RUF metro



RUF DualMode system offers new and attractive solutions to metro lines and electric cars

DualMode

RUF DualMode vehicles are equipped with a unique drive system It has 2 positions:

- Open
- Closed

The RUF vehicles can use normal roads when the drive system is open and the road wheels carry and propel the vehicle.

The RUF vehicles can us a special triangular monorail when the drive system is closed against the top of the triangular monorail.

The vehicles can switch between the two modes at 30 km/h





Drive System qualities

The friction between the drive wheels and the monorail can be adjusted to fit the needs. During acceleration and climbing, the pressure is increased so the power transfer is maximized. Normally the pressure will be low and the rolling resistance will be at a minimum.

The drive wheels makes sure that the passengers experience a smooth ride without sideways accelerations.

The support wheels are smooth, so the rolling resistance is very low.



Magnetic switch

The RUF system has no mechanical switch. The switch is performed by means of a magnetic guidance principle known from the tunnel under the English channel where service vehicles are running at 50 km/h guided by means of magnetic fields.

The field is created by 2 parallel wires and a sinusoidal wave with a frequency of 5-20 kHz It is possible to switch between several directions without delay.









Dynamic train creation

The RUF system consists of many small vehicles coupled in trains.

There is no mechanical coupling between the vehicles, so they can change length dynamically.

See: <u>www.ruf.dk/ruftrain.exe</u> created by Palle R Jensen with support from EU research projects: **CyberMove and CyberCars**



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Off line stations

The RUF metro drives from station to station without stopping at the stations in between. This is possible due to the magnetic switching principle.

This will assure short travel times and make it easy for the users to understand.

It will also prevent suicidal persons to jump in front of a fast moving train.







Space requirements

RUF vehicles are max. 2 m wide and 2 m high. This means that a tunnel tube can contain up to 3 RUF monorail lines.

Compared with other monorail systems, RUF is very slender.



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Mini_metro:
2,65 x 3,40 m
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Maxi_metro: 2,00 x 2,00 m







Very low noise

The RUF metro is electric, so the motor noise is minimal. The vehicle weight is very small, so the wheel noise is very small. The metro doesn't brake via the support wheels, so they are always perfectly round and silent.

The chassis will dampen most of the sound from the wheels. Very little will spread to the surroundings.

Wheel Noise



Vehicle weight [kg] per seat (excl. pass.)



On Demand

The RUF system consists of many small vehicles coupled in trains.

The length of the trains depends on the demand. This is possible due to the very efficient drive system.

The trains are coupled electronically.



Low construction cost

A normal metro line is very costly and only one train can be placed in every tunnel tube.

Because RUF is very slender, one tube can contain up to 3 lines.

No levelling is needed when running on the surface. Only a mast for every 20 m in order to carry the standard rail modules. No complicated switching is needed. The DualMode function is used for switching at 30 km/h.

Very little room is needed for a new RUF metro line.

A RUF metro line is estimated to cost 24 million DKr pr km bidirectional line (\$7 million per mile).

RUF junctions

A RUF network typically has a mask size of $5 \ge 5$ km.

A junction is a complex structure organized as 4 satellites around a central structure.

Compared to a highway junction, a RUF junction takes up very little space.

No barriere effect

The RUF metro normally runs elevated or underground.

Very few animal will be killed by the system. The social life on the surface will not be affected.

Low road destruction

The vehicle weight is low. When the RUF metro uses the roads, it does not destroy nearly as much as a normal bus. A truck destroys the pavement as much as 10.000 cars !

System performance

The RUF system is able to handle steep slopes, unlike a normal train system where 6% is the maximum slope. This is very important in a city metro system where space is very limited. It is possible to create a metro line where the stations are at the surface and the acceleration and deceleration is helped by gravity. Energy efficiency will be superior.

The ride comfort is very high since the drive system assures no sideways acceleration unlike what is found in a normal train system.

The emergency braking is performed by a direct rail brake in the rear of the vehicle. This makes it possible to brake without creating flat surfaces on the support wheels.

The ride will be smooth and comparable to car comfort.

Easy access to the vehicles

The RUF metro has a door for every seat. This makes it extremely easy to enter and leave the vehicle.

The delay when picking up a passenger is also minimized, so the travel time is short. A wheelchair can be placed between two folding seats in the front.

Metro without virus spread

The RUF metro has no standing. The seats are separated and the air circulation is organized so that no airborne virus is spreading. Because there is no standing, the passengers need not touch any structures inside the metro. They wait until the vehicle has stopped and then they just leave the seat without any need to touch.

Exchangable cabine

The RUF metro consists of a platform on top of which different cabines can be placed.

This means that the expensive parts (the drive system) can be used during the day for passenger transport, but outside rush hours, it can be used for many different purposes. Freight etc.

One especially interesting application, is as an alternative to using air transport inside EU. With an average speed of 175 km/h it is possible to reach a lot of interesting destinations while you sleep in a cabine equipped with beds. You can also save a hotel room, if you only need one day in your destination city.

Flex fare

In a normal metro, every seat cost the same and standing is not cheaper. In a RUF metro, there is no standing and everyone has a seat.

All seats are not equal. Some are more luxurious than others. The monorail need to be able to bend with a curve radius of at least 25 m, the seats in the middle will be smaller.

Because access to the seats are directly from street or platform, it is possible to collect different fares for different seats. This means that it is possible to attract car-drivers who are willing to pay a high price for being collected at their doorstep and delivered shortly after at the office door. No parking ! No congestion.

RUF Tram without rails and overhead wires

The RUF metro can run in the streets as a tram. The vehicles are coupled together electronically and they are powered by small batteries.

No overhead wires and no rails in the pavement. The vehicles are being recharged when they are running on the monorail system in and out of the central city. An old fashioned tram line can be stopped by a car. A RUF tram can easily avoid obstacles.

RUF Park and Ride

Park and Ride is difficult using normal train systems. The users are asked to park at a distance from the train station, since it is difficult to find space for a parking lot close to the station.

They will now have to walk to the platform and wait for the train in all kind of weather.

RUF Park and Ride can use parking lots at the end of the highways, where it is possible to find space for a large parking lot.

The maxi-ruf vehicles can collect users directly from their cars. They only have to walk a few meters.

Radial RUF lines can connect the parking lots with the central metro lines or to the RUF tram lines.

RUF performance

As part of the EU programs: CyberMove and CyberCars, several tools have been developed in order to evaluate the performance of RUF networks.

Copenhagen and Los Angeles have been used as cases.

A CBA for the Cph network showed a 29% IRR(30) for an investment of 3 billion €

RUF interchange

A RUF network is able to connect efficiently with other systems.

RUF access

Access to the vehicles is extremely easy and fast. It is possible to collect passengers even in very narrow streets.

Normally GPS will be used, but special bus stops can also be used.

RUF dimensions

All passengers are seated in the RUF system all the time. This ensures a low air resistance, since the frontal area is much lower than for a bus or a train. It will also mean lower weight per passenger. 360 kg per passenger in a fully loaded maxi-ruf is estimated.

Dimensioner:

RUF aestetics

RUF rides on a triangular monorail.

It can be elevated, but it can also be placed in a tube like a normal metro.

A multi lane highway can be converted to be both a highway and a RUF line.

A street can be converted into a multi purpose structure for RUF, bicycles and a channel for flash flood prevention. When using the streets, it is smaller than traditional trams.

RUF coverage

RUF is DualMode which means that it can attract users from a much larger area than a train line.

This is important if you plan to create a system where you don't need a car.

RUF Ultra Light Rail

Normal "Light Rail" can only serve a line.

It is assumed that passengers are willing to walk 600 m to their destination.

This will severely limit the number of users.

RUF Ultra Light Rail can serve a relevant area around the access points along the line.

The line speed is high so the service is attractive.

RUF economy 1

The construction cost of a RUF line is low. There is no need for a service center for vehicles, since they can drive by themselves with chauffeur to a service workshop.

The small dimensions makes it easy to implement a new line along existing infrastructures.

A calculation of a proposed RUF system along Ring 3 in Copenhagen was done by NIRAS.

If it was implemented as a single mode system, with the same number of stations as the proposed Light Rail, it would cost approx. half and deliver twice the speed of the Light Rail line.

RUF economy 2

A RUF network can service a city with a combination of a fast monorail network and a flexible electric bus service along the normal streets. RUF = Rapid Urban Flexible In a city like Copenhagen a very attractive Public Transport service can be offered.

RUF user friendliness

If you are trying to find the best maxi-ruf in order to get to your destination, you can see from the colour coding in which direction the best access junction is positioned.

RUF climate solution

RUF metro can deliver that kind of Public Transport which can attract car drivers because:

It has high comfort

It is fast – door to door

It is safe from future vira

You do not need parking

Once a monorail network has been created, the car manufacturers will create electric cars for the monorail network. It will be good for the climate because:

The cars will be powered from the monorail The power needed will be very low on the monorail The small batteries will be recharged on the monorail Many will use it because you avoid congestion A commuter will be able to work on a computer in the car.

