Advanced testing technologies for active safety systems to reduce road fatalities
IN PHYSICS
According to accident statistics from different research there is a high amount of fatal and seriously injured accidents involving cars and vulnerable road users like pedestrians and bicyclists. More than 90% of these accidents are caused by human failure. That’s the reason why car manufacturers and system suppliers are working on the development of new advanced driver assistance systems (ADAS) to prevent or mitigate collisions with pedestrians, bicyclists or other vulnerable road users. Autonomous emergency braking (AEB) systems and front collision warning (FCW) are increasingly common, using sophisticated technology to automatically intervene when a driver fails to brake in time.

4activeSystems GmbH works in the field of active vehicle safety to develop and produce advanced testing technologies and target objects like pedestrian-, bicyclist-, scooter- or other vehicle-dummies. Our challenge is to simulate a realistic accident situation and displaying the dummies in a realistic way with regard to different sensor systems like radar, infrared, mono- or stereo-cameras.

Our customers are primary international automotive manufacturers and suppliers. 4activeSystems GmbH is part of the 4a technology group. All 4a companies are linked by their joint mission statement: “in physics we trust …”.

4activeSystems produces dummies, which replicate human properties in size and shape. The child dummy represents a child at the age of 7 years. 4a dummies can be recognized by mono and stereo cameras as well as radar and infrared systems. In infrared is 50% reflectivity, between 850nm and 910nm. There is no danger of crashes for the dummy, respectively the test vehicle, during a test.
• **adult**
  - body height 1800mm
  - shoulder width 500mm
  - torso angle 85°
  - weight < 4 kg

• **child**
  - body height 1154mm
  - shoulder width 298mm
  - torso angle 78°
  - weight < 2 kg

• **IR reflectivity** from 850 to 910nm measured in 45° and 90°
  - clothes and skin 40% - 60%
  - hair 20% - 60%

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• for testing in rainy conditions
• **very robust - crashes up to 60km/h**
• no hard impact points
• **3rd leg for better stability in windy conditions**
• the dummy is Euro NCAP compliant

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• heated cover
• additional spare parts are available
## Spare parts 4activePS

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4activePA is even more similar to humans and the movement of the legs is more realistic. Additional options for the dummy are moving arms and a moving head. The dummy is detectable by radar, infrared and camera sensors, also the Micro Doppler spread is humanlike.

The 4activePA dummy is based on a modular system, needing only a few minutes to exchange damaged parts. Crashes up to 60km/h are possible without damage to the test vehicle and dummy.
- **adult** body height 1800mm
  shoulder width 500mm
  torso angle 85°
  weight < 7.5 kg

- **child** body height 1154mm
  shoulder width 298mm
  torso angle 78°
  weight < 4 kg

- **IR reflectivity:** from 850 to 910nm measured in 45° and 90°
  clothes and skin 40% - 60%
  hair 20% - 60%

- **RCS reflectivity:** measured with a 77GHz sensor
  average curve 0dBsm - measured ±5dBsm in free space
  Micro Doppler characteristic leg movement (knee+ankle)
  humanlike distribution of the entire RCS

- waterproof in rainy conditions - application temperature -5°C to 40°C
- **very robust** - **crashes up to 60km/h**
- no hard impact points prevents damage to test vehicles
- **battery powered** - **test with one battery for entire day**
- automatic triggering with 4activeSB or manual operation with remote control
- **Euro NCAP standard tests or optional programmed tests**
- modular system - hip, center tube, legs, electronic unit and battery are easy to change

- moving arms and a moving head
**10 commandments for testing with articulating dummies**

- **max. 20s**
  For manual testing the low-run time shouldn’t exceed 20s.

- **max. 40°C**
  The outside air temperature shouldn’t be higher than 40°C - servo motors could overheat.

- **max. peak wind 8m/s**
  The max. peak wind speed for testing is 8m/s - average max. 4m/s. Otherwise the movement patterns could be incorrect.

- **no testing disconnect battery**
  If the dummy is replaced or not in use, the battery has to be disconnected.

- **START**
  Don’t start the dummy, if it is lying on the ground or in the car!

- **Use the adapter in right direction, so that the dummy is able to release during a crash.**

- **The rope, fixed on the neck of the dummy, has to be tight.**

- **brake before overrun**
  Don’t drive over the dummy; especially after a crash!

- **1,5-2,5 cm**
  Legs must not touch the center tube and the surfboard. Clearance to the surfboard has to be 1,5-2,5cm.

- **The angle of the torso should be 5° (adult) and 12° (child).**
Spare parts 4activePA child

- 15a 4activePA
- 15b basekit (2x15c, 6x15f, 2x15h, 2x15k)
- 15c hip
- 15d pair of legs

- 15e battery
- 15f servomotor (calibrated & controlled)
- 15g outer cover complete
  - 15gP1 outer cover - torso
  - 15gP2 outer cover - legs
- 15h center tube
- 15i set of lower interface disks (5pcs)

- 14m remote control
- 14n charger
- 14o programming kit
- 14p electronic unit

- 15j optional arm movement
- 15t heated cover
  - (8t3 is required)
Spare parts 4activePA adult

14a 4activePA
14b basekit (2x14c, 6x14f, 2x14h, 2x14k)
14c hip
14d pair of legs
14e battery
14f servomotor (calibrated & controlled)
14g outer cover complete
14gP1 outer cover - torso
14gP2 outer cover - legs
14h center tube
14i stabilizer
14k set of lower interface disks (5pcs)
14l set of o-rings for hip (20pcs)
14m remote control (for 14a and 15a)
14n charger
14o programming kit
14p electronic unit (for 14a and 15a)
14j optional arm movement
14t heated cover (8t₃ is required)
4activeHT is available for static, articulated and for deer target - these dummies are for testing passive IR systems like night vision. The heated cover consists of heating mats, laminated on the inner side of the cover to achieve an optimal heat transfer to the outer surface.

The heating control unit is able to control 5 different zones (face, arms, hands, torso and legs). The cover is equipped with 10 sensors to control the temperature.
### Technical Information

- **deer**
  - body height 700mm
  - weight 3kg
  - 4 heating zones - head, left and right body, legs

- **adult**
  - body height 1800mm
  - shoulder width 500mm
  - torso angle 85°
  - weight 5kg
  - 5 heating zones - head, arms, hands, legs, torso

- heating zones between 20°C and 45°C

### Key Features

- heated covers are available for different dummy types
- specialized for infrared sensors - e.g. night vision test
- separate heating zones are adjustable
- the heated cover of the dummies are powered by a battery at the roadside
- heating control unit is in the torso of the dummy
- heated dummies are crashable up to 20km/h - cables with special plugs release during a crash
- uniform distribution - no hot spots

### Options

- available for 4activePA, 4activePS and animal targets
Spare parts 4activeHT

• separate parts with heated cover of the pedestrian dummy’s
  - head
  - arms
  - torso
  - legs
  - hands

• separate parts with heated cover of the deer dummy’s
  - head
  - left and right body
  - legs

• battery incl. charger
• inner structure - 3D dummy for individual type (8a or 16t)
• heating control unit
4activeBS has rotating wheels for realistic characteristics. The following test scenarios are possible and the dummy crashable - crossing with 60km/h and longitudinal with 45km/h. The dummy is build upon a modular system and spare parts are easy to change. The torso of the dummy is adjustable to different angles, from a sporty position to a upright. An further option for the 4activeBS are movable pedals and additional reflectors.

- rotating wheels
- RCS,IR, visual properties are humanlike
- cyclist speed 35km/h
- crashable up to 60km/h
- total weight 10kg
- compatible with 4activeSB and 4activeXB
• bike handlebar (NL) height 1200mm
  handlebar (EU) height 1150mm
  diameter wheels 700mm
  wheel distance 1230mm
  weight 6kg
• dummy weight 4kg
  total height 1840mm
  total length 1940mm

• rotating wheels, if they are on the ground
• for longitudinal and crossing scenarios
  • longitudinal crashes up to 45km/h differential speed
• crossing test up to 60km/h crashable
• torso and legs removable, bike is able to fold up for transport and storage
• adjustable position of the torso with two handle bar sets
• very easy to exchange spare parts
• very robust - clips on the back wheel opens during a crash
• tensioning ropes offer better stability
• reflectors - white: front and wheels, red: back, orange: pedal

• moving pedals available
• new surfboard with an adjustable interface and better tracking properties is available
Spare parts 4activeBS

13a5  bicycle v5 - adult
13h   wheel
13i   frame
13j   tire
13k   rim
13l   spoke (15x)
13m   wheel hub
13n   luggage rack
13o   chain stay
13p   seat stay
13q   handlebar (NL)
13r   handlebar (EU)
13s   bicyclist
13s1  cover of bicyclist
13s2  torso of bicyclist
13s3  legs of bicyclist
13s4  arms of bicyclist
13t   steering fork
13u   chain protection
13v   seat post
13w   lower interface
13x   disk of lower interface (5x)
13y   tensioning ropes
13z5  bicycle (excl. Dummy)
4activeMC scooter

4activeMC is available in two different models - motor scooter and motorbike. Both of them suit with the 4activeSB and 4activeXB systems.

The properties are realistic for radar and camera systems. The target is crashable. There are rotating wheels for better RCS detection.
4activeMC motorbike has rotating wheels, for more realistic testing. The rotating wheels are spare parts and easy to change.

The motorbike is useable with 4activeSB and 4activeXB. The properties are realistic for radar and camera systems. The dummy is crashable. For transport the dummy, wheels and the fork are removable.

- motorbike speed - 65km/h
- properties like real motor cycles
- weight motorbike 15kg
- crashable
- compatible with 4activeSB and 4activeXB
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<td>Wheel distance</td>
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<td><strong>Scooter</strong></td>
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<td>Total length</td>
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<td>Total height</td>
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<td>Wheel distance</td>
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<tr>
<td>Wheel diameter</td>
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<tr>
<td>Weight</td>
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**Key Features**
- Two different models available - scooter and motorbike
- Rotating wheels for more realistic Micro-Doppler spread
- Human dummy is removable from the bike/scooter
- Tests in longitudinal and crossing directions are possible
- The MC dummies are crashable from any directions
- Spare parts are easy to change in a few minutes
- Motorbikes are compatible to SB, XB and FB small
- License plate are reflective material

**Options**
- Additional active lights and indicators are available
Spare parts 4activeMC motorbike and scooter

11b 4activeMC bike

- motorbike
- dummy (torso, legs, arms)
- back wheel
- front wheel
- spokes
- fork
- handlebar
- mounting components to surfboard (4pcs)
- ankle joint
- set of magnetic anchor
- license plate

11c 4activeMC scooter

- scooter
- dummy (torso, legs, arms)
- back wheel
- front wheel
- spokes
- handlebar
- mounting components to surfboard (4pcs)
- ankle joint
- set of magnetic anchor
- license plate
**4activeC2**

free standing car target

- speeds up to 80km/h
- crashable from all directions with 65km/h
- weight 55kg
- available in different models
- reassembly in 2min

**4activeC2** dummy is a free standing 3D target with radar and visual properties, like a real car. The dummy is crashable up to 65km/h from any direction and is rebuild in two minutes by two people. For transport **4activeC2** can be disassembled.

The car has reflective light, optional available are active lights and indicators. For **4activeC2** spare parts include - label panels, locking system, wheels.
Technical Information

- total length 3850mm
- total width 1620mm
- total height 1480mm
- ground clearance 250mm
- wheel diameter 650mm
- wheel distance 2485mm
- weight 55kg

Key Features

- easy to build up with a system of zippers and fasteners
- build up for first time in 10min
- rebuild after a crash in 2min - car stays in one shape after crash
- crashable up to 65km/h without damages
- wheels are true dimensions - width and diameter
- modular system for transport and exchanging spare parts
- reflective light panels in the front and in the rear
- reflective license plate
- 3D side mirrors

Options

- active lights available - indicators, brake lights
- other car sizes available - SUV or small car
Spare parts 4activeC2

12a  4activeC2 - small size car
12b  4activeC2 - middle size car
12c  4activeC2 - SUV

- front part of C2
- back part of C2
- top part of C2
- inner skeleton
- side mirrors
- zipper front
- zipper back
- zipper top
- set of sticker - wheels
- set of sticker - lights and reflectors
- set of sticker - windows and cooler
- license plate
The mobile test rig 4activeSB can be easily transported. System installation is performed by two people in about half an hour. The system works battery powered, with a minimum operating time of 10 hours at low temperatures.

4activeSB is for testing with pedestrian targets - articulated, static, deer and cyclist. Longitudinal and crossing scenarios are possible to test.
- max. speed 20km/h
- max. acceleration 3,5m/s²
- max. system length crossing 35m
- max. system length longitudinal 50m
- weight: driving unit 85kg, deflection unit 60kg, surfboard 12kg

• build up and disassembling in 30 minutes
• for testing with all pedestrian dummies, bicyclists and slow motor cyclists
• triggers via light barriers or GPS/IMU (Novatel, OXTS, RaceLogic, Genesys, iMar)
• easy to operate via WLAN - with laptop or control panel
• triggering of the dummy is automatic
• correction of velocity during GPS testing
• battery powered - possible to test a whole day - power supply with 230V

• three different platforms (surfboards) available
  - with active release of the magnets - electronic inside
  - with passive release of the magnets
  - optimized with adjustable wheels for better tracking (NEW)
• upgrade for longitudinal tests
• cover for radar invisibility
Spare parts 4activeSB

100  base 4activeSB (incl. 2b + 2d + 5a)
1a   10m-10 km/h (pedestrian, base) (incl. 7a)
1c   35m-20/km/h (bicyclist) (incl. 7c)
2c1-c5 light barrier system 1 - 5
2d   reflector
2e   deflection unit SB
2g   LB sensor
2h   cable incl. LB plug and drum 65m
3a   option wireless (incl panel)
3d   charger for driving unit 4activeSB
3e   Visu/programming - tool
3g   WLAN panel
3h   cover for driving unit of 4activeSB
4a   Novatel dGPS (incl. glonass)
4b   OXTS emulation
4c   IMAR emulation
4d   GENESYS emulation
4e   RACELogic emulation
4f   WCAN (Sorcus)
4g   glonass upgrade for Novatel dGPS
4h   software/firmware maintenance
4i   hardware maintenance service
5a   platform I for 4activeSB
5a1  platform I SB (dark grey)
5a2  platform I SB (black)
5c   platform I SB without elektronic
5e   interface for articulating dummy 4activePA (child or adult)
5e1  top plate with magnets of interface 5e
5e2  mounting plate of interface 5e
5g   charger for platform SB
5h   platform II for 4activeSB
5h1  interface for Platform II
5h8  safety release version 2 for Platform II
6a   sliding plate incl. 6 screws
6b   set of belt-interface incl. 8 screws
6c   infeed rail incl. 2 screws
6d   set - deflection roller
6e   set - drive wheel
6f   set - draw roller
7a   belt 25m - AT10/16
7b   belt 50m - AT10/16
7c   belt 75m - AT10/16
7d   belt 33m - AT10/16
7e   belt 100m - AT10/16
7f   manual take up equipment for 25m, 50m, 75m belt
4activeXB
extended range surfboard platform

The mobile test rig 4activeXB can be easily transported. The system needs no fixed power supply, it is powered by a 2kW generator. This system is waterproof - all components are, at least, IP64 protected.

4activeXB can attain more speed - up to 50km/h, it´s more realistic for tests with motorcyclists or car parking scenarios. Also pedestrian dummies and bicyclists are compatible.

- Euro NCAP AEB VRU compatible
- vehicle speeds up to 80km/h
- platform speed max. 50km/h
- up to 65m displacement path
- portable system
- quick set up
### Technical Information

- max. speed 50km/h
- max. acceleration 6m/s²
- max. system length 65m
- weight
  - driving unit 150kg
  - deflection unit 135kg
  - surfboard 12kg

### Key Features

- same key features as 4activeSB
- GNSS/INS triggered system (Novatel, OXTS, RaceLogic, Genesys, iMAR)
- safety system with remote control
- for bigger, faster and heavier targets - motorcyclists, half cars
- testing crossing and longitudinal scenarios
- parking test scenarios
- power supply with a 2kW power unit - in peak power situations a super capacitor with 17kW is inside
- waterproof - IP64 leveled
- to operate with laptop or tablet and safety remote control

### Options

- three different platforms (surfboards) available
  - with active release of the magnets - electronic inside
  - with passive release of the magnets
  - optimized with adjustable wheels for better tracking (NEW)
- upgrade for longitudinal tests
- cover for radar invisibility
Spare parts 4activeXB

110  base 4activeXB
2f   deflection unit XB
3a   option wireless (incl. panel)
3g   WLAN panel
4a   Novatel dGPS (incl. Glonass)
4b   OXTS Emulation
4c   IMAR Emulation
4d   GENESYS Emulation
4e   RACELogic Emulation
4f   WCAN (Sorcu)
4h   software/firmware maintenance
4i   hardware maintenance service
5d   platform I for 4activeXB
6i   carrier grip
6o   set of belt interface incl. 8 screws
6p   set deflection roller
6q   set drive wheel
6r   set draw roller
7b1  belt 50 AT 10/32
7e1  belt 100 AT 10/32
7d1  belt 150 AT 10/32
4activeFB is a GPS controlled platform with special materials to offer a very low radar cross section used for testing AEB VRU scenarios. The platform has an extremely low profile and is very robust, can be driven over by passenger and commercial vehicles.

- FBsmall 30km/h (50/72km/h)
- FBlarge 50km/h (72/80km/h)
- extrem low profil
  - FBsmall 10mm - 15mm
  - FBlarge 50mm - 85mm
- absolutely waterproof
- traversable with cars & trucks
- very low RCS
### Technical Information

- **max. speed**: 50km/h (72km/h)
- **length x width x height**: 2400x1400x60(85)mm
- **total weight**: 130kg
  - platform: 85kg
  - 3 battery packs: 15kg
- **3x 7.5kW motors**
- **50.4V with 695.5Wh per battery**

### Key Features

- **all wheel drive - 3 wheel drive**
- **GNSS/INS compatible system** (Novatel, OXTS, RaceLogic, Genesys, iMAR)
- **safety system - open safety network**
  - 2nd safety CPU - for all safety relevant operations (emergency stop, safe low speed/torque, timeout of datas,...)
- **all antennas are enclosed in the platform - completely waterproof**
- **2 antenna system high performance GPS + Glonass/IMU - RTK L2 solution**
- **polymer cover with reinforced structure**
- **robust - overdrive with heavy vehicles (trucks) is possible**
- **very low radar cross section**
- **ground clearance is adjustable with air suspension**

### Options

- available - FB small 30km/h (50/72km/h)
- available FB with 50km/h (72/80km/h)
- possible to adapt competitive targets