to deal with other cultures in the neighborhood ? Complicated question, especially regarding the Romas, which have a profoundly different rule system.
- Financial aspects. How to deal with insurance payments, equipment costs, and so on. Only on membership participation ? How to define the amount of this participation ?

(Question : What does Ostrom say on "membership" for a highly-demanded common ?)

## 2 Governance model : the management of common-pool resources

A common-pool resource (CPR) is the term used by Elinor Ostrom instead of the more generally used term Commons in her book "Governing the Commons".

It seems that a community garden can be considered as a CPR, and that Ostrom's analysis is relevent to study community gardens.

The difference between a common good and a commons is that you can exclude someone from the second (e.g. restrict access to a water source) but not from the first (e.g. restrict access to breathing air).

It's important to note thate there are different layers of rules in the CPR system. Usually CPR rules are subject to rules at a higher-level (e.g. formal legal system).

For a politcal theorist, an institutional organisation is viable if the following aspcets can be explained :

1. Why is the institution created ?
2. How does it ensure the commitment of the members.
3. How does it avoid free-riders.
4. How does it ensure that rules enforcement (sanctions).

Ostrom discusses two main classes of CPR probles :

1. Appropriation problems : who can take what from the commons ?
2. Provision problems : who maintains the commons ?

# 3 Governance model : Cooperatives

A cooperative can by loosely defined by the following two characteristics :

1. It is a commercial enterprise that is owned by its employees (employees = stake holder, stake holder = employee). Employees are directly interested not only in their personal income and interests, but also in the sustainability of the company, as it is the source of their income. Because the fate of the employees is linked to the fate of the cooperative and vice versa, the general opposition between employer/employee is much reduced.
2. Each employee has to same voting right. Decisions in the cooperative are collectively taken by all the owners-employees. To ensure equilibrium and long-lasting cooperative work, the ”One man, one vote” rule is applied. Wether you are owner of 50% or 1% of the company does not count in your weight for a decision.

A major concern of most cooperatives is its long-term survival. The benefits of the enterprise are often used to assure the continuity of its activity. Cooperatives have often ”security funds” to ensure their resilience (for instance in case of equipment failure). They also have some sort of in-house social security. Cooperatives have many different policies to how this fund is created and who/when/why this fund can be accessed.

Cooperatives statuses are highly differentiated, adapted to the context of the companies, and usually highly-responsive through fine-tuned democratic processes.

The rules that govern the cooperatives evolve constantly (also because the legal framework imposed by the state evolves). In a cooperative, only the “vision” is continuous. The members, its structure, its status continuously change.

A cooperative can kill itself, if the powers in the company are not well-balanced, or if most of the crew abandons the vision – which is the number 1 reason for success or failure, and one of the weaknesses of this form of organisation.

Inequality of income between members is not necessarily a problem, as long as there remains a balance. A farmer who own 15 cows will earn more than a farmer who only own 2 cows.

How decisions are taken depends from one coop to another. It can be through a majority vote or through consensus, or through more complicated schemes such as hierarchically embedded decision units. Mediators play a very important role in cooperatives to resolve internal conflicts.

More and more companies opt for "for benefits" status, instead a "for profit" one. "For benefits" companies target global social benefits for their employees and society at large, rather than only "profitable" economical ones.

# 4 Community garden in Brussels

The rooftop garden in Brussels was started by Annemie. Now she want to open her rooftop garden to others. She know several people in her neighbourhood that are interested in joining the project. Annemie's garden is well documented elsewhere (opengreens.be).

The legal status of the garden is in a precarious situation, as there is no written but only a verbal agreement. As long as the co-propriété does have a profitable activity in mind with the rooftop, there is probably not an immediate danger for expulsion.

For the UAF (urban artfarm) we are thinking of writing a charter or a manifesto in a collective writing session.

# 5 Community garden at La Plaine

The initiative the start the garden in La Plaine was taken by Peter Hanappe. Peter contacted Suzanne de la Fuenta, teh former “responsable démarche quartier”, who is still close to the

There is 120m2 of cultivatable ground avialble. There are

– 2 raised beds of 50cm high, 1m wide and 15m long (30m2),
– 2 raised beds of 70cm high, 1m wide and 15m long (30m2),
– 1 raised beds of 10cm high, 3m wide and 20m long (60m2),

The last bed (60m2) is the extra or experimental bed.

For the organisation of the community and the set of rules to be decided, Peter wants to guarantee that :

– a minimum number of rules are used (simplicity)
– the community has the autonomy to change the rules (autonomy)
– no one gains too much influence, or that no one takes the ownership the garden (division of power ?)
– the rules are respected and that the garden and its infrastructure are maintained (monitoring/sanctions)
– a positive atmosphere reigns (conflict resolution)

There could be two types of participants. The first type, the “members”, pay an annual membership fee (to pay the insurance for example) of 10 euros. They must agree to the charter of the garden and must/can also participate in the decision taking. They can get a small piece of “dedicated” land of 2m2 that will be taken from the 60m2 of raised bed gardens. The number of “full” members should remain smaller than 30 people/families.

The second type, the “visitors” don’t pay a fee. They can’t take decisions and don’t have their dedicated plot. They do have to agree to some basic set of rules (clean up...). They can work on the 60m2 of extra plot that we have available. We need visitors so we can invite people into the garden so that they can experiment (even for one afternoon). This should allow people from the neighbourhood to come into the garden and have some activity and avoids a feeling of exlusion. It also allows schools to participate.

If there are too many people interested, they should be stimulated and helped to start a new community garden.

Other rules to be studied :
– mix of species : There could a rule to favor the experimentation on the combination of species

# 6 Alternative economies

An example of alternative economies in Belgium is http ://letsvlaanderen.be, where citizens organize into local groups for the exchange of services, based upon working with a ’token’, in this case LET.

# 7 Website and database

## Database and entry forms

The OpenGreens database offers a rich set of data structures to capture the data of the gardens. Lessons learned :

1. Reduce entry time.
2. Allow cross-bridging between fields in the database to allow re-entry.
3. Be able to connect the pictures with every type of entries.

We learned from the existing database that complexity and too many possibilities can lead to a non-use of the tool.

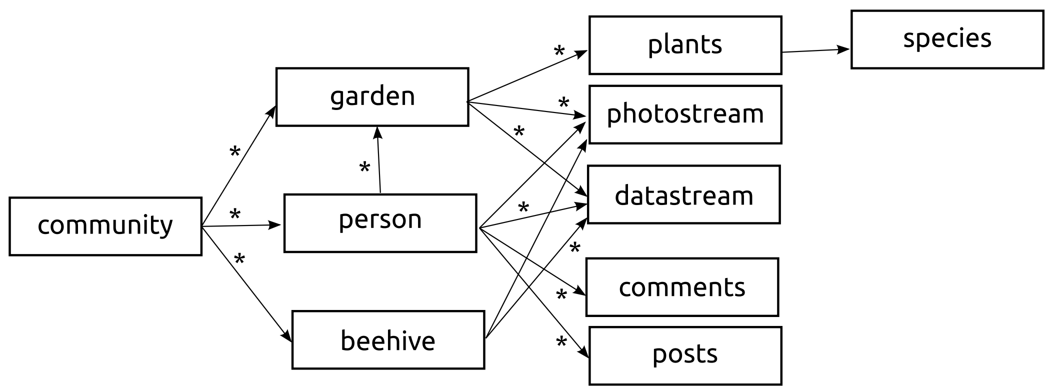
To facilitate the entry of the plants used in the different gardens, we can print out labels with a QR code. It's not defined yet what should be on the QR code, or whether one or more QR codes are needed. The possible information includes the code name, the genus, the species, the variety, the plant-date and the GPS location. You can then print the QR code, and put it in your garden as a label near the plant. Using a smartphone with the P2P Food Lab software, a camera, GPS, and Internet access, people can take a photo of the label and the information will be registered in the online database. The QR code could also be used by the webcam in the greenhouse to detect the plants that are being cultivated. Everyone can create an entry, as the QR code directly codes for the information of the entry, no need of centralized code generation. Once the QR code is scanned we can add additional information and observations later if necessary.

Design principles for DB front end :

- The entry should request only minimum necessary information.
- Entries should work as much as possible with default values that only have to be changed if necessary.
- Request minimal information to create an entry, but allow to add more fields to complete the entry if necessary. Allow also for facultative display of entry information, to avoid long and unclear entries.

## Database schema

First draft :




## Social media

Direct meetings (in the garden) can be held instead of online discussions (forum, blog). A blackboard in the garden can display the recent information, including a summary of the online activity so that people without easy Web access can follow the activities. The website/blog can have a newsletter or news section that summarises the info.

We need tools for monitoring the garden and tools for creating the knowledgde database. We should define clearly what is the added value of another garden database.

## Web site

Discussing the provided outcome of the P2P Food Lab project, we can distinguish 2 broad sections :

– A practical section, the field studies
– A reflective section on social innovation

For now we will look at the communication/documentation only from the practical approach.

We will set up a shared docu-system where all field-workers can contribute to, a system that can justiy the approach of citizen science and community memory.

If we want to be sure of frequent contributions, we have to make the system as accessible and flexible as possible.

In the beginning we should opt for a combination of existing tools with one single login. We can look into Wordpress or Tumblr, linked to Flickr for a photostream and Padma/Pandora for a videostream. We will also add a datastream (via Cosm) for the sensor data from the gardens (see diagram Peter).

For the garden-monitoring-contribution to these blogs/wiki's/websites, we will develop a cross-platform app on mobile phones.

Design principles :

- What are the minimum requirements to have a useful web site ?
- Reuse existing services and develop only what is specific to our project ("added value").
- Develop open-source versions only when there is enough demand : To allow complete control and transparency, we should develop in-house tools for blogging, pictures storage, data storage, and so on. But this requires a huge amount of work, and we will have to think where we want to put our energy in priority. Maybe if we motivate several partners (ReFarmTheCity, FabLabBCN, OKNO, Sony...) we can generate the critical mass to develop such tools quickly and allow their maintenance.

Technology :

- Wordpress (P2P Food Lab) : blog posts, personal portal, community portal
- Cosm (Cosm) : datastream
- Flickr (Flickr) : photostream
- Pandora (P2P Food Lab) : video (not in diagram)
- MediaWiki (P2P Food Lab) : knowledge base
- OpenID : for authentication ( ? ? ?, alternatives facebook, Google accout, www.clavid.com, ...)

# 8 Beehive

## Robustness of the sensor network

Annemie has issues with one of her sensor networks which continuously stops working. This is a key issue we have to tackle for P2P Food Lab and BEE-O-ICT : if the sensor networks are not robust enough, the users may lose heart and all the participative aspect of citizen science may collapse.

## Electromagnetic rediation

The bees do not like the PC boards. They left a super (une hausse) empty between their broodcase and the super hosting the PC board. They may be disturbed by the clock frequency ? Luckily, they do not feel visibly disturbed by the sensors.

## Monitoring

The main objective is to monitor the health of the beehive, not to produce more honey. We want to monitor when the beehive collapses, and when to intervene – and hopefully, how to do it correctly. The monitoring should be as little intrusive as possible. Every disturbance costs the bees energy and it may take them a day before there are back into their normal activities after the beehive has been opened. The goal of the intelligent beehive is not necssarily to understand the bees but to help them and to detect when there are problems.

Annemie faces problems with robustness of the Arduino sensor solution. The Arduino has to be (very) regularly rebooted. It is not clear why. The best solution will probably require some trial and error. The Arduino may have to reboot automatically using a timer.

For exterior, we should work with professional sensors. The current sensors are suited used for hobby projects only. The sensor in the OKNO beehive are currenlty not wokring. They may be broken, or there may be problems with the wiring. Because of the conditions (ouside, difficulty to replace broken sensors) is is probably wise to use simple and robust sensors.

1. Temperature outside and distribution of temperature inside. This allows us to locate the kernel through interpolation, and get a value of the average temperature, reflecting health of the colony (optimal is 35 C). [(o)] Temperature sensors grid with a natural comb shape ?
2. Humidity : This is also a health parameter, as bees keep normally humidity at a constant 60% in the hive.
3. Visual stream : Camera at the front of the beehive
4. Bee counter : See also this instructable, [todo : link], and this company, http ://users.telenet.be/lowland.
5. Weight of the beehive : to measure the weight of the bees and the weight of the honey. Precision expected : 100 g. (see also www.beewise.eu).

6. Audio : the beehive in Barcelona measure the sound intensity (decibels). Annemie is not sure about the usefulness of this measure. A more interesting sound analysis is measuring the frequency band of the bees' sound. A higher pitch may indicate a healty colony. A low pitch may indicate the preparation of a swarm. (see the Apidictor, http ://www.instructables.com/id/iphone-apidictor-for-acoustal-beehive-swarm-detect/).
7. $CO_2$
8. An e-nose in beehive to categorise the honey is difficult because the bees will cover it with propolis. Seems like another research axis.
9. Chemical analysis of honey, beewax and propolis : this will be done by external labs.

## Design principles for a biomimetic bee-hive

1. Form : Ideal capacity is around 35-38 L. When you leave Apis Mellifera (Europe) in the wild, they usually install themselves in a hollow tree, whereas Apis Dorsata (Asie) directly builds its comb on a tree branch outside. When you leave Apis Mellifera in a box without structure, they build their combs in function of their relative position to the sun, together with design elements from their previous beehives. In human-designed beehives, we can distinguish to types of frame alignments : perpendicular to the entry, or cold type, as it allows an efficient air circulation ; or parallel to the entry, or warm type, as it reduces air circulation and increase thermal inertia of the hive. We have to find a trade-off between an organic, natural shape which bee-hives refined over the years, and an ergonomic shape allowing us to monitor efficiently what we want. Annemie sees a beehive imitating the natural shape of comb - elongated semi-spherical shape - hanging from a tree with an entry from the top.
2. Materials : Annemie sees a mix of beewax and propolis. This material, easy to melt and therefore to print, would allow us to have a great liberty in shape. My only concern is with mechanical strength, and the relative precious character of this kind of material, which may be "wasted" in such a structure. However, combs are made of wax, so a beehive made of bee-produced materials would be elegant. According to Annemie, beewax and propolis do not have a signature of a specific

bee colony, so we can easily recycle propolis and beewax from other beehives. We could also support some of the shape with textile - based on locally grown hemp and linen. Annemie's hypothesis is that a beehive in wax/propolis/resine is better for well-being of bees.

3. Equipment : A self-sustained thymol-based (or other) varoa repulsive system.

Annemie's main objective through Bee-o-ICT. Help bees to survive, and find new ways to support them.

Apis mellifera specialize on one plant type. They get all the pollen from one specific plant before switching to another one.

## Non-invasive temperature sensing

In a minimalistic beehive, where bees build all the structure by themselves, we have to insert sensors afterwards. A way could be to use catheter-based systems to insert chirurgically sensors in the structure with minimal destruction/influence.

## Temperature monitoring grid design

It may be possible to observe the position of the bee nucleus using only a few sensors combined with a temperature conduction/convection/radiation model. However, before we can be sure what the appropriate density is of the sensors, we will use a set of sensor on a 3D grid. From this data we can extract the appropriate model/sensors for a simplified monitoring system, and we may observe other interesting phenomena.

For a fine integration of sensors, we can take inspiration from previous work on smart textiles.

On each frame, four sensors on each corner, then four sensors in a smaller square in the middle of the frame, and then one sensor at the very center of the frame (see Fig. 2) Sensors are thermistors, a small resistive element whose resistance varies with temperature, encapsulated in glass. Such sensors are more robust than more sophisticated ones, with a small circuit allowing the conversion of resistance in voltage information. We will let them naked on the frame, and let the bees cover them with propolis. We will just assume a given response time due to this thermally insulating layer. We will connect the sensors to the ground through cables structuring the frame, so that we can power them with only one wire – which already makes $12 \times 9 = 108$ wires for the whole broodcase. The wires will be selected to be as thin as possible – only a single copper wire coated with (bee-compatible) polish. Each sensor will be connected to a analog multiplexer so that they can be measured one at the time. A Wheatstone bridge is used to convert resistance information in voltage information (see Fig. **??**). This Wheatstone bridge will be installed out of the frame, and connected to a multiplexer allowing to read the 108 sensors using a single Arduino chip. The thermistor resistance range will be selected so that the wire resistance can be neglected. Electro-magnetic fields generated by the grid should not be a problem, as only changes in current and tension generate them. If we monitor at very low frequency, we should not produce disturbing electro-magnetic fields for the bees.

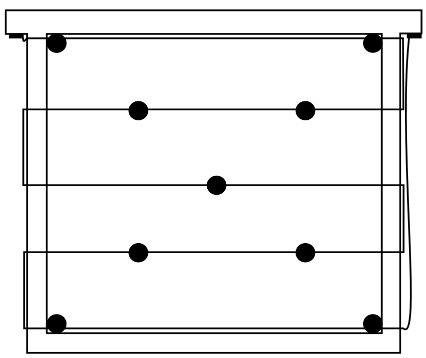


FIGURE 1 – A frame of the beehive with nine thermistors on the metal wire.

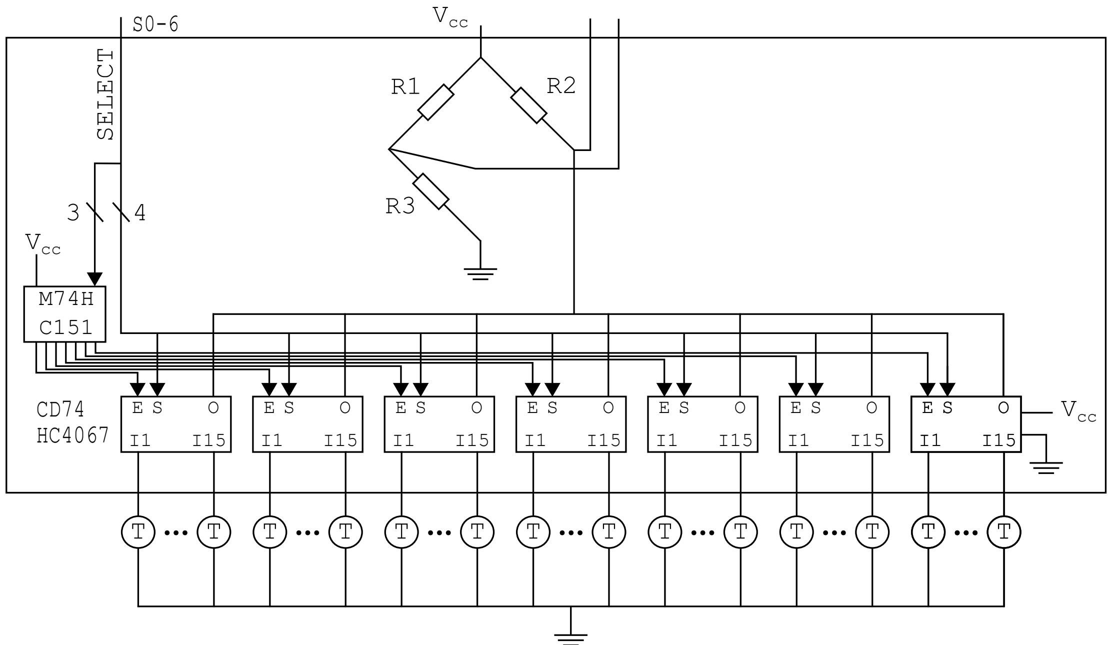



FIGURE 2 – The multiplexer board and Wheatstone bridge.

| Component | Specs/number | Quantity |
|---|---|---|
| R1 | 100k | 1 |
| R2 | 100k | 1 |
| R3 | 560k | 1 |
| Analog multiplexer | CD74HC4067 | 7 |
| Digital multiplexer | M74HC151 | 1 |
| Thermistor | EPCOS B57560G104F | 108 |

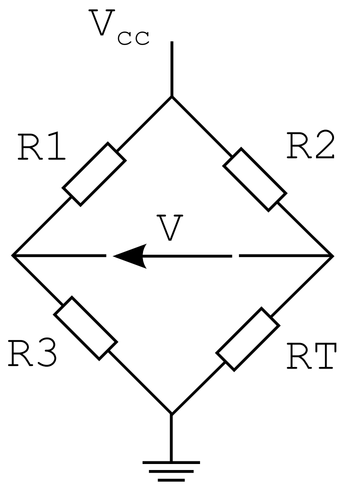



FIGURE 3 – Wheatstone bridge.

**Setup 1**

- Wheatstone bridge, R1=R2=R3=100k.
- Output voltage : -1.348 to 1 V.

| T (°C) | RT (kΩ) | V (V) |
|---|---|---|
| 0 | 333.964 | -1.348 |
| 10 | 201.659 | -0.842 |
| 25 | 100.000 | 0.000 |
| 35 | 64.759 | 0.535 |
| 45 | 42.951 | 0.998 |

**Setup 2**

- Wheatstone bridge, R1=R2=100k, R3=400k.
- Minimum tempartures : approx. -4 degrees.
- Output voltage : 0.152 to 2.5 V.
- With an amplifier this can be brought to a voltage range of 0.3 to 5 V.
- Using a 10-bit ADC between 0-5V, this gives 962 discrete temperature readings.

| T (°C) | RT (kΩ) | V (V) |
|---|---|---|
| 0 | 333.964 | 0.152 |
| 10 | 201.659 | 0.658 |
| 25 | 100.000 | 1.500 |
| 35 | 64.759 | 2.035 |
| 45 | 42.951 | 2.498 |

**Setup 3**

- Wheatstone bridge, R1=R2=100k, R3=560k.
- Minimum tempartune : approx. -9 degrees.
- Output voltage : 0.395 to 2.740 V.
- With an 1.82× amplification this can be brought to a voltage range of 0.73 to 5 V.
- Using a 10-bit ADC between 0-5V, this gives 874 discrete temperature readings.

| T (°C) | RT (kΩ) | V (V) |
|---|---|---|
| 0 | 333.964 | 0.395 |
| 10 | 201.659 | 0.900 |
| 25 | 100.000 | 1.742 |
| 35 | 64.759 | 2.277 |
| 45 | 42.951 | 2.740 |

**Setup 4**

- Voltage dividor, R1=100k.
- Output voltage : 1.502 to 3.448 V.

| T (°C) | RT (kΩ) | V (V) |
|---|---|---|
| 0 | 333.964 | 3.448 |
| 10 | 201.659 | 3.342 |
| 25 | 100.000 | 2.500 |
| 35 | 64.759 | 1.965 |
| 45 | 42.951 | 1.502 |

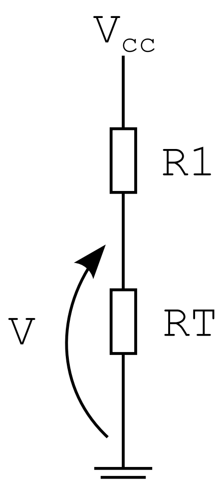



FIGURE 4 – Voltage division.