Commission Implementing Decision of 10 March 2014 on the approval of the light emitting diodes low beam module 'E-Light' as an innovative technology for reducing CO2 emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council (Text with EEA relevance) (2014/128/EU)

ANNEX

METHODOLOGY FOR DETERMINING THE REDUCTION IN CO_2 EMISSIONS DUE TO THE USE OF THE LEDS LOW BEAM MODULE E-LIGHT, IN AN M1 VEHICLE

1. Introduction

In order to determine the CO_2 reductions that can be attributed to the use of the LEDs in Low Beam module, named E-Light, in an M1 vehicle, it is necessary to establish the following:

(a) the testing conditions;

(b) the test procedure;

(c) the formulae for calculating the CO_2 savings;

(d) the formulae for calculating the standard deviation;

(e) the determination of the CO_2 savings for the certification by type approval authorities.

2. Testing conditions

The requirements of UN/ECE Regulation No 112[(1)] on Uniform provisions concerning the approval of motor vehicle headlamps emitting an asymmetrical passing beam or a driving beam or both and equipped with filament lamps and/or light-emitting diode (LED) modules shall apply. For determining the power consumption, the reference is to be made to point 6.1.4 of Regulation No 112, and points 3.2.1 and 3.2.2 of Annex 10 to Regulation No 112.

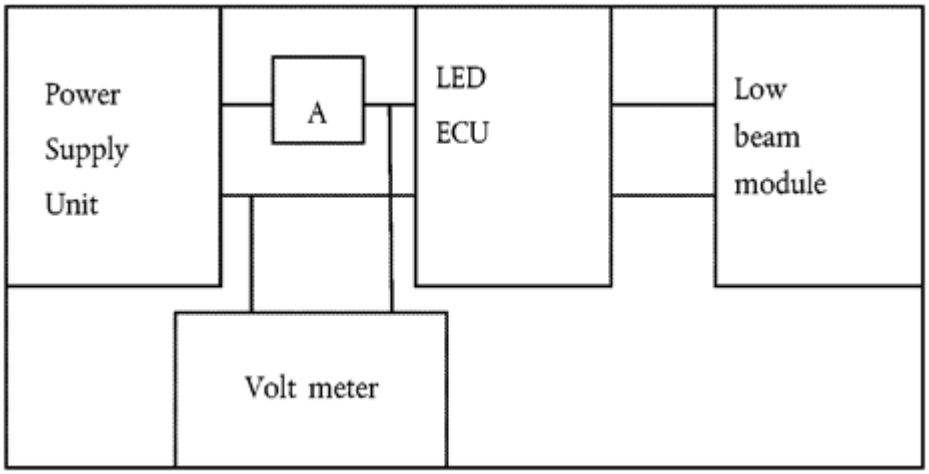
In addition, a warming-up of the equipment under test (EUT) during 30 minutes shall take place by delivering a current of 0,78 A to the EUT, with a voltage of 13,4 V. The EUT consists of the electronic control unit (ECU) of the LED lamp and the low beam module.

3. The testing procedure

Measurements are to be performed as shown in the figure. The following equipment is to be used:

— Two Digital Multi Meters, one for measuring the DC-current, and the other for measuring the DC-voltage.

— A power supply unit.



In total ten measurements is to be done with the following voltages: 9,0 V; 10,0 V; 11,0 V; 12,0 V; 13,0 V; 13,2 V; 13,4 V; 14,0 V; 15,0 V; 16,0 V (where values of 13,2 V and 13,4 V are typical values for the voltages in passenger's vehicles).

For each voltage the current is to be measured respectively.

The exact installed voltages and the measured current is to be recorded in four decimals.

4. **Formulae**

The following steps are to be taken to determine the CO_2 savings and to determine whether the threshold value of 1 g CO_2/km is met:

Step 1 : Calculate the power savings;
Step 2 : Calculate the CO_2 savings;
Step 3 : Calculate the error in the CO_2 savings;
Step 4 : Verify the threshold value.

4.1. *Calculate the power savings*

For each of the 10 measurements the power which is used is to be calculated by multiplying the installed voltage with the measured current. This is to result in 10 values. Each value is to be expressed in four decimals. Then the mean value of the used power is to be calculated, which is the sum of the 10 values for the power divided by 10.

The resulting power savings are to be calculated with the following formula:

Formula (1)

$$\Delta P = P_{\text{baseline}} - P_{\text{eco-innovation}}$$

Where:

ΔP : Power savings in W;
$P_{baseline}$: Power of the baseline, which is 137 W;
$P_{eco\text{-}innovation}$: Mean value of the used power of the eco-innovation in W.

4.2. *Calculate the CO_2 savings*

The formulae to calculate the CO_2 savings of the eco-innovation are:

For a petrol-fuelled vehicle:

Formula (2)

$$C_{CO_2} = \Delta P \times UF \times V_{Pe\text{-}P} / \eta A \times CF_P / v$$

For a diesel-fuelled vehicle:

Formula (3)

$$C_{CO_2} = \Delta P \times UF \times V_{Pe\text{-}D} / \eta A \times CF_D / v$$

Where in these formulae CO_2 is the CO_2 savings in g CO_2/km.

The input data for the formulae (2) and (3) are:

ΔP : Saved electrical power in W, which is the result of step 1
UF : Usage factor which is 0,33 for a low beam lamp
v : mean driving speed of the NEDC, which is 33,58 km/h
$V_{Pe\text{-}P}$: consumption of effective power for petrol-fuelled vehicles, which is 0,264 1/kWh

$V_{Pe\text{-}D}$: consumption of effective power for diesel-fuelled vehicles, which is 0,22 1/kWh
ηA : efficiency of the alternator, which is 0,67
CF_P : conversion factor for petrol fuel, which is 2 330 g CO_2/l
CF_D : conversion factor for diesel fuel, which is 2 640 g CO_2/l

4.3. *Calculate the statistical error in the CO_2 savings*

The statistical error in the CO_2 savings is to be determined in two steps. In the first step the error value of the power is to be determined as a standard deviation being equivalent to a confidence interval of 68 %.

This is to be done by formula (4).

Formula (4)

$$S_{\bar{x}} = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n(n-1)}}$$

Where:

$S_{\bar{x}}$: standard deviation of arithmetic mean [W];
x_i : measurement value [W];
$\bar{x}$: arithmetic mean [W];
n : number of measurements, which is 10.

Then the error in the CO_2 savings is to be determined using the propagation law, which is expressed in formula (5).

Formula (5)

$$\Delta \bar{C}_{CO_2} = \sqrt{\sum_{i=1}^{n} \left(\frac{\partial C_{CO_2}}{\partial P} \times eP_i \right)^2}$$

Where:

ΔC_{CO_2}: mean total error of the CO_2 saving (gCO_2/km)
$\partial C_{CO_2}/\partial P$ sensitivity of calculated CO_2 saving related to input value x_i
eP_i: error of input value (W)

Substituting formula (2) in formula (5) leads for petrol fueled vehicles to:

Formula (6)

$$\Delta C_{CO_2} = 0{,}0090\ gCO_2 / kmW \times eP$$

Where:

ΔC_{CO_2} : the error in the CO_2 savings (g CO_2/km);
eP : the error in the power consumption (W).

Substituting formula (2) in formula (5) leads for diesel fueled vehicles to:

Formula (7)

$$\Delta C_{CO_2} = 0{,}0085\ gCO_2/kmW \times eP$$

Where:

ΔC_{CO_2} : the error in the CO_2 savings (g CO_2/km);
eP : error in the power consumption (W).

4.4. *Verify the threshold value*

By means of formula (8) the threshold value is verified. The minimum threshold value is 1,0 g CO_2/km.

Formula (8):

$$MT \leq C_{CO_2} - \Delta\bar{C}_{CO_2}$$

Where:

MT	:	minimum threshold (g CO_2/km)
C_{CO_2}	:	total CO_2 saving (g CO_2/km), which must be expressed in 4 decimals,
$\Delta\bar{C}_{CO_2}$	:	mean total error of the CO_2 saving (g CO_2/km), which must be expressed in 4 decimals.

5. **Eco-innovation code to be entered into type approval documentation**

For the purposes of determining the general eco-innovation code to be used in the relevant type approval documents in accordance with Annexes I, VIII and IX to Directive 2007/46/EC of the European Parliament and of the Council[(2)], the individual code to be used for the innovative technology approved through this Decision shall be '5'.

E.g. the code of the eco-innovation in the case of eco-innovation savings certified by the German type approval authority shall be 'e1 5'.

(**1**) E/ECE/324/Rev.2/Add.111/Rev.3 – E/ECE/TRANS/505/Rev.2/Add.111/Rev.3, 9 January 2013.

(**2**) Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (Framework Directive) (OJ L 263, 9.10.2007, p. 1).

Changes to legislation:
There are outstanding changes not yet made to Commission Implementing Decision of 10 March 2014 on the approval of the light emitting diodes low beam module 'E-Light' as an innovative technology for reducing CO2 emissions from passenger cars pursuant to Regulation (EC) No 443/2009 of the European Parliament and of the Council (Text with EEA relevance) (2014/128/EU). Any changes that have already been made to the legislation appear in the content and are referenced with annotations.
View outstanding changes

Changes and effects yet to be applied to the whole legislation item and associated provisions

– Annex para. 5 words omitted by S.I. 2019/550 reg. 10(3)