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COMMISSION IMPLEMENTING DECISION (EU) 2016/588

of 14 April 2016

on the approval of the technology used in 12 Volt efficient alternators 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)

(OJ L 101, 16.4.2016, p. 25)

Amended by:

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		No	page	date
► <u>M1</u>	Commission Implementing Decision (EU) 2020/759 of 8 June 2020	L 179	13	9.6.2020

▼B**COMMISSION IMPLEMENTING DECISION (EU) 2016/588****of 14 April 2016**

on the approval of the technology used in 12 Volt efficient alternators 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)*Article 1***Approval**

The technology used in the Valeo high efficient alternator with high efficiency diodes and in the Bosch efficient alternator with MOS gated diodes is approved as an innovative technology within the meaning of Article 12 of Regulation (EC) No 443/2009.

*Article 2***Application for certification of CO₂ savings**

1. The manufacturer may apply for certification of the CO₂ savings from one or several 12 Volt (V) efficient alternators intended for use in M₁ vehicles, provided that it complies with the following conditions:

- (a) it is a component used solely to charge the vehicle battery and to power the electrical system of the vehicle when its combustion engine is running;
- (b) the mass of the efficient alternator does not exceed the mass of the baseline alternator of 7 kg by more than 3 kg;

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- (c) its efficiency is at least:
 - (i) 73,8 % for petrol- or E85-fuelled vehicles other than turbo-charged;
 - (ii) 73,4 % for turbo-charged petrol- or E85-fuelled vehicles;
 - (iii) 74,2 % for diesel-fuelled vehicles;
 - (iv) 74,6 % for vehicles fuelled with liquefied petroleum gas (LPG) other than turbo-charged;
 - (v) 74,1 % for turbo-charged LPG-fuelled vehicles;
 - (vi) 76,3 % for vehicles fuelled with compressed natural gas (CNG) other than turbo-charged;
 - (vii) 75,7 % for turbo-charged CNG -fuelled vehicles.

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2. An application for the certification of the savings from one or several efficient alternators shall be accompanied by an independent verification report certifying that the alternator or alternators comply with the conditions set out in paragraph 1.
3. The type approval authority shall reject the application for certification if it finds that the alternator or alternators do not comply with the conditions set out in paragraph 1.

*Article 3***Certification of CO₂ savings**

1. The reduction in CO₂ emissions from the use of an efficient alternator referred to in Article 2(1) shall be determined using the methodology set out in the Annex.
2. Where a manufacturer applies for the certification of the CO₂ savings from more than one efficient alternator referred to in Article 2(1) in relation to one vehicle version, the type approval authority shall determine which of the alternators tested delivers the lowest CO₂ savings, and record the lowest value in the relevant type approval documentation. That value shall be indicated in the certificate of conformity in accordance with Article 11(2) of Implementing Regulation (EU) No 725/2011.

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3. Where the innovative technology is fitted in a bi-fuel or flex-fuel vehicle, the approval authority shall record the CO₂ savings as follows:
 - (a) for bi-fuel vehicles using petrol and gaseous fuels, the CO₂ savings value with regard to LPG or CNG;
 - (b) for flex-fuel vehicles using petrol and E85, the CO₂ savings value with regard to petrol.
4. The certified CO₂ savings recorded by reference to eco-innovation code No 17 may only be taken into account for the calculation of the average specific emissions of manufacturers until and including the calendar year 2020.

▼B*Article 4***Eco-innovation code**

The eco-innovation code No 17 shall be entered into the type approval documentation where reference is made to this Decision in accordance with Article 11(1) of Implementing Regulation (EU) No 725/2011.

*Article 5***Entry into force**

This Decision shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.



ANNEX

METHODOLOGY TO DETERMINE THE CO₂ SAVINGS OF A 12 V EFFICIENT ALTERNATOR

1. INTRODUCTION

In order to determine the CO₂ savings that can be attributed to the use of an efficient alternator in an M₁ vehicle, it is necessary to specify the following:

- (1) the testing conditions;
- (2) the test equipment;
- (3) the determination of the efficiency of the efficient alternator and the baseline alternator;
- (4) the calculation of the CO₂ savings;
- (5) the calculation of the statistical error.

Symbols, parameters and units

Latin symbols

C_{CO_2} — CO₂ savings [g CO₂/km]

CO₂ — Carbon dioxide

CF — Conversion factor (l/100 km) — (g CO₂/km) [g CO₂/l] as defined in Table 3

h — Frequency as defined in Table 1

I — Current intensity at which the measurement shall be carried out [A]

m — Number of measurements of the sample

M — Torque [Nm]

n — Rotational frequency [min⁻¹] as defined in Table 1

P — Power [W]

$s_{\eta_{EI}}$ — Standard deviation of the eco-innovative alternator efficiency [%]

$\overline{s_{\eta_{EI}}}$ — Standard deviation of the eco-innovative alternator efficiency mean [%]

$s_{C_{CO_2}}$ — Standard deviation of the total CO₂ savings [g CO₂/km]

U — Test voltage at which the measurement shall be carried out [V]

v — Mean driving speed of the New European Driving Cycle (NEDC) [km/h]

V_{Pe} — Consumption of effective power [l/kWh] as defined in Table 2

$\frac{\partial C_{CO_2}}{\partial \eta_{EI}}$ — Sensitivity of calculated CO₂ savings related to the efficiency of the eco-innovative alternator

▼ B*Greek symbols* Δ — Difference η — Baseline alternator efficiency [%] η_{EI} — Efficient alternator efficiency [%] $\overline{\eta_{EI_i}}$ — Mean of the eco-innovative alternator efficiency at operating point i [%]*Subscripts*

Index (i) refers to operating point

Index (j) refers to measurement of the sample

EI — Eco-innovative

m — Mechanical

RW — Real-world conditions

TA — Type approval conditions

B — Baseline

2. TEST CONDITIONS

The testing conditions shall fulfil the requirements specified in ISO 8854:2012 ⁽¹⁾.

Test equipment

The test equipment shall be in accordance with the specifications set out in ISO 8854:2012.

3. MEASUREMENTS AND DETERMINATION OF THE EFFICIENCY

The efficiency of the efficient alternator shall be determined in accordance with ISO 8854:2012, with the exception of the elements specified in the present paragraph.

The measurements shall be conducted at different operating points i, as defined in Table 1. The alternator current intensity is defined as half of the rated current for all operating points. For each speed the voltage and the output current of the alternator are to be kept constant, the voltage at 14,3 V.

*Table 1***Operating points**

Operating point i	Holding time [s]	Rotational frequency n_i [min^{-1}]	Frequency h_i
1	1 200	1 800	0,25
2	1 200	3 000	0,40
3	600	6 000	0,25
4	300	10 000	0,10

The efficiency shall be calculated in accordance with to Formula 1.

⁽¹⁾ ISO 8854:2012 Road vehicles — Alternators with regulators — Test methods and general requirements. Reference number ISO 8854:2012, published on 1 June 2012.

▼ B*Formula 1*

$$\eta_{EI_i} = \frac{60 \cdot U_i \cdot I_i}{2\pi \cdot M_i \cdot n_i} \cdot 100$$

All efficiency measurements are to be performed consecutively at least five (5) times. The average of the measurements at each operating point ($\overline{\eta_{EI_i}}$) has to be calculated.

The efficiency of the eco-innovative alternator (η_{EI}) shall be calculated in accordance with Formula 2.

Formula 2

$$\eta_{EI} = \sum_{i=1}^4 h_i \cdot \overline{\eta_{EI_i}}$$

The efficient alternator leads to saved mechanical power under real-world conditions (ΔP_{mRW}) and type approval conditions (ΔP_{mTA}) as defined in Formula 3.

Formula 3

$$\Delta P_m = \Delta P_{mRW} - \Delta P_{mTA}$$

Where the saved mechanical power under real-world conditions (ΔP_{mRW}) is calculated in accordance with Formula 4 and the saved mechanical power under type-approval conditions (ΔP_{mTA}) in accordance with Formula 5.

Formula 4

$$\Delta P_{mRW} = \frac{P_{RW}}{\eta_B} - \frac{P_{RW}}{\eta_{EI}}$$

Formula 5

$$\Delta P_{mTA} = \frac{P_{TA}}{\eta_B} - \frac{P_{TA}}{\eta_{EI}}$$

where

P_{RW} : Power requirement under ‘real-world’ conditions [W], which is 750 W

P_{TA} : Power requirement under type-approval conditions [W], which is 350 W

η_B : Efficiency of the baseline alternator [%], which is 67 %

Calculation of the CO₂ savings

The CO₂ savings of the efficient alternator are to be calculated with the following formula.

Formula 6

$$C_{CO_2} = \Delta P_m \cdot \frac{V_{Pe} \cdot CF}{v}$$

where

v : Mean driving speed of the NEDC [km/h], which is 33,58 km/h

V_{Pe} : Is the consumption of effective power specified in the following Table 2

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Table 2

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

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CF: Is the factor specified in the following Table 3

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Table 3

Fuel conversion factor (CF)

Type of fuel	Conversion factor	
	[100 g CO ₂ /l]	[g CO ₂ /l]
Petrol/E85	23,3	2 330
Diesel	26,4	2 640
LPG	16,3	1 629
	[100 g CO ₂ /m ³]	[g CO ₂ /m ³]
CNG (G20)	18,0	1 795

▼ **B****Calculation of the statistical error**

The statistical errors in the results of the testing methodology caused by the measurements are to be quantified. For each operating point the standard deviation is calculated as defined by the following formula:

▼ B*Formula 7*

$$s_{\eta_{EI_i}} = \frac{s_{\eta_{EI_i}}}{\sqrt{m}} = \sqrt{\frac{\sum_{j=1}^m (\eta_{EI_j} - \bar{\eta}_{EI_i})^2}{m(m-1)}}$$

The standard deviation of the efficiency value of the efficient alternator ($s_{\eta_{EI}}$) is calculated in accordance with formula 8:

Formula 8

$$s_{\eta_{EI}} = \sqrt{\sum_{i=1}^4 h_i \cdot s_{\eta_{EI_i}}^2}$$

The standard deviation of the alternator efficiency ($s_{\eta_{EI}}$) leads to an error in the CO₂ savings ($s_{C_{CO_2}}$). That error is calculated in accordance with formula 9:

Formula 9

$$s_{C_{CO_2}} = \sqrt{\left(\frac{\partial C_{CO_2}}{\partial \eta_{EI}} \cdot s_{\eta_{EI}}\right)^2} = \frac{(P_{RW} - P_{TA})}{\eta_{EI}^2} \cdot \frac{V_{pe} \cdot CF}{v} \cdot s_{\eta_{EI}}$$

Statistical Significance

It has to be demonstrated for each type, variant and version of a vehicle fitted with the efficient alternator that the error in the CO₂ savings calculated in accordance with Formula 9 is not greater than the difference between the total CO₂ savings and the minimum savings threshold specified in Article 9(1) of Implementing Regulation (EU) No 725/2011 (see Formula 10).

Formula 10

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

where:

MT: Minimum threshold [g CO₂/km], which is 1 g CO₂/km

Test and evaluation Report

The report shall include:

- Model and mass of the tested alternators
- Description of the bench
- Test results (measured values)
- Calculated results and corresponding formulae

The efficient alternator to be fitted in vehicles

The type approval authority is to certify the CO₂ savings based on measurements of the efficient alternator and the baseline alternator using the test methodology set out in this Annex. Where the CO₂ emission savings are below the threshold specified in Article 9(1), the second subparagraph of Article 11(2) of Implementing Regulation (EU) No 725/2011 shall apply.