Commission Implementing Decision (EU) 2020/1222 of 24 August 2020 on the approval of efficient vehicle exterior lighting using light emitting diodes as an innovative technology for reducing CO2 emissions from internal combustion engine powered light commercial vehicles with regard to NEDC conditions pursuant to Regulation (EU) 2019/631 of the European Parliament and of the Council (Text with EEA relevance)

ANNEX

Methodology to determine the CO_2 savings of Efficient Exterior LED Lighting under NEDC for use in light commercial vehicles

1. INTRODUCTION

This Annex sets out the methodology to determine the CO_2 (carbon dioxide) emission savings to be attributed to the use of efficient vehicle exterior lighting using one or an appropriate combination of LED lights listed in Article 1, for use in light commercial N_1 vehicles powered by an internal combustion engine.

2. TESTING CONDITIONS

The testing conditions shall fulfil the requirements of UN/ECE Regulations Nos 4 ([1]), 6 ([2]), 7 ([3]), 19 ([4]), 23 ([5]), 38 ([6]), 48 ([7]), 91 ([8]) 100 ([9]), 112 ([10]), 119 ([11]) and 123 ([12])**(1)**. The power consumption shall be determined in accordance with point 6.1.4 of UN/ECE Regulation No 112, and points 3.2.1 and 3.2.2 of Annex 10 to that Regulation.

For the low beam adaptive front lighting system (AFS) falling within at least two of the Classes C, E, V or W as defined in Regulation UN/ECE No 123 (see Table 1), the power consumption measurements shall be done at the LED intensity of each class (P_k), where k corresponds to each class specified at Table 1 as defined in Regulation UN/ECE 123.

If it is agreed with the technical service that Class C is the representative/average LED intensity for the vehicle application, power consumption measurements shall be done in the same way as for any other exterior LED light included in the combination.

TABLE 1

Classes of Low beam AFS

Class	See point 1.3 and footnote 2 of UN/ECE Regulation 123	% LED Intensity	Activation Mode[a]
C	Base Passing Beam (Country)	100	50 km/h < speed < 100 km/h Or when no mode of another passing beam class is activated (V, W, E)
V	Town	85	Speed < 50 km/h
E	Motorway	110	Speed > 100 km/h
W	Adverse Conditions	90	Windshield wiper active > 2 minutes

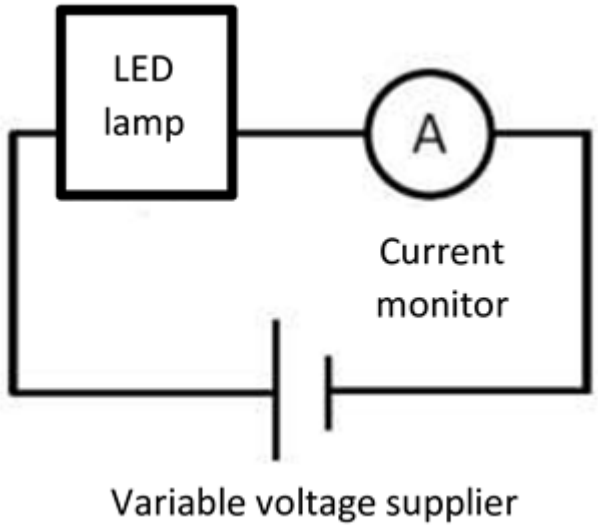
a Activation speeds shall be checked for each vehicle application in accordance with UN/ECE Regulation No 48 section 6, chapter 6.22, paragraphs 6.22.7.4.1 (class C), 6.22.7.4.2 (class V), 6.22.7.4.3 (class E), 6.22.7.4.4 (class W).

2.1. **Test equipment**

The following test equipment shall be used:

— a power supply unit (i.e. variable voltage supplier);
— two digital multimeters, one for measuring the DC-current, and the other for measuring the DC-voltage.

Figure 1 shows a possible test set-up, with the DC-voltage meter integrated in the power supply unit.



2.2. **Determination of the power savings**

2.2.1. *Measurement of the power consumption*

For each efficient exterior LED light included in a combination, the measurement of the current shall be performed at a voltage of 13,2 V. LED module(s) operated by an electronic light source control gear, shall be measured as specified by the applicant.

The manufacturer may request that additional measurements of the current shall be performed at other voltages, where the necessity to do so can be demonstrated on the basis of verified documentation.

In any case the measurements (n) shall be performed for each voltage at least five times consecutively. The applied voltage and the measured current shall be recorded in four decimals.

The power consumption shall be determined by multiplying the voltage with the measured current. The average of the power consumption for each efficient exterior LED light ($\overline{P_{EI_i}}$) [W] shall be calculated as set out in Formula 1 with four decimals to be taken into account in the calculations. When a stepper motor or electronic controller is used for the supply of the electricity to the LED lamps, then the electric load of this component is to be excluded from the measurement.

Formula 1

$$\overline{P_{EI_i}} = \frac{\sum_{j=1}^{n} \left(V_{EI_{i_j}} \cdot I_{EI_{i_j}} \right)}{n}$$

where,

$V_{EI_{ij}}$	is the tested voltage of each LED vehicle light i
$I_{EI_{ij}}$	is the measured current of each LED vehicle light i
n	is the number of measurements of the sample
j	refers to an individual measurement of power consumption

In case of low beam AFS, the power consumption ($P_{EI_{AFS}}$) [W] shall be calculated as the average of the LED power consumption for each class k, weighted according to the NEDC time share per speed range, in accordance with Formula 2.

Formula 2

$$P_{EI_{AFS}} = \sum_{k=1}^{K} NEDC\_share \cdot \overline{P_k}$$

where,

$\overline{P_k}$	is the power consumption at the LED intensity for each class k as the average of n consecutive measurements.
K	is the number of classes associated with the low beam AFS.
NEDC_share	is the NEDC time share per speed range in each class as defined in Table 2.

TABLE 2

NEDC time share per speed range

Speed range	NEDC_share
< 50 km/h	0,6805
50 – 100 km/h	0,2881
> 100 km/h	0,0314

When the low beam AFS does not fall within all four classes specified in Table 1, the NEDC_share of the missing classes shall be attributed to class C.

2.2.2. *Calculation of the power savings*

The power savings of each efficient exterior LED light (ΔP_i) [W] shall be calculated in accordance with Formula 3.

Formula 3

$$\Delta P_i = P_{B_i} - \overline{P_{EI_i}}$$

where,

P_{B_i}	is the power consumption of the baseline vehicle light i [W]
$\overline{P_{EI_i}}$	is the average power consumption of the eco-innovative vehicle light i [W]

The power consumption of the different baseline vehicle lights is defined in Table 3.

TABLE 3

Power consumption for different baseline vehicle lights

Vehicle light	Power consumption (P_B) [W]
Low beam headlamp	137
High beam headlamp	150
Front position	12
License plate	12
Front fog lamp	124
Rear fog lamp	26
Front turn signal lamp	13
Rear turn signal lamp	13
Reversing lamp	52
Cornering lamp	44
Static Bending lamp	44
End-outline marker lamps (vehicles width > 2,1 m)	12
Side marker lamps (vehicles length > 6 m)	24

3. CALCULATION OF THE CO_2 SAVINGS

The CO_2 savings shall be calculated in accordance with Formula 4.

Formula 4

$$C_{CO_2} = \left(\sum_{i=1}^{m} \Delta P_i \cdot UF_i\right) \cdot \frac{V_{Pe}}{\eta_A} \cdot \frac{CF}{v}$$

where,

v	is the mean driving speed of the NEDC, which is 33,58 km/h
η_A	is the efficiency of the alternator, which is 0,67
UF_i	is the usage factor of the vehicle light i as defined in Table 4
V_{Pe}	is the consumption of effective power for each fuel approved, as defined in Table 5
CF	is the fuel conversion factor as defined in Table 6.

TABLE 4

Usage factor for different vehicle lights

Vehicle light	Usage factor (UF)
Low beam headlamp	0,33
High beam headlamp	0,03
Front position	0,36

License plate	0,36
Front fog lamp	0,01
Rear fog lamp	0,01
Front turn signal lamp	0,15
Rear turn signal lamp	0,15
Reversing lamp	0,01
Cornering lamp	0,025
Static Bending lamp	0,039
End-outline marker lamps (vehicles width > 2,1 m)	0,36
Side marker lamps (vehicles length > 6 m)	0,36

TABLE 5

Consumption of effective power

Type of Engine	**Consumption of effective power V_{Pe} [l/kWh]**
Petrol/E85	0,264
Petrol/E85 Turbo	0,280
Diesel	0,220
LPG	0,342
LPG Turbo	0,363
	Consumption of effective power V_{Pe} [m^3/kWh]
CNG (G20)	0,259
CNG (G20) Turbo	0,275

TABLE 6

Fuel Conversion Factor

Type of fuel	**Conversion factor (CF) [g CO_2/l]**
Petrol/E85	2 330
Diesel	2 640
LPG	1 629
	Conversion factor (CF) [g CO_2/m^3]
CNG (G20)	1 795

4. CALCULATION OF THE UNCERTAINTY OF THE CO_2 SAVINGS

4.1. **General methodology**

The uncertainty of the CO_2 savings ($s_{C_{CO_2}}$) [W] shall be calculated in accordance with Formula 5.

Formula 5

$$s_{C_{CO_2}} = \frac{V_{Pe} \cdot CF}{\eta_A \cdot v} \cdot \sqrt{\sum_{i=1}^{m} \left(UF_i \cdot s_{\overline{P_{EI_i}}} \right)^2}$$

where,

m	is the number of exterior LED lights in the combination tested.
$s_{\overline{P_{EI_i}}}$	is the statistical margin of the power consumption of each i-th LED light fitted in the eco-innovative vehicle which shall be calculated in accordance with Formula 6.

Formula 6

$$s_{\overline{P_{EI_i}}} = \sqrt{\frac{\sum_{j=1}^{n} \left(P_{EI_{ij}} - \overline{P_{EI_i}} \right)^2}{n(n-1)}}$$

In case of a low beam AFS the statistical margin of the power consumption ($s_{\overline{P_{EI_{AFS}}}}$) [W] shall instead be calculated in accordance with Formulas 7 and 8.

Formula 7

$$s_{\overline{P_k}} = \sqrt{\frac{\sum_{j=1}^{n} \left(P_{c_j} - \overline{P_k} \right)^2}{n(n-1)}}$$

Formula 8

$$s_{\overline{P_{EI_{AFS}}}} = \sqrt{\sum_{k=1}^{K} \left(NEDC\_share \cdot s_{\overline{P_k}} \right)^2}$$

where,

n	is the number of power consumption measurements, which is at least 5 as indicated in section 2.2.1
i	corresponds to each vehicle light
j	refers to an individual measurement of power consumption
$\overline{P_k}$	is the average of the n values of P_k
K	is the number of classes associated with the low beam AFS.

5. ROUNDING

The CO_2 savings (C_{CO_2}) and the uncertainty of the CO_2 savings ($s_{C_{CO_2}}$) shall be rounded to two decimal places.

Each value used in the calculation of the CO_2 savings shall either be applied unrounded or be rounded to the minimum number of decimal places which allows the maximum total impact (i.e. combined impact of all rounded values) on the savings to be lower than 0,25 [g CO_2/km].

6. CHECK AGAINST THE MINIMUM CO_2 SAVINGS THRESHOLD

The type-approval authority shall ensure for each type, variant and version of a vehicle fitted with the efficient exterior LED lights that the minimum threshold criterion as specified in Article 9(1)(a) of Implementing Regulation (EU) No 427/2014 is met.

When verifying whether the minimum threshold criterion is met, the type-approval authority shall take into account, in accordance with Formula 9, the CO_2 savings determined in point 3 and the uncertainty determined in point 4.

Formula 9

$$C_{CO_2} - s_{C_{CO_2}} \geq MT$$

where,

MT	is the minimum threshold equal to 1 g CO_2/km
C_{CO_2}	is the CO_2 savings [g CO_2/km] as defined in point 3
$s_{C_{CO_2}}$	is the uncertainty of the CO_2 savings calculated in accordance with point 4 [g CO_2/km].

7. CERTIFICATION OF THE CO_2 SAVINGS

The type approval authority is to certify the CO_2 savings in accordance with point 3 based on measurements of the LED Lighting system and the baseline halogen lamps using the test methodology set out in this Annex. Where the CO_2 emission savings are below the threshold specified in Article 9(1) of Implementing Regulation (EU) No 427/2014, the second subparagraph of Article 11(2) of that Regulation shall apply.

(1) ([1]) OJ L 4, 7.1.2012, p. 17, ([2]) OJ L 213, 18.7.2014, p. 1, ([3]) OJ L 285, 30.9.2014, p. 1, ([4]) OJ L 250, 22.8.2014, p. 1, ([5]) OJ L 237, 8.8.2014, p. 1, ([6]) OJ L 148, 12.6.2010, p. 55, ([7]) OJ L 323, 6.12.2011, p. 46, ([8]) OJ L 164, 30.6.2010, p. 69, ([9]) OJ L 302, 28.11.2018, p. 114, ([10]) OJ L 250, 22.8.2014, p. 67, ([11]) OJ L 89, 25.3.2014, p. 101, ([12]) OJ L 222, 24.8.2010, p. 1.

Changes to legislation:
There are outstanding changes not yet made to Commission Implementing Decision (EU) 2020/1222. 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 :

- Annex point 6 words substituted by S.I. 2020/1418 reg. 11(5)(a)
- Annex point 7 words substituted by S.I. 2020/1418 reg. 11(5)(b)