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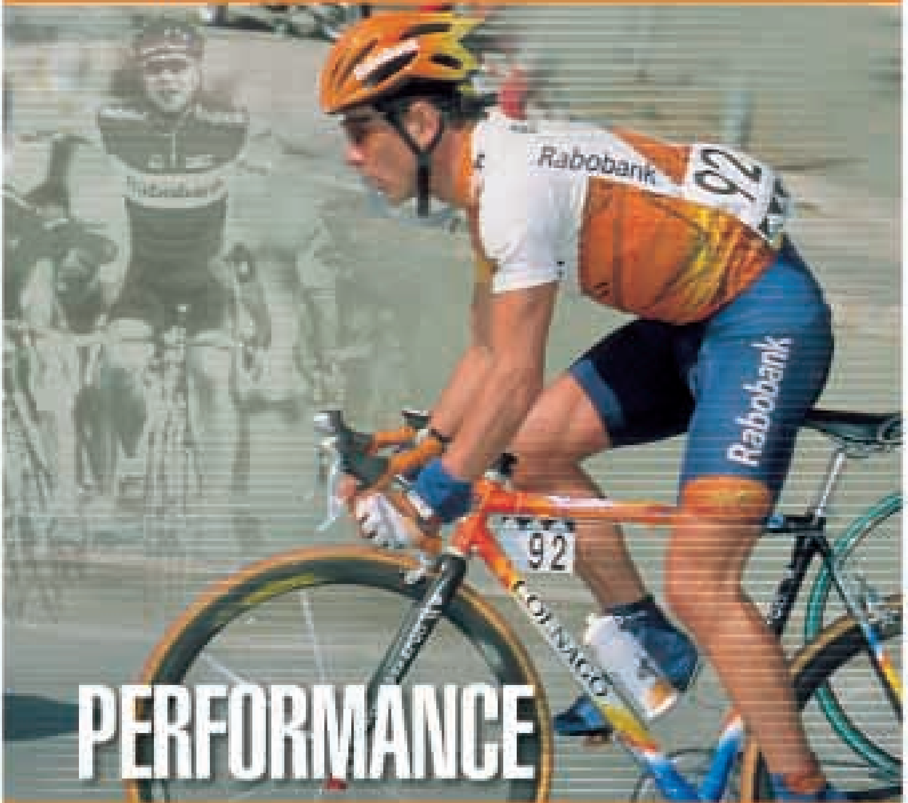


# PERFORMANCE CYCLING

POLAR

# POLAR PERFORMANCE CYCLING

**A comprehensive guide for your personalized cycling training.**



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- The measurement of the maximal lactate steady state (MLSS) using a single exercise test
- The estimation of heart rate at the MLSS using a single outdoors test, in experienced cyclists
- The effect of environmental conditions (temperature, wind) on heart rate and power output in cyclists
- The effect of strength training on cycling performance

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# Index





# Introduction

This “Polar Performance Cycling” guide is aimed at cyclists with various levels of fitness and with different objectives. Competitive as well as recreational cyclists can get the necessary information from this booklet. Of course, we don't pretend that after reading this booklet every reader will be capable of designing a training program that is perfectly tailor-made for him/her. That requires the knowledge and dedication of a coach. But our minimum aim is that every reader can set up a training program without making any major errors.

Step by step the principles of making and following a training program are explained. Firstly, some general training principles are explained. This is followed by a clarification of the maximal lactate steady state (MLSS) and how to determine this MLSS. Thereafter the heart rate zones (based on the MLSS) and the corresponding types of training are explained in detail. In the final chapter it is explained how to set up a training program.

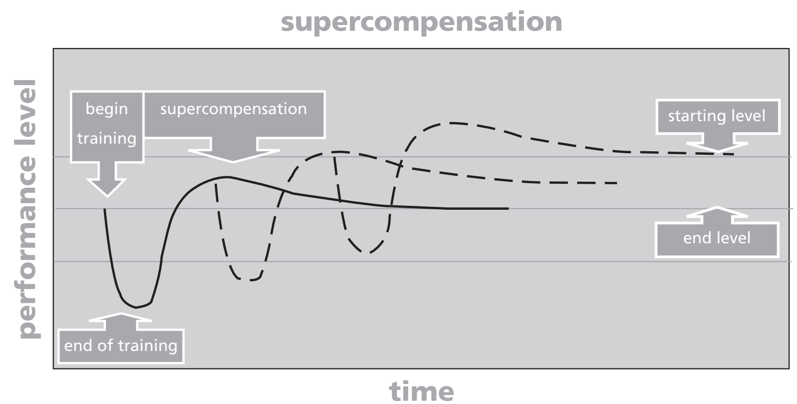
# 1. General training principles

## 1.1 Damage and recovery

The first generally recognised training rule is that training progress is caused by the recovery after a training, and not by the training itself! Training is nothing more and nothing less than causing damage to your body. After this damage, nature takes over and repairs, but not back to its original level: the recovery process goes a bit further. In other words, the body enhances the damaged tissue (for example a muscle). This additional aspect in recovery is called *supercompensation*. Supercompensation starts some time after training and then disappears again a short while thereafter. The more strenuous training is, the longer it takes before the supercompensation occurs, but then the improvement in damaged tissue is greater. The course of the supercompensation is shown in a diagram in figure 1.

The trick of a training program is to start each training at the moment the supercompensation from the previous training is at its highest point. Of course, that's not easy. **How you feel is always the deciding factor!** If, for example, you have made a training program and you don't feel so good in an intensive period, you adapt your program by taking out the intensive workouts. Obviously it's too simplistic to suggest you plan your training each time at the highest point of the supercompensation from your previous training. For example, if you are at a training camp in the mountains, it is quite possible that there is not enough time between workouts to recover to such an extent that during the training on the next day you can feel an improvement. It is even possible that at the end of a training camp your performance is not as good as it was at the start. That's no reason to panic. If you see to it that you cycle at a low intensity for about a week, you get back the total sum of the supercompensation from all the training days of the training camp. The same applies to the so-called weekend cyclists. If you're unable to train a lot during the week due to job or study commitments, the majority of your training will be done at the weekend. In that case it does no harm to, for example, train on Sunday, while the recovery from Saturday's training has not yet fully completed. This is no problem, due to the fact that you train much less during the week, you get enough time to recover.

*Figure 1: The course of the supercompensation after three workouts. Each workout was done at the exact moment that the supercompensation from the previous workout was at its highest point: your performance improves.*




## 1.2 Specificity

A second important training rule is that you become good at the type of training you do. A cyclist who cycles mainly in the mountains and who is used to cycling at a low cadence, will be excellent at cycling in hilly terrain, but can easily be left behind on a flat ride with a bit of wind. The same thing applies the other way round. A criterion cyclist has to focus on short accelerations and sprints, not long rides with steep climbs. Each discipline requires its own approach! In this booklet we shall therefore try to indicate which forms of training belong to which discipline.

# 2. The maximal lactate steady state (MLSS)

The intensity of training in this booklet is divided into several zones. These zones are determined according to your maximal lactate steady state (MLSS). The MLSS is defined as the highest power output that can be maintained longstanding without a continuous rise of lactate in the blood. This can be clarified by the following. Lactate is generally associated with strenuous exertion. However, our body also produces lactate when at rest, for example when we're sitting in a chair watching TV. But it doesn't accumulate, because the lactate produced is being removed. During exercise, for example during an easy bike ride at a pace of 20 km/h, the lactate production increases, but the produced lactate is removed at the same rate. Lactate accumulation does not take place. If you start cycling faster, for example at 30 km/h, again the

production of lactate increases. The lactate concentration in the blood initially increases somewhat (we can measure that in the blood), but after a while the clearance of lactate has readjusted itself: the balance has returned. This is called an increased but stable lactate concentration in the blood. In other words, you are tired, but the fatigue does not increase. You can definitely cycle at this pace for at least half an hour. If you then start cycling at 40 km/h, the lactate clearance can no longer keep up with lactate production. Despite the fact that you are cycling at one pace, lactate continues to accumulate until you have to lower the pace.

There is a certain power output at which the lactate clearance can still just keep up with lactate production. This maximum equilibrium is called the *maximum lactate steady state* (MLSS). In other words, the highest power output you can maintain (at least half an hour) without a continuous increase of lactate in the blood. The power output at MLSS (MLSSw) is strongly related to cycling performance, and therefore MLSSw is used to assess training progression in road cyclists. The heart rate that corresponds to the MLSSw is called MLSShr. According to the MLSShr, the training intensity can be divided into five heart rate zones which are explained in more detail in chapter 4 ("Heart rate zones"). In short, for a cyclist, the determination of MLSS can be of great value. In the next chapter it is explained how the MLSS can be determined.

# 3. Testing

## 3.1 Determining the MLSS

The determination of the MLSS is easier said than done. If you really want to do it properly, you will have to have it determined through a laboratory test. Generally such a test is performed on a braked ergometer, with which the resistance is increased in small increments. Thus, you are forced to increase your power output. Using lactate or ventilation (the amount of air you breathe in per minute) measurements, one can then determine at which power output the lactate clearance can no longer handle lactate production (MLSSw). With the corresponding heart rate (MLSShr) you can determine five heart rate zones, with which you can steer your training intensity. The MLSSw gives you information about your performance level.

The latter objective can also be achieved by means of a Polar fitness test, the *OwnIndex*. This test uses a number of variables to estimate your maximum oxygen uptake, which can be used as a measure of your performance level. Moreover, you also need your maximum oxygen uptake again for the *OwnCal* function, which gives you an insight into your energy consumption.

### Polar Tip

**$VO_{2max}$-test**
All advanced S-Series models have this unique $OwnIndex_S$ function. During a safe, only 5 minute test your $VO_{2max}$ (maximum oxygen uptake) is being predicted.

**Main benefits:**
- It is a quick, safe and easy way to check and track your fitness level yourself
- It measures cardiovascular (aerobic) fitness

All advanced S-Series models have the $OwnCal_S$ feature which shows on the display the cumulative energy expenditure (in kilocalories, kcals) of an individual during exercise and total kilocalories of the current exercise session after exercise.



## 3.2 Measuring and estimating maximum and MLSS heart rates

Besides determination in a lab test, you can also estimate the MLSShr. The **easiest estimation** is to **use 91% of your maximum heart rate**. The best way to determine your maximum heart rate is to use a heart rate monitor during several maximal exertions, such as races, or rides with short climbs. The highest value you have seen or recorded, is your maximum heart rate. You can also use the *Polar HRmax prediction*. It uses a number of variables, such as age, weight, resting heart rate, OwnIndex, gender and height to predict your maximum heart rate. A good alternative if - perhaps because of the training phase you are in - you do not intend to put in a maximum effort. But if you really want to know for sure, you could also do the following.

Please note: it is extremely strenuous! It is only useful if you are fully rested. If you are not fully rested, you will probably not reach your maximum heart rate! Choose a route that you can cover in about 5 to 10 minutes and that ends with a short climb. Cycle this route at a speed that you can just keep up over said distance (after a warm-up of at least half an hour) **at a high cadence** (more than 90 rpm). At the end you sprint up the ascent. The highest heart rate you have recorded with *Max Heart Rate Record*, probably approaches your maximum heart rate. To estimate your MLSShr, take 91% of your maximum heart rate.

### Polar Tip

The HRmax-p function predicts your individual maximum heart rate value more accurately than the age-based formula (220 - age). The test lasts approx. 5 minutes and can be taken in resting supine position.

**Main benefit:**
- Quick, safe and easy method to predict your maximum heart rate.

Another method to estimate MLSShr is a bit more complicated, but also more accurate. Find a route where you can continue cycling uninterruptedly for half an hour, for example a racing track with fast bends, or a long straight road where you can ride safely without crossings. After a 30-minute warm-up you start cycling at 80% of your maximum heart rate. In this case you need not know your maximum heart rate precisely, an indication is sufficient; use, for example, the maximum heart rate that *HRmax-prediction* calculates. Every 5 minutes you increase your heart rate by five beats until the moment that you are really struggling to complete 5 minutes at the corresponding heart rate. And by 'struggling' we mean: your legs 'are getting heavy', you can no longer control your breathing frequency and, most importantly, during the course of the 5-minute interval, it is becoming *increasingly difficult* to maintain your heart rate. As soon as you feel this, complete the 5 minutes concerned and stop the test (easy cool down). Your MLSShr is 5 to 8 bpm lower than your heart rate at the last completed 5-minute interval. Example: at a heart rate of 183 you are struggling to complete 5 minutes. In that case your MLSShr is approximately between 175 and 178 bpm.



# 4. Heart rate zones

In the previous chapter it has been explained how to measure the heart rate at the MLSS (MLSShr). If you have done so (or if you have had your MLSShr determined in a laboratory) you can calculate five heart rate zones: Respectively zone **R, E1, E2, E3 and P.**

Table 1 provides these zones and the corresponding limits as a percentage of MLSShr. For instance, if your MLSShr is 170 bpm, the limits of the E1-zone are calculated taking 75% and 85% of 170 bpm, resulting in limits of 128 and 144 bpm. Thus, when your heart rate is between 128 and 144 bpm you are training in the E1 Zone. In the next chapter ("Training") the heart rate zones and corresponding types of training are explained in detail.

### Polar Tip

Training in different heart rate zones requires different settings. In all advanced S-Series models of your Polar heart rate monitor you have the 'Exercise Set' function. It lets you define 5 different types of exercises which can be named also using the software.

**Example**

| | |
|---|---|
| Name of exercise | E1 |
| Interval | Off |
| Timer | Off |
| Limits 1 (= warm-up) | 80-139 |
| Limits 2 (= training) | 140-159 |
| Recovery | On |

## 4.1 How to use heart rate zones

When cycling in a certain heart rate zone, the **aim is to cycle at the heart rate in the middle of the zone.** When your E1-zone is 128-144 bpm, your aim is to keep your heart rate around 136 bpm. Of course, you shouldn't keep your heart rate at this value, but rather use it as a target, the upper and lower limits as the acceptable margin. The important thing is that you must not cycle constantly at the top or bottom of the zone, the average heart rate of a training session in a certain zone should be around the middle of this zone.

| Heart Rate Zone | Type of Training | Limits % of MLSShr | Your personal limits of MLSShr | MLSS in % of your maximum HR |
|---|---|---|---|---|
| R | Recovery training | 60 - 75 % | ..... - ..... | ..... - ..... % |
| E1 | Endurance training | 75 - 85 % | ..... - ..... | ..... - ..... % |
| E2 | Intensive endurance training | 85 - 95 % | ..... - ..... | ..... - ..... % |
| E3 | MLSS-training | 95 - 100 % | ..... - ..... | ..... - ..... % |
| P | Power training | All out | ..... - ..... | ..... - ..... % |

*Table 1: The heart rate zones, corresponding limits as a percentage of the heart rate at maximal lactate steady state (MLSShr), and the type of training that is done in the zone (see chapter 5: "Training"). For estimation of MLSShr, see "Estimating the heart rate at the MLSS". From your absolute MLSS limits (column 4) you can then calculate your zones in % of your maximum HR.*

Take into account that the heart rate lags behind when the power output is increased: you should allow your heart rate to adjust to the increased training intensity. For instance, when you start cycling at a E3-intensity after a period in E1, the adaptation time of the circulatory system and accordingly of the heart rate may mount up to several minutes. Don't try to compensate this by cycling at a higher speed or power output at the beginning of an intensive workout, try to cycle at a constant pace. Of course, you can control this if you have Polar *Power Output* at your disposal.

Finally, it is very important that you become aware of the fact that the response of the heart rate to an exercise of certain intensity, is not constant, but rather varies from day to day. Therefore, you should never follow a certain target heart rate blindly, how you feel always takes priority. After all, it has been proved that trained cyclists are very accurate at feeling when they are exceeding their MLSS. Thus, when during an E3-workout (which should be performed just below MLSS-intensity) you feel that you are exceeding your MLSS, despite the fact that you are within the E3-limits, you should lower the E3-limits and aim at a lower target heart rate. In this manner, every first interval of a training session is a test to verify whether the target heart rate is correct. For the following interval or intervals you can then adjust the target heart rate, if necessary.

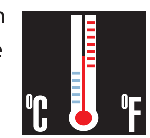


Variation in your heart rate during exercise has to be taken into account under influence of the following factors.

- **Temperature and wind.** It has been found in a study by the authors of this booklet, that the heart rate at a certain power output is affected by temperature and riding wind. In this investigation, 15 racing cyclists cycled at their MLSS, under various standardised conditions. It showed that the heart rate at a power output corresponding to the MLSS was higher in a situation with high temperature and no wind, compared to a situation with low temperature and normal riding wind. So if you are cycling uphill in warm conditions, both factors enhance each other: the heart rate can - just like that - be 5 to 15 (!) bpm higher than if you were cycling on a flat road at the same power output but on a cold day in spring. For this, Polar has incorporated a thermometer in the watch.

## Polar Tip

Polar S700-Series have a built-in thermometer. When displaying altitude during your trip, you can also see in the bottom right corner the temperature. The thermometer measures temperature between -10° and +60° Celsius.




**Main benefit:**

- You can directly draw conclusions about the impact of temperature on heart rate during your rides.

- **Seasonal period.** In a period of relative rest (off-season) your MLSShr may be higher than during periods in which you train a lot. Often, your maximum heart rate changes with it, so that your MLSShr - as a percentage of your maximum heart rate - stays roughly the same. **So it is not the case that you can continue cycling at a higher heart rate as a result of training.** That's only the case when you start with endurance training as a completely untrained person. Through training you increase your power output at the MLSS, your heart rate stays the same or sometimes even decreases somewhat. It is therefore advisable to have your MLSShr determined a few times during the season, so that you can keep a check on the course thereof.

- There are **various other factors** that can make your heart rate differ from one day to another. Stress for instance, or the time at which you train (the evening heart rate is higher).

## 4.2 Heart rate zones and power output

The **training intensity is controlled using heart rate.** However, this does not give you feedback whether you are doing well or not so well. Riding easily in your E3-zone doesn't mean that your performance level in that zone is high. Heart rate measures what you feel, to measure what you do requires the **Polar Power Output.** With this you can measure the power output in a certain heart rate zone, which gives you feedback on the progression in performance you are making in that zone.

### Polar Tip (see also page 47)

Optional to the S700-Series Polar offers a **power output system** that measures power directly from the chain. The system also measures **left/right balance,** which is an index of the power output balance between the left and right strokes making up one rotation. The **Pedalling Index (PI)** measures the evenness of power output throughout each pedal rotation. A higher PI score shows that your power was produced more evenly throughout the pedal rotation.

**Main benefits:**
- The system redefines the training of serious cyclists with information gained from the Polar power output system.
- The system does not require changes on the bikes – no need to change hubs, wheels or cranks unlike other models.
- The system weighs only 276 grams compared to over 550 grams in other models.



But power output can, in some situations, also be used to steer the intensity of training. At the beginning of an intense interval for example, your heart rate is lagging behind the increased intensity, and you may tend to compensate this by starting too fast. You can control this by tracking your power output: The power output during an interval should be reasonably constant.

For the most intensive type of training - the power training - heart rate can't be used very efficiently to steer the intensity of training. This is because the intervals are short (up to 5 minutes), and very intense and therefore the heart rate will be lagging behind the intensity during the entire interval: it will not reach a stable value. Thus, using a certain target heart rate is not possible. The general guideline for a P-training is therefore just to cover as much distance as possible during the intensive interval (like a time trial). But it is also possible to use a target power output, however for that you need to have an indication at which power output you can complete the concerned interval. That is a matter of experience.

# 5. Training

## 5.1 Endurance training (E1 and E2)


**Endurance training** is done at an **easy pace**, in heart rate zone E1. You can also do a more intensive endurance training (zone E2). In this zone the largest amount of fat is burned per unit of time. You can obviously set these zones on your heart rate monitor. For example, in the case of an E1 training you can see afterwards how much time you were actually riding in the intended zone. Your average heart rate also provides information about how well you stuck to the training task. The *%HRmax* function is very user-friendly. With this function you can show your heart rate as a percentage of your maximum heart rate. In this case you may enter your MLSShr as HRmax and express the measured heart rate as a percentage of your MLSShr. Then you only have to stay between 75 and 85% to cycle in zone E1. If you want to train in E2 it is 85 and 95%. Endurance training should be done at a high cadence. Always try to stay above 90 rpm. For that you obviously need the *Polar cadence* sensor.

### Polar Tip

The % HRmax function lets you view your heart rate as percentage of your maximum heart rate. If you want to use another maximum (e.g. MLSShr) you can manually edit your HR max in the user settings. Please keep in mind that changing this value affects the calorie counting feature of OwnCal$_s$ since calculations are linked to your maximum heart rate.


As a result of endurance training you will be able to cycle more and more efficiently (see page 20, Why?). This means that for a certain power output, less energy is required, so you can cope with increasingly longer distances. However, to be able to cycle a ride of 9 hours duration, it is not necessary to do endurance workouts of at least 9 hours. An endurance training of 3 hours also has a positive effect on your



performance in respect of a 9-hour ride. Each hour of additional training doesn't give the same performance gains: i.e. the effect of each added training hour becomes smaller and smaller and could even become negative, for instance when the required recovery impairs other training sessions that are scheduled that week. In most cases the best thing to do is a shorter endurance training (for instance 3 to 4 hours), which gives you the opportunity to train intensively the day after.

When you want to do **altitude training** make sure that you are **at least above 1500 metres,** otherwise the altitude training has little use. Furthermore long endurance training rides take preference over short intensive training rides. The E1-zone is therefore a target zone. In practice you'll probably soon be training more intensively, because at a high altitude your heart rate is a bit higher, and furthermore the terrain is generally hilly, which instinctively gives rise to a more intensive training. But it's better to try and train somewhat less intensively so that you can increase the duration. To monitor altitude you can use the altimeter function in the POLAR S700-Series, which also shows you the number of ascended meters.

### Polar Tip

Polar S700-Series have a built-in altimeter. The altitude sensor measures the barometric pressure of the surrounding air between –488m to 7590m above sea level with an accuracy of +/- 1m.

**Main benefits:**


- You can follow your progress during your uphill ride and pace yourself accordingly if you know the altitude of the peak.
- The ascended meters show you how many meters you have climbed during one trip.

It teaches your body to be efficient with the energy present in your body, because **it stimulates the burning of fat and mechanical efficiency.** The first is beneficial, because there's an almost unlimited supply of fat in your body, whereas the other important energy source, carbohydrate, can easily be exhausted. The second is beneficial because it means that when cycling at a certain power output, less energy is required. Furthermore endurance training increases the energy stored in your body. So on the one hand the **energy is used more efficiently** and on the other hand there is more energy available. Thus, during a long ride you will **stay fresh for longer** and *after the ride* you will **recover faster,** because the energy supplies are not exhausted.

## Polar Tip

MEASURES YOUR ENERGY CONSUMPTION
A correct energy balance is important for endurance sports. OwnCal uses your weight, exercise time, actual heart rate, maximum heart rate and your $VO_{2max}$. Using measured maximum values gives most accurate OwnCal readings.

- gives information about your energy consumption
- helps to plan a proper sporting diet
- helps to control and evaluate the training

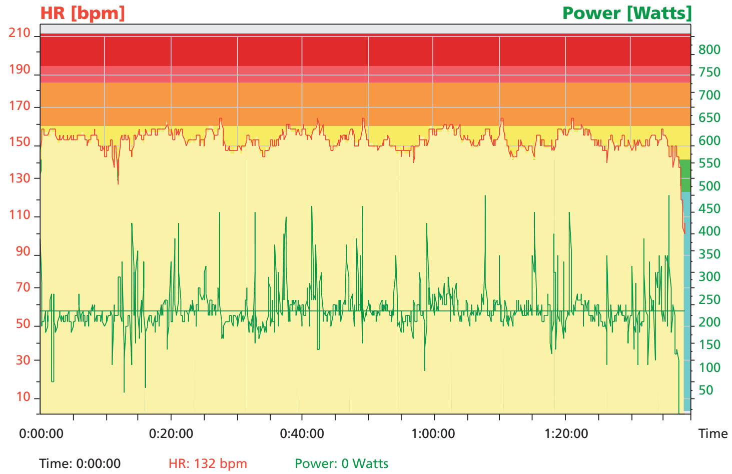
**Endurance training should be done at a high cadence.** This is explained by the following. During cycling, you want to use as much so-called slow-twitch fibers as possible. These fibers are more efficient than the so-called fast-twitch fibers and produce less lactic acid. With increasing force exerted on the pedals, more and more fast-twitch fibers are used, instead of the more efficient slow-twitch fibers. Thus, to cycle efficiently (i.e. using as much slow-twitch fibers as possible) you need to reduce the force during each pedal revolution, which is done by cycling at a high cadence (for instance 100 rpm). However, although far more efficient than fast-twitch fibers, slow-twitch fibers are normally not very efficient at a high cadence! Thus, one of the aims of endurance training is to make these slow-twitch fibers also efficient at a high cadence, which is done by training at a low intensity and high cadence. Cycling at a high cadence is especially important for those who continue to do strength training throughout the season.



A second reason why you have to cycle at a high cadence is a much simpler one. Your muscles are being trained because they *contract* each time you pedal. When you are cycling at a cadence of 60 rpm, your muscle contracts only 60% (per unit of time) of the number of times compared to 100 rpm. So you don't have to cycle as far to get the same training effect! So drum it into yourself that during an endurance training it is the number of pedalling revolutions that counts, not the amount of kilometres or hours.

Endurance training is part of every racing cyclist's training program. Whether you plan to cycle long cycle tours, or short vicious criterium rides, the **endurance training forms the basis for any training plan.** The difference is in the percentage of endurance training in relation to the total training volume. A cyclist wanting to cycle long flat rides will mainly have to do endurance training, whereas a competitive cyclist - mountain bike or road - will have to omit part of the endurance training for much more intensive workouts.

If you possess the Polar *Power Output,* the combination of monitoring heart rate and monitoring power may give very interesting feedback on the progress you are making as a result of the workouts: Has your power increased in the E1-zone after a period of training?




*The heart rate- and power-curve of an E1-training. The MLSShr for this cyclist is 187 bpm. The limits of this type of training are relatively far removed from each other (in this case 140-158 bpm, the yellow zone in the curve), which means there is quite a bit of play as far as intensity is concerned. Do bear in mind though that, as in this curve, you train roughly in the middle of the zone on average. So don't train constantly right at the top (which happens quite often), or right at the bottom. The middle of the zone is your target! The green line is the power curve. The mean power during this training was approximately 240 watt, but as you can see the power output was rather stochastic. This is caused by circumstances such as wind, curves and traffic lights. It is better to use the heart rate as a training target in this type of training.*

## 5.2 Maximal lactate steady state (MLSS) training (E3)


The principle of a MLSS-training session is that you cycle slightly less intensive than your MLSS. Less intensive is better because with MLSS-training it is more harmful to train 5% too intensively, than 5% too easy. Because of the threshold-like character of the MLSS, cycling slightly more intensive than the MLSS results in lactate accumulation, which takes away part of the effect of the training. The heart rate zone of a MLSS-training is E3, between 95 and 100% of the MLSShr.



You can do the MLSS-training in the following ways:

*1. Long intervals (10 minutes or more), followed by a long (full) recovery (10 minutes or more).*

You cycle the intervals in your MLSS-heart rate zone (E3-zone), **between 95 and 100% of your MLSShr.** If your MLSShr is, for example, 180 bpm, then your E3-zone is between 171 and 180 bpm. Take the middle of the zone (175 to 176 bpm) as a reference point. Give your heart rate time to adapt itself to the higher intensity. Try to ride as stable a tempo as possible. The recovery periods you use are just as long as the intervals. However, you do go on cycling! Roughly maintain a pace you would normally use for endurance training. Make sure that - before you start a following interval - your heart rate is around the heart rate used for endurance training (E1-zone: 75-85% of your MLSShr). Try as much as possible to cycle at a high cadence (>90 rpm). If you want to train yourself to ride in the mountains, you can do the MLSS-training in the mountains; the cadence may be a bit lower (70-90 rpm), but still try to ride with a small gear! Training in mountainous terrain is especially suitable for an MLSS-training. However, in that case you do need climbs of more than 3 km long.

You can adjust the intervals somewhat at the start of the season by cycling at between 85-95% of your MLSShr (intensive endurance training, E2-zone) for the first 5 minutes. This way you can get used to the intensity. During the course of the season this less intensive part

### Polar Tip

**Example**

| | |
|---|---|
| Exercise Set | E3 (or MLSS) |
| Interval | ON |
| Interval Timer | 10 min |
| Repeat Interval | 03 |
| Interval Limits 2 | 171-180 |
| Recovery Timer | 10 min |
| Limits 3 | 135-153 |

Exercise SET

disappears and you can extend the intervals later on from 10 to 20 minutes, with an unchanged recovery of 10 minutes.

*2. Short intervals (2 to 5 minutes) with a short recovery period (between a half and a whole minute).*

Now the **recovery is incomplete.** I.e., the h**eart rate** does not drop to 75-85% of the MLSShr, but **stays above 90%.** Thus, during the recovery period you cycle at a pace that results in a heart rate (at the end of the recovery) that corresponds to 90% MLSShr. With this type of training it is very important that during an interval you give your heart rate time to adjust to the increased intensity. During an interval your pace has to be constant, so during the first minute it is quite possible that your heart rate is a bit lower than the E3-zone. Use of the *Power Output* is very attractive with this type of training, because it makes it easy to check whether your power output is constant during the intervals. Finally you have to try to keep the cadence above 90 rpm. When cycling with intervals it is best to use the Polar *Interval Trainer.* In it you can enter the duration of the intervals and the recovery periods and also indicate the upper and lower limit for each period. Your Polar heart rate monitor then indicates when to start an interval and when to start a period of rest. This way you can fully concentrate on the training and you don't always need to use easy to remember intervals of 5 or 10 minutes.

## Polar Tip

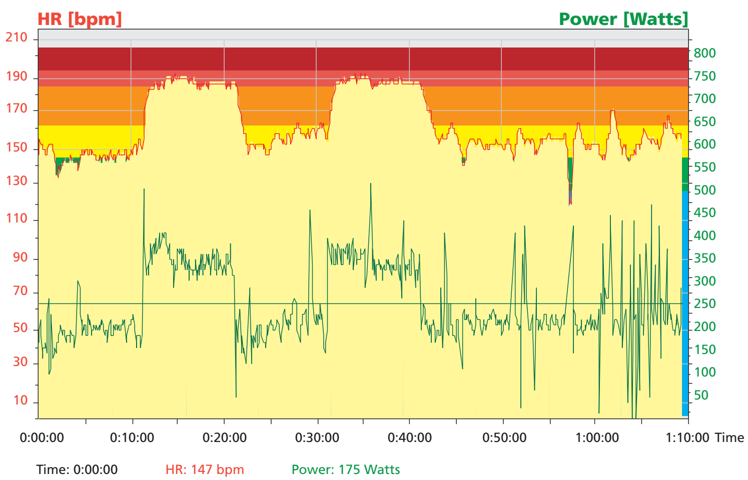
POLAR INTERVAL TRAINER
When cycling with intervals you can best use the Polar Interval Trainer. This allows you to set timers for exercise periods and resting periods, and also upper and lower zones. Your Polar heart rate monitor tells you when to start each exercise period and each recovery period. Now you can concentrate completely on your training and not on calculating when each interval starts.



*3. Only for road racers. The most pleasant type of MLSS-training is the madison training.*

For this you need a training partner, who is roughly just as strong as you are. The principle is very simple. Each of you spends a period cycling up front (5 minutes or longer), while the other drafts behind his training partner. You then repeat this at least 4 times. So basically you simply alternate cycling up front, but with very long turns up front. The parts you are cycling up front are done in your E3-zone. Your recovery is incomplete, because even when you're drafting the intensity is rather high. Also here it applies that you have to let your heart rate rise slowly when you are cycling up front. Try to cycle at a constant pace; that's also more pleasant for your training partner hooking up to your wheel as you come past. Of course, that becomes very easy if you have the Power Output Analysis. Obviously this type of training cannot be done uphill, because then the effect of drafting is rather small. That's also the reason why this type of training is not very suitable for mountain bikers. At the start of the season you do, for example, four repeats, whereas later on you can increase that to ten repeats.

**WHY?** As just explained, your power output at the MLSS largely determines your performance level. It is therefore obvious that you have to train at an intensity that roughly corresponds with your MLSS. After all, you become good at what you do often (specificity-principle). But there is more. The more intensive training is, the more progress you may expect. But the problem is that after an intensive training, with frequent lactate accumulation, the recovery process is long. The fact is, that lactate causes a lot of damage to muscular tissue and it sometimes takes a few days before you can train at full capacity again. In that case you may as well have done two or three lighter workouts. Well then, an MLSS-training is a kind of **optimum between the most intensive training possible and the fastest possible recovery.** After all, the lactate in the blood remains stable during exertions up to the MLSS. This way you are still putting in a very intensive effort, without the disadvantage of having to recover for a long time until the next training. Besides that, *during training,* you need little recovery. There is no lactate accumulation and therefore you do not need to recover for as long after an interval. This way you can put in an intensive effort for a long time during training (all intervals added together). If you were to do the training more intensively than your MLSS, you would become exhausted after one or two intervals, whereas you can do many more at MLSS intensity. So out of all types of training, in the long run you can expect the most progress to come from an MLSS-training session.




*The heart rate- and power output-curve of an E3 training. The training consisted of two intervals of 10 minutes in zone E3 (in this case between 182 and 191 bpm), the recovery period was 10 minutes, in E1. Make sure that it takes a while before your heart rate goes into the intended zone. Your heart rate always needs some time before it adjusts to the load. So don't start sprinting at the start of an interval in order to reach the zone as fast as possible; in that case you are working too intensively at the start of the interval. You can check this very easily with the power output, if you have the Polar Power Output Sensor. As you can see, during the intervals, this rider cycled at a rather consistent power output, around 350 watt. Furthermore he cycled nicely in the middle of his E3-zone, around 187 bpm.*



## 5.3 Power training (P)


Power training is located in the intensity zone above the MLSS. In short it comes down to: **as fast as you can.** The objective is that you are trained to deliver a great deal of power in short bursts and that you get used to the lactate accumulation that occurs when doing so. There are numerous possibilities. The **interval times can vary from 10 seconds to 5 minutes** and complete as well as incomplete recovery periods can be used. Incomplete recovery will cause lactate to accumulate to very high concentrations. However, the effect is not in proportion to the effort (and the recovery) required. A useful rule of thumb is to use a **recovery period** that is t**hree times longer than the interval with a minimum of 3 minutes.** The guideline of the training intensity is simply to cover as much distance as possible during the interval, just like a time trial. The intensity of the interval is therefore dependent on its duration: the shorter the interval, the higher the intensity. You don't use your heart rate to steer your training intensity. After all, you cannot use a specific heart rate value as a target, because the intervals are too short and too intensive for the heart rate to adapt fully to the intensity: it will not reach a stable value. You can, however, use the course of your heart rate to evaluate the training. If the maximum heart rate you achieved barely rises above your MLSShr (during an interval of at least one minute), it could mean that you may not have gone all out, or that you are still tired from previous workouts.


In contrast to the heart rate, the **power output can be used as a training guideline for power training.** The fact is, it is advisable to try and keep your power output as constant as possible during an interval. In that case you could try, for example, to cycle at about 350 watt during an interval period of one minute. If that works, you could try the next time to cycle at a higher power output; that gives you direct information about your training progress! Of course, for this you need to have an indication at which power output you can complete the concerned interval-duration: a matter of experience.

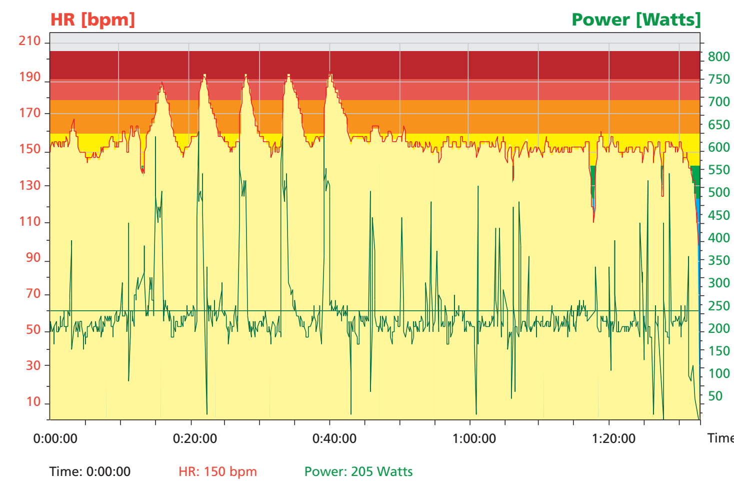
An excellent form of power training, which many racing cyclists do instinctively, is participating in races for training purposes. This is done best when the course of the concerning race is flat, and therefore it is easy to stay in the pack. In that case you can decide when to train intensively (for instance closing a gap) or not (i.e. drafting in the pack). Obviously such a workout is only useful if such aspects are also actually part of the race or cycle tour for which you are preparing. If you're training for a heavy tour ride, with many long climbs, you barely need to do any power training, because your maximal power plays an insignificant role during such rides.

During power training it is **highly advisable to use the Polar IntervalTrainer** function on your Polar heart rate monitor. Because the intervals are brief, it is sometimes difficult to remember from which minute to which minute exactly you have to go all out, and when a period of relative rest starts, certainly if your thinking power is not operating at full speed due to the exertion. With the *Interval Trainer* you can enter the duration of the intensive periods and the periods of rest. Thus schedule the intensive work periods and recovery periods for easy identification during the training session.


So we now know (see chapter 3, Maximal Lactate Steady State) that there is a specific speed or a specific power output whereby the clearance of lactate can just keep up with the production thereof. If the power output remains constant, the lactate concentration in the blood remains stable. But during races and certain cycle tours the intensity will not always stay below the MLSS. During cycle tours with short vicious climbs, you will regularly have to perform above your MLSS, not to mention real races, where the power to cycle very fast for a short time is the deciding factor between winning or an early exit in the sag wagon. This power is mainly down to talent, but can also be improved through training. You do so with the aid of **power training.** The problem with this type of training is, however, that it indeed results in **a great deal of progress, but that you also have to wait a long time before you can start the next intensive training** in order to be able to benefit from the supercompensation. If you don't really need to do this type



of training, you would be better off giving priority to MLSS-training. So if you are training for a long, relatively flat cycle tour, you can limit the power training to a minimum. On the other hand, due to the varied tracks, **mountain bikers** almost always have to deliver short explosive efforts. For them the **power training should always be part of the program.**




*The heart rate- and power output-curve of a P training. The training consisted of 5 intensive periods of 1 minute, with a recovery period of 5 minutes in zone E1 (the yellow zone in the curve). You can't use a target heart rate, because it is too slow in adjusting to the intensity. The only guideline with this type of training is to cover as much distance as possible during the intensive period. Try to keep the power output constant during the intensive moment. You can control this with Polar Power Output. This rider could cycle at a reasonably constant power output of approximately 500 watt during the intervals. Your heart rate should at least exceed the upper limit of the E3-zone. If not, you are probably tired from previous training sessions. In that case it is better to quit the training session, and repeat it at another day when you are well recovered. The cyclist in this example reached a maximal heart rate of 194 bpm, well above the 187 bpm upper limit of his E3 zone.*

## Polar Tip

INTERVAL TRAINER FUNCTION
Guides you automatically through the whole interval training.

| | |
|---|---|
| **Example** | P training |
| Interval | ON |
| Timer 1 (warm-up) | 10 min |
| Limits 1 (warm-up) | 80-150 |
| Interval Timer | 1 min |
| Intervals | 05 |
| Limits 2 (interval) | 100-194 |
| Recovery Timer | ON |
| Timer 3 (cool down) | 5 min |
| Limits 3 | 100-150 |


## 5.4 Recovery training (R)


Recovery training is done at **very low intensity.** The cadence need not be very high; use a rate that feels pleasant to you. The maximum duration is an hour and your maximum heart rate is 75% of your MLSShr. You can set your Polar heart rate monitor so - with the aid of the *%HRmax* function - that your heart rate is shown as a percentage of your MLSShr. You do so by entering your *MLSShr* in the %HRmax function. In that case your heart rate is constantly shown as a percentage of your MLSShr. The only thing you have to do is to **stay below 75%.**



The main training principle is that your performance level improves through the recovery after training, not through the training itself. Sometimes training has been so strenuous that you still haven't recovered the day after. In that case, you could simply rest or you could accelerate the recovery process by doing recovery training. So, unlike all other workouts, recovery training is not a way of causing damage (the training *stimulus*) followed by recovery, but a way of speeding up the recovery after a previous stimulus. So you should already feel better immediately after a recovery training session.

## 5.5 Strength training

Strength training on your bike should actually be approached the same way as strength training in the gym, only you are now using your bike as strength training instrument. The optimum way to do strength training is as follows: Look for a steep hill, preferably one that abruptly goes from flat to a steep climb. You ride with a **very large gear** (depends on the hill, see further on), at a **cadence of about 60 rpm to the foot of the hill. Once you're on the hill, you simply try to maintain your cadence. As soon as you drop below 50 rpm, you have to stop.** You have to choose your gear so that you are able to do 30 to 40 pedal revolutions (i.e., 20 left and 20 right) before you drop below 50 rpm. If you drop below 50 rpm after 20 pedal revolutions for instance, you have to choose a smaller gear. That is simply a matter of trial and error. You can do this in the saddle as well as out of the saddle, but it is preferable to do most of the series in the saddle.

Strength training is very good during long endurance training sessions, as it can make a pleasant change. Moreover, the combination of endurance training and strength training seems to be very efficient, because the strength training prevents your maximal power decreasing as a result of the endurance training (see page 33, Why?). In that case you do, for example, a number of series (e.g. 4) of 30 to 40 pedal revolutions, followed by *complete recovery.* That means 3 minutes or longer. It is the intention that each series is roughly equally strenuous. If you get the feeling that it is becoming increasingly strenuous, you have to extend the recovery period. During the recovery period intensity is very low, equal to recovery training. That means that - during the recovery period - your heart rate should drop to below 75% of your MLSShr. After completing four series you may continue your endurance training, or do another four series after 20 minutes in E1.

The features of the Polar Power Output are very useful for strength training. The power output feature gives you information on your training progress, the left-right balance gives feedback on whether both legs contribute equally to the power output, and cadence indicates whether you are training at the correct pedal rate. Bear in mind, though, that when you are interpreting the data you have to take into account any differences in the speed at which you do the strength training. At a higher speed your power output is probably a bit higher, so if you cheat a bit with the cadence your power output is automatically higher. So, if you can increase the speed quite easily during a series, it would be better to change to a bigger gear, or find a steeper hill.


The above described strength training has two outcomes. Firstly, **strength training prevents a decrease in the maximal power** as a result of endurance training. Cyclists often complain about lacking maximal power (or lacking "speed") after a long period of endurance training. This is not just a feeling, it has been established in scientific research. But this decrease in maximal power can be prevented by combining endurance training with strength training. Now, instead of decreasing, the maximal power improves.

A second effect of **strength training** is that it **improves your climbing- and time trial-ability.** This is because strength training increases the strength of the so-called slow-twitch muscle fibers. Because of this, the contribution of the fast-twitch fibers (which are stronger, but become fatigued more easily) to the actual outcome of muscular work can be delayed.




# 6. Setting up a training program

## 6.1 Introduction

In this chapter we shall briefly explain how you can make your own training program, using your newly gained knowledge. The advantage of making your own training program over a fixed program is that you can gear the workouts to yourself. In other words, you can make the training program so that you improve your weak points and more importantly, so that you keep room for adjustments in periods when you're not doing so well. You can imagine that if you are following a fixed training program, you can completely lose the plot in case of illness or another kind of setback. After all, you can't step back into the training program just like that after an illness; that could cause overtraining.

If you are able to make your own training program, you can simply adjust the program. In fact, that's the first rule in making training programs. **How you feel is the deciding factor in what kind of workouts you do.** If you feel bad and your training program stipulates intensive training, you simply adjust it and make it into a day of rest, or easy training. This way you can always use your own insight to add or remove certain accents. So that means it is not advisable to make a fully worked-out training program too far in advance (e.g. 3 months).

It is better to make a program in broad outlines or **structured program** in which you indicate that in certain periods you will be focusing on specific accents. You could, for example, place the emphasis on endurance training for a few weeks (in the so-called preparation phase). Such a training program is much less specific and lends itself much better to possible adjustments. In that case, if everything is going smoothly and you are precisely on **schedule**, you could specify your structured program a week in advance for example. This way you can - up till the last moment - determine whether to adjust your program. Imagine, for instance, that you've just been ill and you're not feeling well: You could simply adjust your program by omitting a few accents from it. An intensive training week with a lot of E3 then becomes, for instance, a calm week, no higher than E1.

Another important rule is that - when making a program - you should always be aware that you are making **efficient choices**. Assume that you can only train for a limited number of hours. So if you add a certain workout to your program, at the same time you will have to omit a certain workout. So you have to make a decision: firstly, which workout results in the most training effect per hour and, secondly, does that effect correspond with the target for this period? So if you are preparing for a very long cycle tour, for example of more than 200 km, you could ask yourself whether it is very efficient to include an endurance training of at least 6 hours every week, in order to prepare for the distance of your training target. You then invest a great deal of time into one aspect of training: is this investment proportional to its effect? (see paragraph 5.1; Endurance training).

The third and last rule is **variation**. In training jargon it is also known as periodisation. In practice it amounts to nothing more and nothing less than the fact that you progress faster if you train 6 times in week 1 and twice in week 2, than if you train 4 times in both weeks. So make sure you don't do the same every week, you'll get yourself in a “rut”: your body no longer recognises the training as a stimulus and the training progress disappears, but the tiredness after a training remains the same! So don't be afraid to vary, mainly by scheduling weeks of relative rest in which you do only 50% of the normal training volume.

## 6.2 Structure: Periods and targets

A training program works with periods and targets. First of all, you have **to determine the period in which you want to perform well.** That is in any case necessary to structure your program. So always determine a target. Then you determine the periods when you have sufficient time to train and above all, the periods when you don’t. That is important, because in certain phases you’ll have to train a lot and in other phases the training load has more than halved itself, and it is obviously advisable to co-ordinate that with your other activities.

From the date of your target you then count back to determine the **starting and finishing points** of your training periods. The **first period** is the so-called **transitional phase** or non-specific phase. In



practice, this phase often coincides with the off season, when you are basically in a period of relative rest. In this period, you maintain your general condition, sometimes with other sports e.g. skating or cross-country skiing. This is also the period for paying attention to types of workouts for which you may have less time during the rest of the season, such as strength training. It is best to aim at doing up to 3 strength workouts per week. This may be more than you expect, but by doing so your strength is taken to a certain level which can be maintained throughout the season with only one or two workouts per week. Thus, **it is essential that you boost your strength level in the off season,** because you can profit from this improvement throughout the year with a relatively small amount of work.

During the transitional period the training frequency should not be too high (i.e. 3 to 4 times per week) and therefore the workouts can be quite intensive, because, after all, there’s plenty of time to recover from your efforts. Finally it should be mentioned that it serves no purpose to follow a very specific program, that only adds to (mental) tiredness.

In the **second phase,** which **starts and ends about 16 and 6 weeks before the target** respectively, you train much **more specifically.** I.e., almost all workouts are done on the bike. The majority of the training consists of endurance training, which becomes longer and longer as time goes by. The distance of the endurance training is only partially dependent on the distance of the target you are working towards. Obviously, if your target is a 50-km criterium race, it’s no use to do 6-hour endurance training. But, it could in that case be quite useful to train for 3 hours. That may seem somewhat specific, but the objective of this training is to prepare yourself for the intensive period, i.e., to improve efficiency and fat burning (thus improving your ability to recover), and you can certainly accomplish that with a 3-hour endurance training. Don’t pay much attention to intensive workouts, the only objective of this period is to prepare yourself for the coming intensive period. **At the end of this period a period of relative rest is planned in.** This way you reduce the chance of overtraining to almost zero and you start freshly and rested on the intensive period.

This **intensive period starts about 6 weeks before your target** and ends a week before it. During this period, your main aim is intensity. As explained earlier, in that case your recovery is jeopardised. Is it indeed possible to recover from the heavy stimuli time and time again? If everything has gone well, in the preparation phase you have built up efficiency and ability to recover to such an extent that you can handle the intensity in this period. In other words, you recover fast enough. And that means you benefit from the supercompensation that occurs after each of these intensive workouts. In this period the emphasis lies mainly on the MLSS-training. The power output at which the lactate starts to accumulate is increased as much as possible. You now **divide your training program into periods.** After a **number (two or three) of strenuous weeks follows a less intensive week** in order to be sure that your body completely recovers from your efforts. After all, recovery results in progress, the workout itself just in damage. The intensive period is especially suitable for fitting in a training camp in hilly terrain; the fact is, the MLSS-training is very well suited to cycling uphill. The best thing for racing cyclists during this period is to include a few races, which can be considered as a power training.

**Just before your target (one to two weeks) you reduce the training volume.** This way you'll be sure that you've recovered from the heavy training stimuli and that you'll appear at the start in top condition. Once again, mainly endurance training, but this time alternated with short, very intensive power intervals. The periods of rest between these intervals are long. Now you are ready for your first important target of the season. In figure 2 an example of a structured program is visualised.

Assume that you can maintain the form you've been in since you reached your first target of the season for about 6 weeks. That means that if your second target of the season falls within those 6 weeks, the best thing is for you to **maintain your form.** That means, you continue to train with variation, about the same as in the previous intensive period, only now with more attention to rest. For racing cyclists it is best to take part in many races. After all, you have to use your form. A week before your second target of the season you train a bit more



again, followed by a week's rest with intensive intervals and long periods of rest. In that case, you'll probably still be in good form for your second target of the season.

**If the time between** your first and second target of the season **is more than 6 weeks,** you have to **interrupt your form.** That means, immediately after your first target of the season you break down your form on purpose in order to then build it back up for your second target of the season. You do so by refocusing on endurance training (E1) in the first weeks after your first target of the season, just like in the preparation phase. You'll notice that your form decreases to some degree, but that's exactly the intention. After all, you don't have to be in form, your second target of the season is much later. This period of endurance training is again followed by an intensive period, ending with a week's rest before your second target. The duration of these periods obviously depends on the time between your targets, but roughly speaking you can make the endurance training period and intensive period the same length of time as each other, with a maximum length for the intensive period of 6 weeks. So, if there are 14 weeks between your targets, you do 8 weeks of endurance training and 6 weeks of intensive training (the last week of which is rest).

## 6.3 Two examples of a structured program

To clarify, two examples of a structured program are presented here. We cannot stress enough that you shouldn't use these examples indiscriminately! As mentioned earlier, a training program is strictly individual, so be very critical if you wish to consider these examples as guidelines.

### 6.3.1 Structured program with 10 hours a week training time

**In the first example the training target is a so-called "cyclosportive". That means it involves a timed cycle tour; in other words it is a cycling tour with an element of competition. The length of the ride is 170 km and the course is hilly, with short steep climbs. The cyclist who is going to follow the program is a well-trained athlete, who has been doing such rides for some years now. The cyclist has time to train for about 10 hours a week, but is planning free additional time during a 2-week period in order to be able to prepare himself properly, perhaps by taking a short holiday in hilly terrain. The cycling tour is at the end of week 17. The cyclist has made the following structured program:**

The **transition phase** lasts until the end of week 4. The objective is to maintain his endurance and develop specific strength. The cyclist trains about two to three times on the bike or MTB, quite intensively (as far as in E3). Furthermore, the cyclist does 1 to 3 strength workouts (on the bike or in the gym). In weeks when a lot of time is spent on strength, he spends a bit less time on endurance and vice versa.

The **preparation phase** starts in week 5. Now the objective is to increase his efficiency and fat burning, in preparation of the intensive period. The cyclist now plans to train a lot in E1, preferably for a bit longer (more than 3 hours). In week 7 he trains a bit more, in week 8 a bit less again. Then in week 11 a bit more again, whereupon in week 12 a week of relative rest follows in which the training is reduced to 50%. The E1 training is combined with strength training, which he does a bit more often in weeks when the training volume is a bit lower (weeks 8 and 12).



The **intensive period** starts in week 13. Especially in weeks 14 and 16, he trains intensively. In week 14 the cyclist plans to take a brief holiday in hilly terrain, in order to be able to train intensively. In this period the emphasis lies on the E3 training, but later on the P training will be added to that. In week 15 the cyclist wants to train somewhat less intensively, in order to recover from the training week in the hills.

The last week before **the target** (week 17) the cyclist wants to recover from the work he has done. However, he will continue to cycle, but the intensity is often E1 and if it's more intensive, then for a very short period. Figure 2 represents the above described structured program.

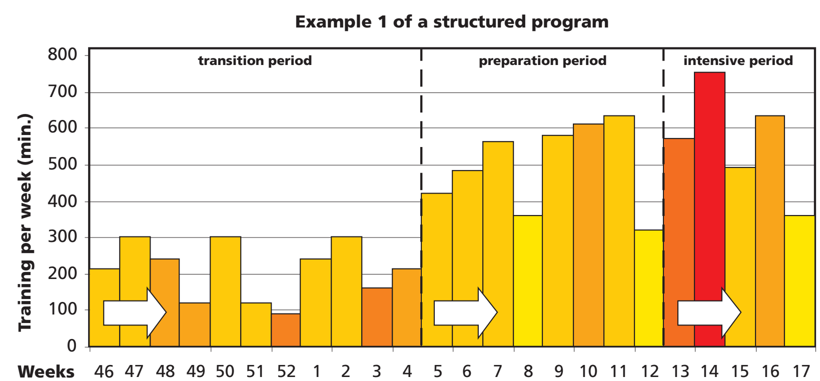



*Figure 2: The first example of a structured program. The cyclist is able to train for about* ***10 hours a week.*** *The first training target is at the end of week 17. The height of the bar indicates the total duration of workouts per week, the colour indicates the mean intensity: light yellow is extensive, red is intensive. The arrows indicate the start of the different periods, transition period, preparation period and intensive period, respectively.*

## 6.3.2 Structured program with about avg. 5 hours a week training time

**The cyclist in the second example has much less time to train, however the training target is the same as in the first example. This is far from ideal, but probably applies to many cyclists. The cyclist in this example trains twice during the week, for about 1,5 hours. In the weekend he trains once. Again the training target is a 170 km ride (see example 1). The result is, that for this cyclist, the training program is a makeshift solution: the preparation is far from ideal but it is the best given the circumstances. The essence of this program is, that it maintains a reasonable level of performance followed by a period of sudden intensified training which boosts the performance level to a short period of form.**

The **transition period** now lasts through week 7. Of course the preparation period could start earlier, if the cyclist wants to, but this extra training will not result in an extra training effect. In the transition phase the training mainly consists of strength training (sometimes once, sometimes up to three times a week), combined with intensive endurance training on the MTB.

The **preparation period** starts in week 8. E1-training is most important in this phase. In the weekend a 3 h E1-ride, up to 4,5 h in week 12. A few short sprints are incorporated into these rides. The workouts during weekdays are also in E1, combined with a few strength training series.

The **intensive period** starts in week 13. The cyclist continues to do the long E1-ride during the weekend, however now the short rides during the week are E3-intervals, in week 15 P-intervals. Week 16 is very important. The cyclist takes some time off for a training-week in hilly terrain. The training volume is doubled compared to previous weeks. Therefore it is possible that recovery during this week is not sufficient. Thus the week thereafter is completely dedicated to the recovery process: during this week the cyclist only does three rides of approximately one hour in R.

If training time is short the above described program is the best solution to attain a relatively high performance level at your training target. However, the drawback of this program is that it literally causes a peak in your performance level. Chances are that after the training target, your form disappears quickly. If you want to stay longer at this level, you should train more, for instance as described in the first example.

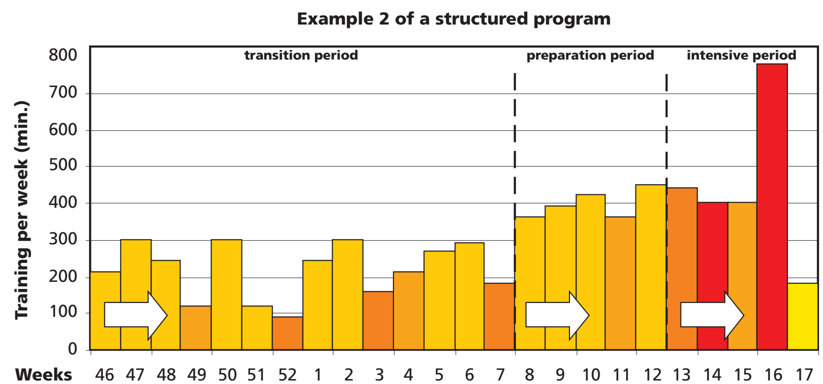



*Figure 3: The second example of a structured program. The cyclist is able to train only three times a week, of which two workouts are maximum 1,5 hours. Again the first training target is at the end of week 17. The height of the bar indicates the total duration of workouts per week, the colour indicates the mean intensity: light yellow is extensive, red is intensive. The arrows indicate the start of the different periods, transition period, preparation period and intensive period, respectively.*

## 6.4 Profiling your structured program

Once you have made a structured program for yourself, you will eventually have to make choices on how to profile it. This obviously depends entirely on the characteristics of your training objective. Are you going to do a long, hilly cycle tour, or is it going to be a short time-trial?

First of all, you have to **determine the intensity of your target** for the season. Are you going to ride above your MLSS? If so, power training will be required. If your target for the season is a race, then you can be sure that you'll also have to cycle above your MLSS. But if it's a recreational ride, then that's not strictly necessary; it depends on the course. The longer the climbs, the smaller the chance of you having to cycle "in the red". But a course with short vicious climbs, requires a great deal of power.

If you decide to include power training in your program, you have another choice to make: does the power training consist of long intervals, or will you also use intervals shorter than 15 seconds, the so-called sprint training. That choice, too, is not a difficult one to make: sprinting only plays a role if you can win or lose, i.e. in races. So, include this type of training in your program only if you are taking part in races; in all other cases other types of training take priority.

Look at each type of training in this way. Consider which type is the most efficient for that period and place it in your program. Then you can use Polar Exercise Set to record the settings for this type of training and then retrieve them again when you repeat the training. Suitable training for that is, for example, the E3 training with short intervals, with intensive periods of 3 minutes and a brief (incomplete) recovery of 1 minute in E2.



### Polar Tip

**Example**

| | |
|---|---|
| Exercise Set | E3 (or MLSS) |
| Interval | ON |
| Interval Timer | 3 min |
| Repeat Interval | 08 |
| Interval Limits 2 | 171-180 |
| Recovery Timer | 1 min |
| Limits 3 | 154-170 |

The applied training zones are:
E1 = 135 - 153
E2 = 154 - 170
E3 = 171 - 180

# Glossary

**$HR_{max}$**
Maximum heart rate ($HR_{max}$) is the highest number of heartbeats per minute (bpm) achieved in an all-out effort.

**Lactate**
By-product (waste product) of the oxidation of glucose with insufficient oxygen.

**MLSS**
The MLSS is defined as the highest power output that can be maintained longstanding without a continuous rise of lactate in the blood. It can also be described as aerobic-anaerobic transition. Energy supply within this range is both aerobic and anaerobic. Production and breakdown of lactate are equal.

**MLSShr**
The heart rate (in beats per minute) at MLSS level.

**MLSSw**
The power output (in watts) at MLSS level.

**RPM**
Revolutions per minute.

**Supercompensation**
In the supercompensation phase, the performance level exceeds the pre-training performance level. It means that once the body has recovered from the training stress, its structures and functions are improved. Supercompensation is also called adaptive reconstruction.

**$VO_{2max}$**
Maximum oxygen uptake per minute. $VO_{2max}$ can be expressed either as milliliters per minute (ml/min = ml x $min^{-1}$) or this value can be divided by the person's body weight in kilograms (ml/kg/min = ml x $kg^{-1}$x $min^{-1}$). The relationship between oxygen uptake ($VO_2$) and heart rate (HR) is linear within an individual during dynamic exercise. $VO_{2max}$ is the basic variable of the intensity of exercise. When determining target exercise intensities heart rate is more practical and useful because it is easily and noninvasively obtained, e.g. on-line during exercise with heart rate monitors.

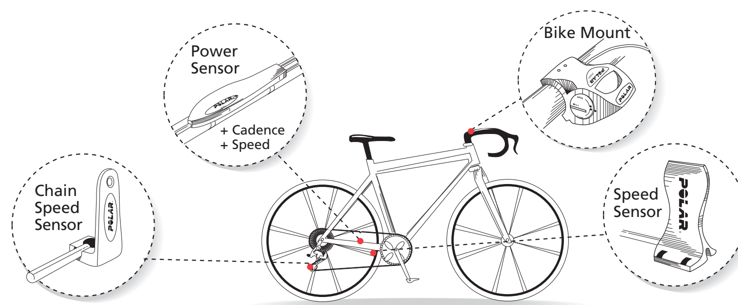


# Polar Power Output System

Serious cyclists can now become even better by using the great new Polar Power Output Sensor, an optional extra available with the new Polar S710 heart rate monitor. Combining heart rate and power output measurements, the Polar Power Output Sensor will redefine how cyclists train. Helping to enhance performance as well as improve technique with pedalling efficiency evaluation.

The Power Output Sensor measures power directly from the chain, unlike other models that use the crank or hub. This precision system combines measures from two key factors:

- Chain tension – using a sensor on the chain stay
- Chain speed – using a sensor on the rear pulley

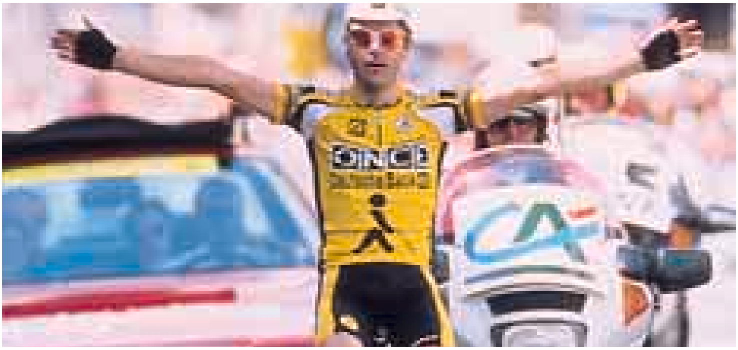




**Polar S700-Series**
- interval training function
- speed sensor, altitude sensor and thermometer
- predicted maximum heart rate
- records up to 99 exercise files
- two-way infrared data exchange
- $OwnIndex_s$ and $OwnCal_s$ functions
- watch, stopwatch, calendar functions
- cadence sensor/power output system optional
- with free Polar Precision Performance Software for training analysis


**Polar S500-Series**
- interval training function
- speed sensor
- predicted maximum heart rate
- downloads training data to computer with SonicLink
- $OwnIndex_s$ and $OwnCal_s$ functions
- watch, stopwatch, calendar functions
- cadence sensor optional
- with free PC Coach Light Software for training analysis

# Polar Performance Cycling




**GOOD TOOLS SPEAK ABOUT THEIR OWNERS.**
**THE BEST ONES DO IT MORE INDIVIDUALLY.**
**POLAR S-SERIES**

The two authors show competitive as well as recreational cyclists how to train better with a Polar heart rate monitor and the Polar Power Output system. The "Polar Performance Cycling" guide explains step by step the principles of making and following a training program and answers you the following questions:

- What are the general training principles?
- Why is maximal lactate steady state (MLSS) so important?
- How can I determine my MLSS?
- What are my heart rate zones (based on MLSS)?
- What are the types of training?
- How can I set up my own training program?
- What are the main phases in my program?

The booklet is amended with many useful tips, heart rate and power charts as well as other examples explaining how you can get most of your Polar heart rate monitor by using the described training methods.

**THE POLAR S-SERIES. A UNIQUE GENERATION OF HEART RATE MONITORS THAT REINVENT YOUR TRAINING AT YOUR OWN LEVEL – MORE PERSONALLY THAN EVER BEFORE!**

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