

# Double lane-change measurements according to ISO 3888-1

**What is the purpose?**

*The double lane-change manoeuvre is used to identify the vehicle dynamics. The target is to analyse and determine the road holding ability and handling characteristics of a vehicle. This test procedure is applicable to vehicles with a gross vehicle mass of up to 3500 kg.*

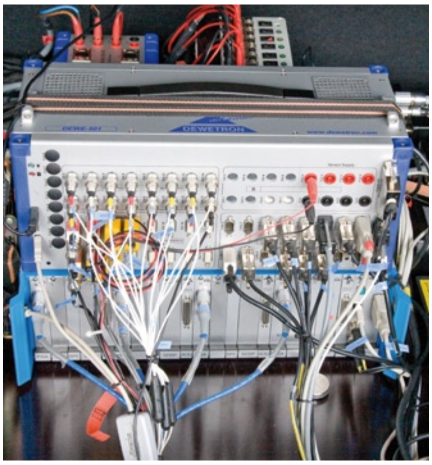
*The severe double lane-change manoeuvre is a dynamic process rapidly driving a vehicle from its initial lane to another lane in parallel, and back to the initial lane, without exceeding lane boundaries [1].*

*During the manoeuvre over steering can occur. In addition to that, frequently the vehicle starts skidding after the second lane change. The scenario gives us a feedback about the overall driving behaviour of the tested car with the focus is on vehicles steering and chassis setup.*

[1] 21st of October 1997, the first series of the Mercedes A type, crashed a the double lane change test

## What is needed?

*Due to the high dynamic nature of this test it is very important to record all measured signals at a high sampling rate and of course record the vehicle signals (e.g. speed) synchronized to the measured signals. This is taken care of by the DEWETRON measurement unit in combination with the DEWESoft acquisition software. No matter whether you are using analogue data, CAN data, GPS data and optional video data … connected*



*The following table gives an overview on which measurement parameters are mandatory and which can be acquired optional.*

| Measurement parameter | Symbol | Unit | Required/Optional |
|---|---|---|---|
| Longitudinal velocity | vx | m/s | Required |
| Lateral Acceleration | αY | m/s2 | Optional |
| Steering-wheel angle | δH | ° | Optional |
| Lateral velocity | υY | m/s | Optional |
| Longitudinal acceleration | αX | m/s2 | Optional |
| Yaw velocity | dψ/dt | °/s | Optional |
| Sideslip angle | ß | ° | Optional |
| Roll angle | φV | ° | Optional |
| Tire temperature | T | °C | Optional |

*The required parameters could simply be acquired from the vehicles CAN bus. However, tests have shown that the vehicles internal sensors do not have the quality, in terms of accuracy, latency and bandwidth, to produce very good measurement results. Moreover, since the internal sensors or their calculation and filter methods can differ between vehicle types, the measurement results acquired from these sensors are not directly comparable. Therefore DEWETRON, as a member of the DTA (Driveability Testing Alliance), can offer full compatibility to sensors provided by each of the DTA-members (DEWETRON, Corrysys-Datron, TÜV-Süd Automotive, GeneSys and Kistler). As seen at the table above there are several signals optional to record. At the manoeuvre description you will see that it is very useful to record more than just the required channels, especially focusing on themes like reproducibility and error verification. DEWETRON provides a measurement setup, which ensures the ability to record all needed signals.*

### GeneSys ADMA-G

*The GeneSys ADMA was engineered for all kinds of driving dynamics measurements and outputs all required motion parameters such as velocity, acceleration, position, rotation angles that will be recorded in this manoeuvre. The ADMA outputs the measurement data via CAN and can be directly connected to the integrated CAN interface of DEWETRON measurement units. The unique DEWESoft measurement software features a plug in specifically designed for the GeneSys ADMA, which allows the user to configure and control the ADMA right out of DEWESoft, without the need for additional software.*

### Corrsys-Datron Measurement steering wheel

*The Corrsys-Datron MSW can be easily mounted instead of any vehicles steering wheel. If the steering wheel cannot be removed, the MSW can be mounted on top using the MSW-adapter. Moreover, the MSW has a wide range of data-output possibilities (CAN, analog or digital) that are all supported by DEWETRON measurement systems. The optional measured steering angle and the steering angle speed derived thereof are obtained by means of a non-contact, optical steering angle sensor.*

*Note: This is just an optional system, but it will increase the reproducibility of your test runs.*

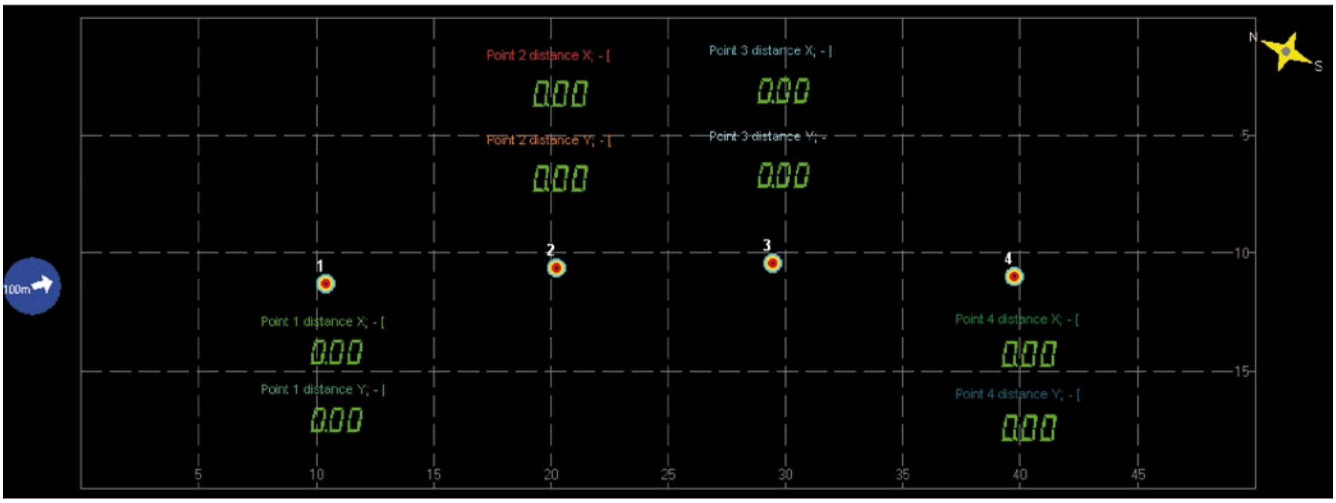
*Warning: The driver airbag must be disabled when using the MSW-adapter!*

### T$^3$M Tire Temperatur Sensors

*The tire temperature sensors measure the temperature inside of the tire. The temperature has an influence to the ability of the tire to transmit forces and thus will influence the driving behaviour of the car. Therefore it is useful to see if the tire is within its working temperature range. Recording of the tire temperatures provides information if several test runs can be compared by each other.*

### DEWETRON Software – Fixed Points

*The fixed points functionality of the software calculates online the relative distance between the measurement vehicle and several user-defined fixed points. These points represent any stationary object, in this case cones. The inputs for the calculation are the GPS coordinates of the vehicle (dynamic) and the fixed points (static). A dedicated display shows the movement of the vehicle in relation to the fixed points on a plane.*



# How is it done?

*Only experienced drivers should run this highly dynamic manoeuvre. A test track and its geometrical dimensions are defined by the standard.*

**Test track Dimensions:**

| Section Nr. | Length of Section | | Width of Section |
|---|---|---|---|
| 1 | 15 m | | 1,1 x vehicle width [2] + 0,25 m |
| 2 | 30 m | | |
| 3 | 25 m | 3,5 m | 1,2 x vehicle width + 0,25 m |
| 4 | 25 m | | |
| 5 | 15 m | | 1,3 x vehicle width + 0,25 m |
| 6 | 15 m | | 1,3 x vehicle width + 0,25 m |

[2]*Vehicle width: overall width of the vehicle without rear view mirrors*

**Possible Problems:**

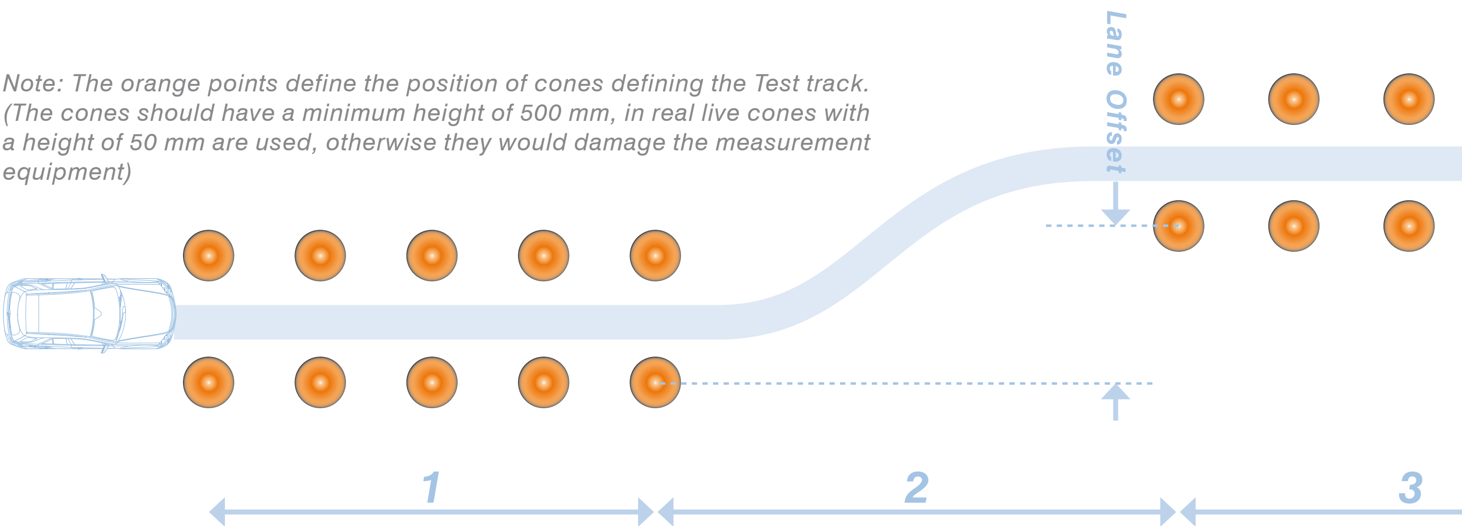
*The definition of a standard test track is the most logical approach to enable reproducible test runs. Unfortunately this is not enough to ensure that all test runs are really comparable. For a better understanding here is a list of what influences the results*

- *Longitudinal dynamics (engine power) influences the test run result; although the test run was designed for testing lateral dynamics.*
- *It is not possible to eliminate the influence of the longitudinal dynamics*
- *Different driving paths will cause different measurement results, leading to a considerable amount of scatter in the measured data*

**Solution:**

*An engine speed of at least 2000 rpm while passing the test track is suggested to minimize the influences of longitudinal accelerations. Furthermore by using the GeneSys ADMA and its high accuracy for position and acceleration signals the application engineer will be able to do a clustering of test runs. Focusing on nearly identical driving paths or longitudinal accelerations could do this. Another measured value should be the velocity at the end of section 1 to get another indicator for the repeatability of all test runs.*

*Note: The orange points define the position of cones defining the Test track. (The cones should have a minimum height of 500 mm, in real live cones with a height of 50 mm are used, otherwise they would damage the measurement equipment)*



## Test run

*The test run is divided in two separate tests, which differ from each other by the entrance speed to the track. At the first test it is 80 km/h and on the second run it is the maximum possible speed to complete the course. A test run is valid if test track limits were not exceeded and none of the cones was displaced.*


**Test run 1**

*As mentioned before it is suggested to run the test at several speeds, at least one run must be started with an entry speed of 80 +/- 3 km/h. Over the test course the throttle position shall be held as steady as possible.*

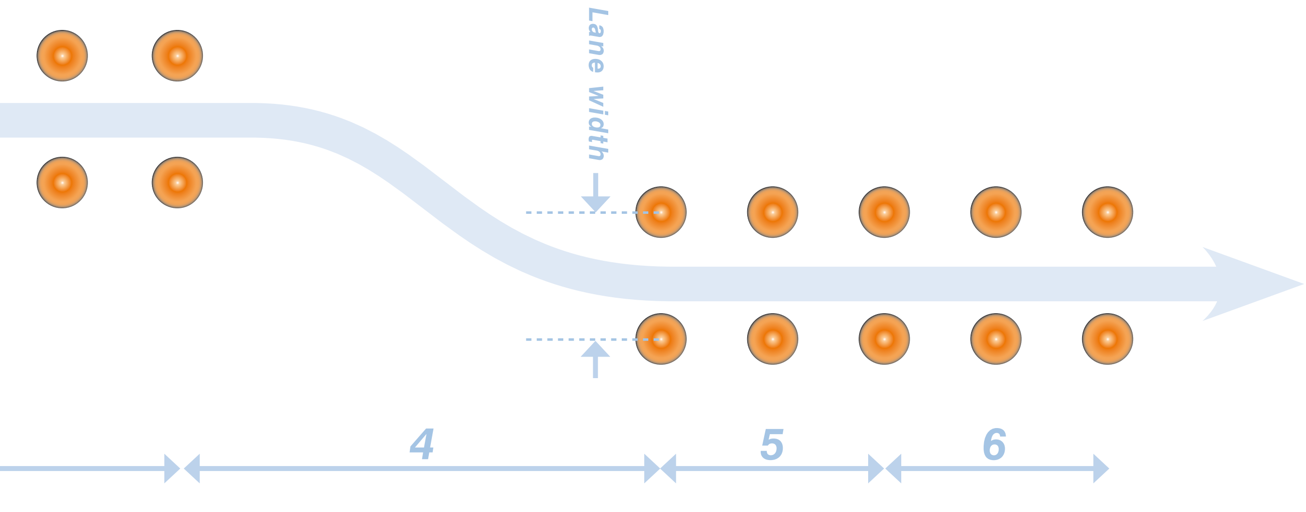
*The goal of these test runs should be to gain more information about*

- *Steering input or motion parameters both with respect to time*
- *Driver control strategies*
- *Subjectively evolutions of the vehicles*

**Test run 2**

*At the second test run, the entry speed should be the maximum speed for a successful passing of the track. Like in test 1 the throttle position should be held constant during the whole test run.*

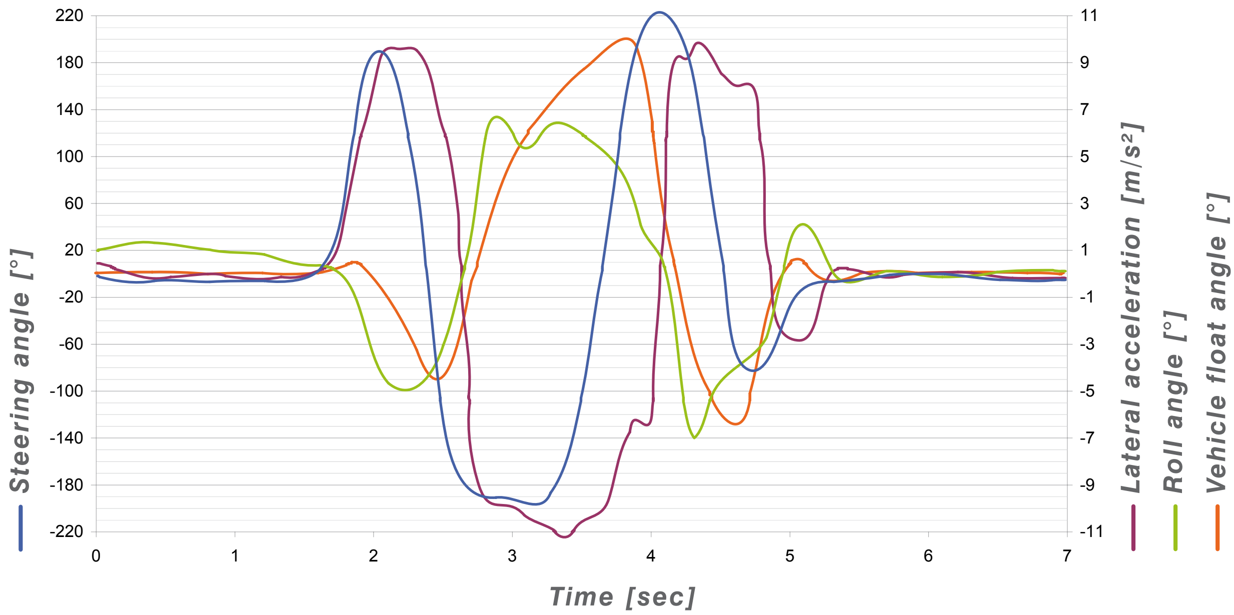
*A second option is to vary the throttle level during the whole test run. Additionally at 2 m after entering Section 1, release the throttle and drive the remaining distance in throttle released position.*



## What does the result look like?

*By using the suggested DEWETRON measurement systems and Software the engineer has the possibility to do online and offline analysis of the double-lane change manoeuvre. In the example the required vehicle CAN information like status of ABS, TSC or ESP and velocity are shown. At the graphs lateral, longitudinal accelerations and velocity are displayed over time, as well as rotational forces in combination with the steering wheel angle.*

The graph above shows a typical double-lane change manoeuvre. At the beginning the phase delay between the steering angle and the lateral acceleration is relatively small but then increases to a factor of 5 at the end of the test. This delay results from the inertia of the vehicle system, derived from the vehicle parameters. Roll angle and roll angle acceleration are almost exactly in phase, with the roll angle exhibiting a greater inertia than the roll angle acceleration. The differences in their polarities result from the definitions of the vehicle coordinates system according to DIN 70000..




### Benefits of using DTA and DEWETRON Equipment

- Full compatibility between sensors of DTA members and DEWETRON measurement system
- Full synchronisation of all sensor signals (analog, digital, CAN, GPS, Video)
- Flexible measurement systems in terms of channel count and configuration
- Total system solution provided by a single system supplier
- Methodical knowledge of DTA members


*Literature*

[1] ISO 3888-1 Passenger cars – Test track for a severe lane – change manoeuvre

[2] ISO 3888-2 Passenger cars – Test track for a severe lane – change manoeuvre

[3] Driveability Test Maneuver - VDA Lane Change

# DEWETRON Ride and Handling Hardware Configuration

| | DEWE-211-RAH-16 | DEWE-501-RAH-64 | DEWE-501-PCI-64 | DEWE-2600-RAH-64 |
|---|---|---|---|---|
| Application | Smallest RAH system, 16 analog inputs | AC-DC-UPS power, 64 analog inputs | 64 channels expansion for DEWE-501-RAH | Fully battery powered, 64 analog inputs |
| Analog input channels | 16 MDAQ inputs | 64 MDAQ inputs | 64 MDAQ inputs | 64 MDAQ inputs |
| Digital channels | 8 x DIO + 2 CTR or 8 DI | 8 x DIO + 2 CTR or 8 DI | 8 x DIO + 2 CTR or 8 DI | 8 x DIO + 2 CTR or 8 DI |
| Channel expansion | No | Yes | No | Yes |
| CAN interfaces | 2 | 4 | Up to 4 (opt.) | 4 |
| Video | DEWE-CAM or USB DirectX | DEWE-CAM or USB DirectX | No | DEWE-CAM or USB DirectX |
| Display | External MOB-DISP-x | External MOB-DISP-x | No | 15" 1024 x 768 |
| Power supply | 8 - 30 $V_{DC}$, external AC adapter | Battery powered, 18 - 24 $V_{DC}$ or 11 - 33 $V_{DC}$ | Battery powered, 18 - 24 $V_{DC}$ or 11 - 33 $V_{DC}$ (UPS battery 1 min.) | Battery powered, 18 - 24 $V_{DC}$, external AC power supply |
| Dimensions (W x D x H) | 317 x 252 x 92 mm 12.48 x 9.92 x 3.62 in. | 439 x 209 x 181 mm 17.28 x 8.23 x 7.13 in. | 439 x 209 x 181 mm 17.28 x 8.23 x 7.13 in. | 417 x 246 x 303 mm 16.42 x 9.69 x 11.93 in. |
| Weight | Typ. 5 kg (11 lb.) | Typ. 9 kg (19.8 lb.) | Typ. 8 kg (17.6 lb.) | Typ. 14 kg (31 lb.) |
| MDAQ series modules are available for almost all kinds of sensors | | | | |