

**EGMF ROBOTIC MOWERS PERFORMANCE EVALUATION STANDARD RLM004-1.0/2016**

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**Industry Standard for the evaluation of the performance of Robotic Lawnmowers**

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# Robotic Lawnmower – Mowing Performance Evaluation 1.0

## Foreword

35 This document was written by the EGMF Robotic Lawnmower Task Force to define performance characteristics for comparative Consumer Robotic Lawnmower tests. This document does not cover any safety related requirements.

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## Introduction

A robotic mower is an autonomous machine designed to maintain lawn in a pre-determined area.

85 Its operation is distinct from a standard walk behind lawnmower or a riding lawnmower by its autonomous operation and by the semi-continuous cutting of the lawn

### 90 1. **Scope**

This standard deals with performance criterion for consumer robotic lawnmower under domestic use. All procedures described in this standard are primarily for comparison tests of a range of products under same lawn and weather conditions

95 In this standard the term “machine” means “robotic lawnmower”

### 2. **Normative References**

EN ISO 5395-2 :2013

100 EN 50636-2-107 :2015

### 3. **Terms and Definitions**

105 3.1. **Cutting height**  
shortest distance between bottom edge of the blade and the supporting surface

3.2. **Manufacturer Specification**  
110 Perimeter delimiter specifications, product setup descriptions and programming information as delivered with the machine or which is available on the Internet or at local dealers

3.3. **Standard Lawn Area**  
115 A lawn area which is simulating a standardized lawn for comparative test. It is intended to simulate real lawn conditions

3.4. **Soft obstacle**  
Representing a soft obstacle like a flower bed which needs to be considered when installing a specific machine and is not intended to be cut by the machine

120 3.5. **Rigid obstacle**  
Representing a rigid obstacle like a tree, or rock which needs to be considered when installing a specific machine and is allowed to be touched by the machine

125 3.6. **Charging Station**  
Automatic battery charging facility located on or within the delimited or pre-programmed area

130 3.7. **Cutting means**  
Mechanism used to provide the cutting action

- 135 3.8. **Cutting position**  
Any height setting of the cutting means designated by the manufacturer for cutting grass
- 3.9. **Maintenance Mode**  
Mode where the machine is maintaining a working area under automatic conditions
- 140 3.10. **Teaching Mode**  
Mode where the operator teaches the machine manually or automatically to the standard lawn area.
- 3.11. **Uncut area**  
Area where the lawn is not trimmed down to the adjusted cutting position.
- 145 3.12. **Side wall**  
A rigid wall is simulating a wall, a fence, a curbstone, etc. on the standard lawn area
- 3.13. **Expanded lawn area**  
A lawn area for testing the maximum maintainable lawn size for a machine
- 150 3.14. **Product intervention**  
A situation where a user has to interact with the machine in order to continue the operation of the machine

155 **4. Test preparation**

160 4.1. **General**  
For such comparative tests new machines shall be used. All installations for each machine shall be carried out in accordance with manufacturer instructions. The performance tests shall be started with all machines at the same time, using identical lawns and under identical conditions. Prior to the start of all tests the battery shall be fully charged. The machine cutting position shall be set to the closest specified cutting height which is specified for all following tests.

165 If the machine is equipped with ancillary sensors (e.g. rain sensor) that may limit the functionality and that can be disabled by the user, these sensors shall be disabled.

170 After a product intervention it shall be decided whether to re-start these tests from the beginning or to continue from that instance.

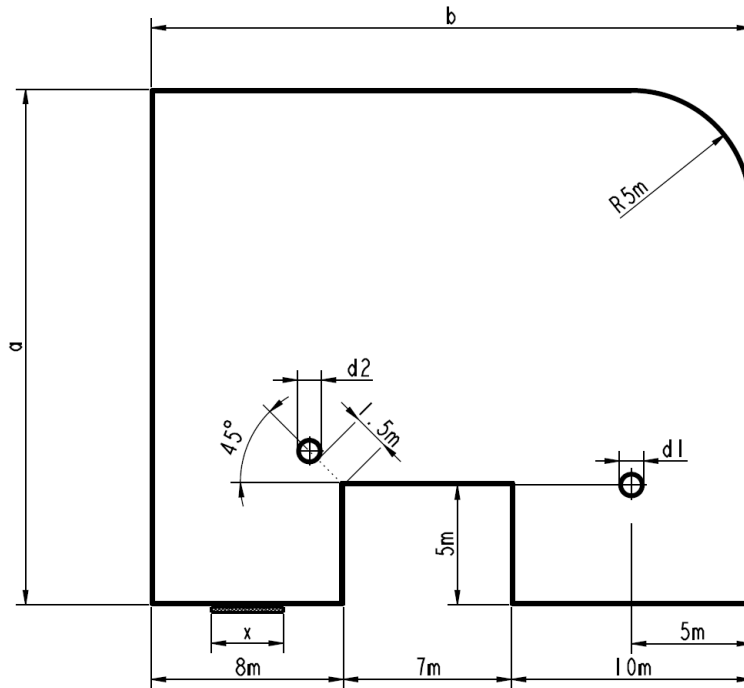
If the product intervention results from external factors e.g. conditions or foreign objects, the elapsed time of the product intervention is added to the 60 h period.

175 Distances between lawn borders should be at least 5m

Note: Products should operate interference free

180

4.2. Standard lawn area



185 a = according lawn area      b=25 m      X = 3 m rigid wall  
 d<sub>1</sub> = 1 m diameter      soft obstacle  
 d<sub>2</sub> = 1 m diameter rigid obstacle 140 mm minimum height

190 Note: It is not intended that the machine touches the soft obstacle  
 Note: It is acceptable for the machine to touch the rigid obstacle"

The lawn area for the comparative test will be decided according to the maximum declared maintainable lawn size of that machine.  
 If a machine is declared for less than 500 m<sup>2</sup> then use the 196 m<sup>2</sup> test lawn. Use configuration A).  
 195 If a machine is declared for greater equal 500 m<sup>2</sup> then use the 496 m<sup>2</sup> test lawn. Use configuration B)

200 Configuration A)  
 A<sub>t</sub> = 196 m<sup>2</sup>      a = 9.5 m

Configuration B)  
 A<sub>t</sub> = 496 m<sup>2</sup>      a = 21.5 m

205 The rigid wall is simulated by an object having a minimum 140\*140 mm wooden post or similar. This post is laid down alongside the outside of the maintained area and fixed to the ground to avoid movement.

210 The charging station should be installed in accordance with manufacturer instructions

The standard lawn is the area to be maintained by the machine i.e. any boundary wire should be installed in accordance with the manufacturer's instructions in order to cut this area.

215

#### 4.3. Lawn Preparation

All tests shall be carried out on a flat, smooth lawn with a max. slope angle of 2° during the lawn growing season. To prepare these lawns it is recommended to cut all lawns at least 1 day prior to the field preparation down to 70 mm with a regular rear discharge rear collect lawnmower to collect all clippings.

To guarantee comparable lawn conditions all lawns should be cut down from 70 mm to 60 mm, or the maximum cutting position if less than 60 mm, under dry conditions with the machine which will be used on this lawn for all following tests. This operation sequence could also be used to finish any kind of machine teaching/preparation modes. Time for this lawn preparation is at least 48 h with cutting sequence settings at the machine to maximum duration.

To minimize the possibility of interventions, the test site should be set up in an area where falling/fallen objects are unlikely to be encountered and where there are no overhanging branches likely to activate any sensors.

Any stops during preparation if related to the installation should be corrected before the test is started, for example rabbit holes or machine stuck in the boundary wire

#### 4.4. Machine preparation and adjustments

Machines shall be adjusted in accordance to manufacturer specifications to cut a lawn area described under 4.2. Any coverage planning, parameters and navigation strategy adjustments e.g. mowing time shall be carried out in accordance to manufacturer specifications and descriptions.

### 5. Tests on standard lawns

#### 5.1. Initial cutting phase

Note: the initial cutting phase is used for evaluation of:

- Area coverage (5.3)
- energy consumption (5.6)
- product intervention during test time (5.7)

##### 5.1.1. Test specification

The cutting position shall be adjusted to:

45 mm or the next lowest cutting position for those machines capable of achieving a height of cut during the preparation phase of equal or more than 60 mm, or;

at least 10mm lower than the highest height of cut used during the preparation phase, for those machines with a maximum height of cut less than 60 mm.

The battery shall be fully charged before starting this test.

The machine shall operate 60 h in automatic mode on the lawn area. Operating parameter shall be set in accordance with manufacturer recommendations for such a lawn area in order to minimize uncut areas and to maximize lawn availability.

The date and place, maximum and minimum daily ambient temperatures are to be recorded in the report. The climatic conditions shall be recorded for example amount and duration of rainfall.

5.1.2. After the completion of the 60 h test in accordance with 5.1.1 the total uncut area shall be determined. During this period the machine shall not be operated. If multiple machines are being evaluated simultaneously than the machines shall be stopped for the same amount of time.

275

## 5.2. Lawn maintenance phase evaluation

Note: the lawn maintenance phase evaluation is used for evaluation of:

- Lawn availability (5.4)
- $T_{off}$  the time the machine is at the charging station either charging or not charging (5.4.1)
- Uncut width at rigid wall and rigid obstacle (5.5.1)
- energy consumption (5.6)
- product intervention during test time (5.7)

280

### 5.2.1. Test specification

The cutting position shall be as in 5.1.1. Battery needs to be fully charged before starting this test.

285

The machine shall operate for another 60h period in automatic mode on the same lawn area the machine was operating on in accordance with test 5.1.1. The operating parameter shall be set in accordance with manufacturer recommendations for maintaining the lawn area in order to minimize uncut areas and to maximize lawn availability.

290

Note: for some machines this may require some settings other than standard factory default and may require the weekly schedule of the machine be reset to a new week.

295

The date and place, maximum and minimum daily ambient temperatures are to be recorded in the report. The climatic conditions shall be recorded for example amount and duration of rainfall.

300

5.3. Area Coverage – standard lawn

5.3.1 Area coverage

After the initial cutting phase, the area coverage shall be at least 98%.  
Compliance is checked by measuring the uncut areas according to 5.3.1.1

5.3.1.1. Area Coverage Evaluation

After the initial cutting phase according to 5.1.1, sum up all uncut areas inside the lawn area that cannot be bounded by a 100 mm diameter circle at the largest sector of this uncut area (see figure 1). All uncut areas are to be evaluated as a best approximated rectangle with the dimension  $a_{Ui}$  and  $b_{Ui}$ .

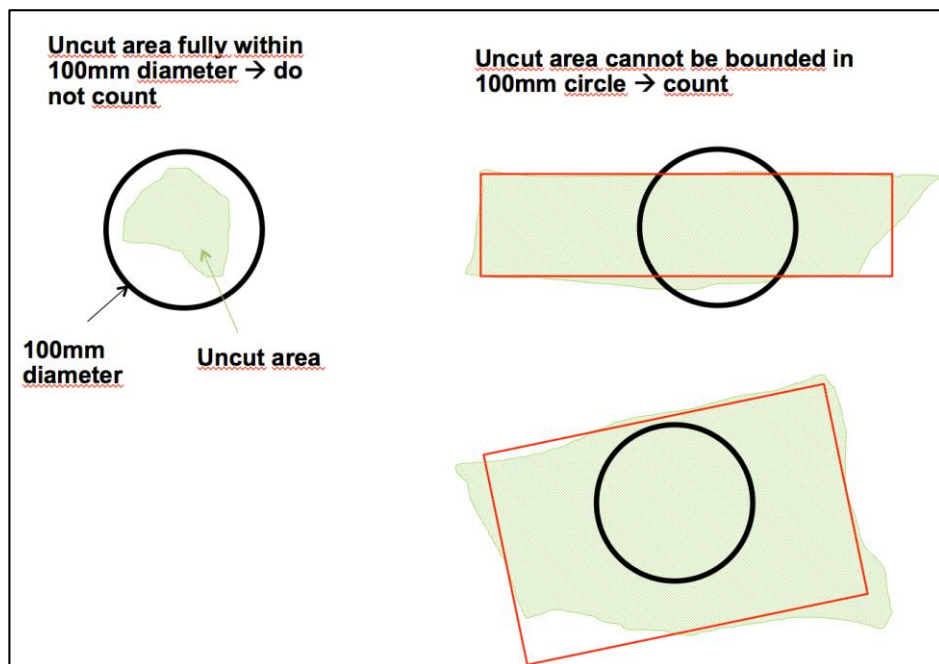


Figure 1

$$A_{Ut} = \sum_{i=1}^n (a_{Ui} * b_{Ui})$$

The total uncut area  $A_{Ut}$  is calculated as the sum of all uncut areas  $A_{Ui}$  in  $m^2$ .

Also the uncut area in front of the rigid wall and around the other obstacles will be counted in regard to area coverage.

For all machines, the evaluation of uncut areas shall be performed by the same person.

The area coverage  $c_A$  in % is calculated as the proportion of total cut area  $A_t - A_{Ut}$  to total lawn size  $A_t$  multiplied by 100.

$$c_A = \frac{A_t - A_{Ut}}{A_t} * 100$$



Include in the items to be reported, the name of the person carrying out the evaluation of uncut areas along with date and location.

340 5.3.2. The test is considered to be successful if after 60 hours 98% of the area has been covered. If the area coverage percentage is less than 98%, this shall be reported, see Annex A.

#### 5.4. Lawn Availability

345 5.4.1. Lawn Availability Evaluation  
Lawn availability shall be measured when the machine is operating in maintenance mode in accordance with 5.2.1

350 The time  $T_{off}$  is the time the machine is at the charging station either charging or not charging. Measurement can be taken from machines data recording systems or another adequate measurement device.

355 To calculate lawn availability all periods  $T_{off(i)}$  greater than 15 minutes are summed up to give a total time  $T_{off}$  rounded to full minutes

$$T_{off} = \sum_{i=1}^n T_{off(i)}$$

360 5.4.2. Lawn availability  $T_a$   
Lawn availability is defined as  $T_{off}$  divided by 60 h test time in %.

$$T_a = \frac{T_{off}}{60h} * 100\%$$

#### 365 5.5. Uncut widths at rigid wall and rigid obstacle

5.5.1. Uncut width at rigid wall evaluation  
The uncut width at rigid walls shall be measured and recorded as an average width over the length of the rigid wall after the machine finished tests in accordance with 5.2

370 5.5.2. Uncut width at rigid obstacles evaluation  
The uncut width at rigid obstacles shall be measured and recorded as an average width over the length of the rigid obstacles after the machine finished the test in accordance with 5.2

#### 375 5.6. Energy consumption

380 5.6.1. Energy consumption evaluation  
The energy consumption shall be measured at the mains socket outlet during the two 60 h test periods specified in 5.1.1 and 5.2.1. The total energy consumption in Wh shall be divided by the 120 h test duration and recorded as the average power consumption.

385 5.6.2. Stated energy consumption  
Average energy Wh consumed by the robotic lawnmower during the lawn preparation and lawn maintenance phases. Energy consumption will be calculated on one day. The average

power consumption per hour described in 5.6.1 multiplied by 24 h.

390 5.7. Product interventions during test time

5.7.1. Product intervention evaluation

The sum of all product interventions during the 120 h test period whilst operating in automatic mode in accordance with the tests 5.1.1 and 5.2.1 shall be recorded.

Time to recover from a product intervention will not be recorded.

395 Reasons for product intervention shall be recorded for later interpretation.

400 6. **Test on expanded lawn areas**

6.1. Evaluation of the maximum maintainable lawn size

6.1.1. Test setup

405 To evaluate the maximum lawn area a machine is capable of maintaining the lawn area as defined in 4.2 shall be expanded by increasing proportionally dimension “a” and “b” accordingly.

410 The machine shall operate and maintain the maximum declared area of lawn for a period of 120 h in automatic mode. The cutting position shall be adjusted to 45 mm or the next lowest cutting position.

415 The battery shall be fully charged before starting this test. Operating parameters shall be set in accordance with the manufacturer’s recommendations.

6.1.2. Area Coverage Evaluation for a maximum lawn area

420 Sum up all uncut areas inside the lawn area after finishing the tests in accordance with 6.1.1 that cannot be bounded by a 100 mm diameter circle at the largest sector of this uncut area (see figure 1). All uncut areas are to be evaluated as a best approximated rectangle with the dimension  $a_{Ui}$  and  $b_{Ui}$ .

The total uncut area  $A_{Ut}$  is calculated as the sum of all uncut areas  $A_{Ui}$  in  $m^2$ .

435 
$$A_{Ut} = \sum_{i=1}^n (a_{Ui} * b_{Ui})$$

425 For all machines, the evaluation of uncut areas shall be performed by the same person.

The area coverage  $c_A$  in % is calculated as the proportion of total cut area  $A_t - A_{Ut}$  to total lawn size  $A_t$  multiplied by 100.

430 
$$c_A = \frac{A_t - A_{Ut}}{A_t} * 100$$

Include in the items to be reported, the name of the person carrying out the evaluation of uncut areas along with date and location.

6.1.3. Area coverage - maximum maintainable lawn area

A lawn is considered to be maintained when after 120 h the area coverage is more than 98%.

440

If the area coverage is less than 98 % the size of the maximum lawn area should be reduced by decreasing the dimension “a” and “b” accordingly. A retest in accordance to 6.1.2 is required until an area coverage of 98% is achieved.

445

## ANNEX A Performance Test Report Template

Test Report Robotic Lawnmower - Mowing Performance Evaluation							
<b>Product</b>							
Manufacturer							
Robotic Lawnmower Type / Serial Number							
Maximum declared maintainable lawn size							
		m <sup>2</sup>					
Maximum cutting position in mm							
		mm					
<b>Test environment and operating parameter</b>							
Place							
Test plot							
Configuration [A/B]							
<b>Initial cutting phase (5.1)</b>							
Date - beginning the test							
Time							
		Test started					
		Test finished					
Climate conditions		Day 1		Day 2		Day 3	
Max./ min. ambient temperature		°C	°C	°C	°C	°C	°C
Amount and duration of rainfall		mm	h	mm	h	mm	h
Operational paramter							
Cutting position		mm					
<b>Lawn maintenance phase evaluation (5.2)</b>							
Date - beginning the test							
Time							
		Test started					
		Test finished					
Climate conditions		Day 1		Day 2		Day 3	
Max./ min. ambient temperature		°C	°C	°C	°C	°C	°C
Amount and duration of rainfall		mm	h	mm	h	mm	h
Operational paramter							
Cutting position		mm					
<b>Test results</b>							
<b>Initial cutting phase (5.1)</b>							
Uncut Area		m <sup>2</sup>	%	area coverage >98% Yes / No			
Evaluated by							
<b>Lawn maintenance phase evaluation (5.2)</b>							
Lawn availability		%					
Uncut width at rigid wall		mm					
Uncut width at rigid obstacle		mm					
<b>Energy consumption evaluation (5.6)</b>							
Energy consumption		Wh					
Average power consumption		W					
Stated energy consumption		Wh					
<b>Product intervention (5.7)</b>							
Sum of product interventions							
Detailed description of interventions							
<b>Maximum maintainable lawn size (6.1)</b>							
Evaluated by							
Uncut Area 1st test		m <sup>2</sup>	%	area coverage >98% Yes / No			
Uncut Area 2nd test		m <sup>2</sup>	%	area coverage >98% Yes / No			
Uncut Area 3rd test		m <sup>2</sup>	%	area coverage >98% Yes / No			
		m <sup>2</sup>	%	area coverage >98% Yes / No			
		m <sup>2</sup>	%	area coverage >98% Yes / No			

**ANNEX B Performance Test Flow Chart**

