

TESS-P



TESS-P Photometer


User Manual

Versión: 2.1

10/03/2021

Cristobal Garcia

STARS4ALL


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CONTROL SHEET

Project	STARS4ALL EU project		
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CHANGELOG

Versión	Purposes	Responsable del Cambio	Fecha del Cambio
01.00	Initial versión	Cristóbal García	30/11/2019
02.00	New hardware version. Csv file for Maps. Improvements.	Cristóbal García	15/08/2020
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1 Introduction.

TESS-P comes out as a continuation of TESS-W for the European project STARS4ALL in collaboration with UCM and UPM.

1.1 Description.

TESS-P (TESS Portable), is a handheld photometer and IR thermometer. It includes an accelerometer and magnetometer to indicate the direction of the target.

It is intended to study the light pollution and the quality of the night sky..

1.2 Requirements.

To charge the battery, an standard smartphone charger with USB C connector is needed (not supplied).


If we want to save the measurements with a GPS reference, it is possible to do so using an Android smartphone and the TESS-P app.

1.3 Precautions for use.

The device should not get wet, and the entry of the sensors should not be touched with the fingers.


The box is not waterproof, and cannot be kept outdoors for a long time.

Any dirt could provoke a mistake in the measure. Optical products are recommended to clean it.

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1.4 Technical Especifications.

Power suply	Rechargeable lithium battery 1200 mAh Type C USB 5v 1A.
Consumption	750 mA charging and 100 mA with charged battery.
Battery duration	4 hours.
Comunicación	BTLE. Optional USB type C for long period lectures. Optional USB type C for long period lectures.
Working Temperature range	-30°C to 70°C
Dimensions	8 x 7 x 3 cm
Weight	200 gr
Sensor type	Photodiode TSL237.
FOV bright	17°
Spectral range of Brightness	400 a 750 nm
Accuracy Brightness	+ - 0.1 mag/arcs ² .
Espectral Range	8 a 23 mag/arcs ² .
IR sensor type	Thermopile MLX90614ESF
IR FOV	35°
Resolution IR temperature	+ - 0.02 °C
IR Temperature Range	-70 .. +380 °C
Sensor Temperature Range	-40 .. 125 °C
Sensor Temperature resolution	+ - 0.5 °C
Bright Calibración	Laboratory LICA UCM.

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2 DESCRIPTION.

TESS-P is a portable photometer for sky bright measures. To complement the measure it also incorporates a IR thermometer and an accelerometer-magnetometer for the point direction.



Illustration 1: TESS-P front with color display. At the bottom USB C connector and 1/4 thread for tripod.

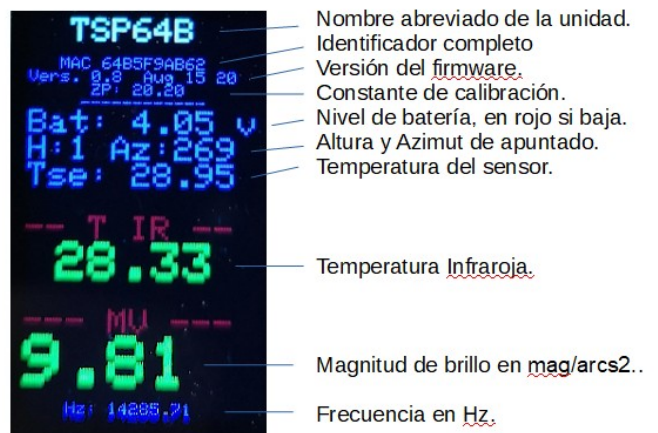



Illustration 2: Fields in the display presentation.



Illustration 3: Below magnitude 17 the display changes to red.

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2.1 Calibración.

To make the bright data useful and comparable to the other photometers, these must be calibrated with a common reference. All the photometers are calibrated by the LICA laboratory of the UCM.

2.2 Start up.

To activate the photometer, just slide the side switch to the red dot position. The measures are updated every second, excepting the magnitude, which depends on how dark is the sky. The measures for dark skies can take even ten seconds.



Illustration 4: Calibration label. Each photometer is calibrated at LICA UCM laboratory.

2.3 Comunicación.

Communication is possible via BT and optionally via USB.

BT communication allows linking with an Android smartphone using the TESS-P app to save measurements.

USB communication allows connection to a laptop. In this way, the battery is not wasted and it is possible to use the tess.exe program for windows or simply read the data with a serial terminal.


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Illustration 5: TESS-P communication options: BT and USB. With USB it is possible to record the brightness evolution of a whole night. In both cases it is possible to activate alarms.

2.4 Battery.

The device is charged with any mobile charger through the type C USB connector.

In order to let the device charge, it is necessary to switch on the device with the switch down, red dot.

The time of complete charge is four hours. The approximate duration of the battery is three hours.

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3 AUXILIARY PROGRAMS.

Although the device works in an autonomous way thanks to its display, we can connect it to a mobile phone or PC to store the measures, generate alarms or obtain graphics.

3.1 APP for Android.


This app is specially intended for the photometer TAS, but also gives interesting services with TESS-P. For instance, storing the data adding the GPS position, taking periodic measures depending on time or distances or even creating alarms for changes in the atmospheric situation.



Illustration 6: App Presentation.

If the telephone is connected to a wifi in a place where a TES-W exists, its name and its IP will appear under the main name by the name "Other W". In the same way, we can watch its measures by editing the name of the sensor and typing that which is on the web.

With the button *SEND* we can send to the web single measures through MQTT. Up to now it is in testing phase through the broker *test.mosquitto.org*, the measures are sent with the topic "*STARS4ALL/TSPxxx/reading*".

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3.1..1 Settings.

To let the program get the measures it is just necessary to set up the name of our sensor. This name is composed of the letters TSP and three numbers automatically extracted from the MAC of the device. It appears on the display and the calibration sticker.

In the field “site” it is allowed to insert a descriptive word, such as the name of the place of observation. This word is added to the file name when the measures are saved.

3.1..2 Register single measures.

The measures can be saved pressing the button “save”. The period of writing can be modified from 1 to 60 seconds pressing the right button “save”. The saved measure corresponds to the average of the measures taken at the fixed time.

The time cell allows fixing a minimal displacement between measures. After the fixed time, if the distance is surpassed, the measure is saved.

Under these buttons there is a counter with the number of saved measures.

3.1..3 Register measures in route.

It is possible to fix the sensor in the upper part of the car with the adequate accessory to take measures in route on a road trip. In this case it is useful to save measures by distance and not by time.



Illustration 7: With the appropriate accessory it is possible to attach the sensor to the car to take measurements on the road.

The file obtained in csv format can be directly uploaded to Google Maps for presentation.

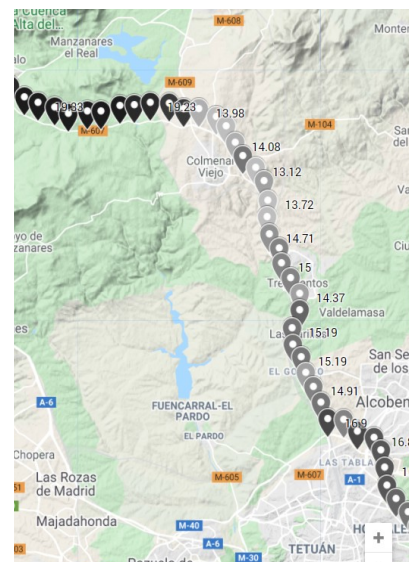



Illustration 8: Route with measurements every km with a gray palette (better sky in black).

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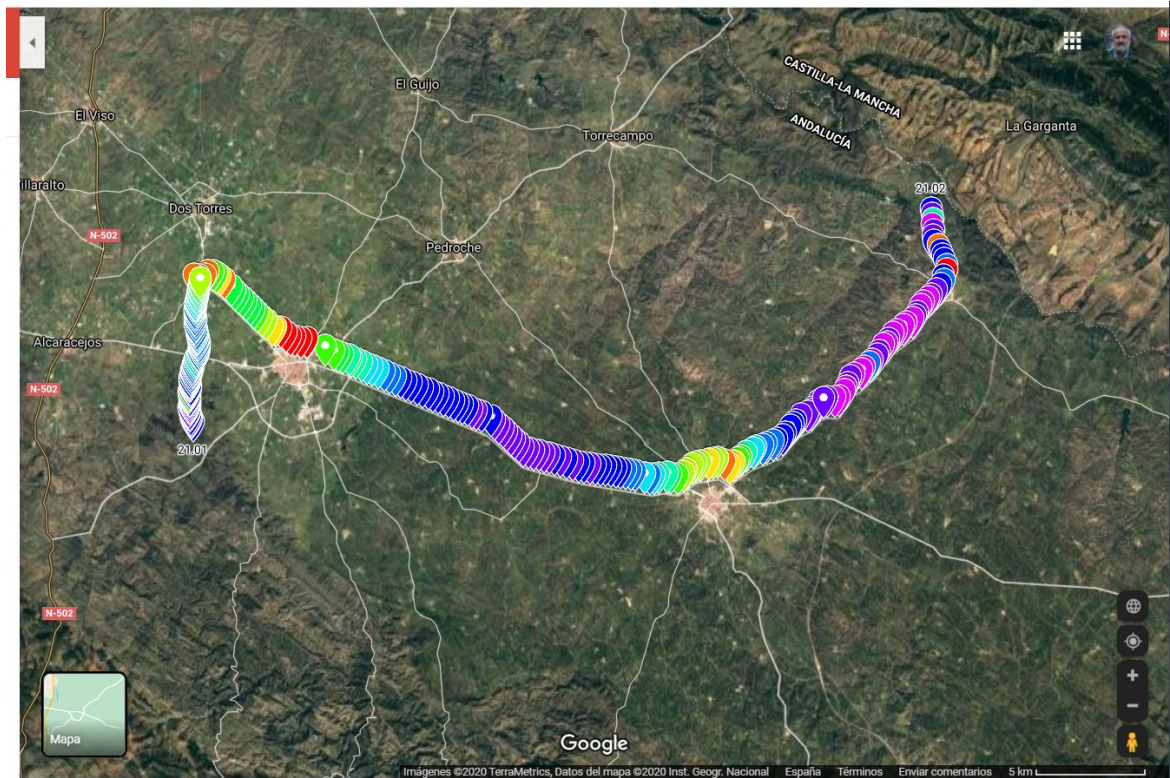


Illustration 9: Tour with color palette assigned to the brightness range.

The colour of each marker depends on a variable, it is normal to associate it to the bright.

Maps offers different palettes, with a maximum of 12 colours each one. The colour is automatically adjusted to the value range.

Clicking on a specific marker we will see the rest of information of the measure.

The aspect of the presentation can be edited from Maps at any time and the map can be shared through a link.


3.1..4 File Localization.

The destiny folder appears in the log line when the file is created. With the file explorer of the mobile phone, we can find them in:

/Android/data/b4a.tessp/files/

example: TSP58C_2019-08-04_001455_colladomed.csv

The name of the file contains the number of identification and the reminder word written in the "site" field.

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3.1..5 File format.

The capture format is csv, with values separated by commas. The decimal values are quoted, excepting the latitude and length, which must be written with a point. It is possible with this format to make routes with measures and the file can be directly imported to Google Maps.

An example of a file with measures each 250 m:

```
# ,TSP8C6,ci:20.18,T IR,T Sens,Mag ,Hz ,Alt,Azi ,Lat ,Lon ,SL,Bat
419,2020-08-24 ,00:14:05,"-4,46","16,51","21,02","0,465",82,0,38.435779,-4.511822,650,"3,96"
459,2020-08-24 ,00:14:46,"-6,72","17,41","21,06","0,448",88,32,38.433623,-4.511154,664,"3,97"
509,2020-08-24 ,00:15:36,"-6,61","18,14","20,78","0,612",83,233,38.431326,-4.510552,675,"3,96"
549,2020-08-24 ,00:16:16,"-6,68","18,54","21,22","0,384",76,59,38.429182,-4.511067,666,"3,96"
```

The sensor 's name, its calibration and the name of the variables are founded in the first line.

Each line contains a secuencial number which indicates the number of the capture, the date and the hour. After that, the variables.

3.1..6 Uploading the file to Google Maps.

Actually, before uploading the file, we must **delete** all the **blank spaces** it contains with a text editor.


Go to Maps Google: → Menu (arriba izq.) → Your sites → MAPS → Create Map.

Import our csv file.

It will ask us to confirm the position, marking by default the columns *Lat Lon*.

Click on Uniform Style and switch to Style by Column, choosing Mag.

In Intervals put 12 and choose the desired color.

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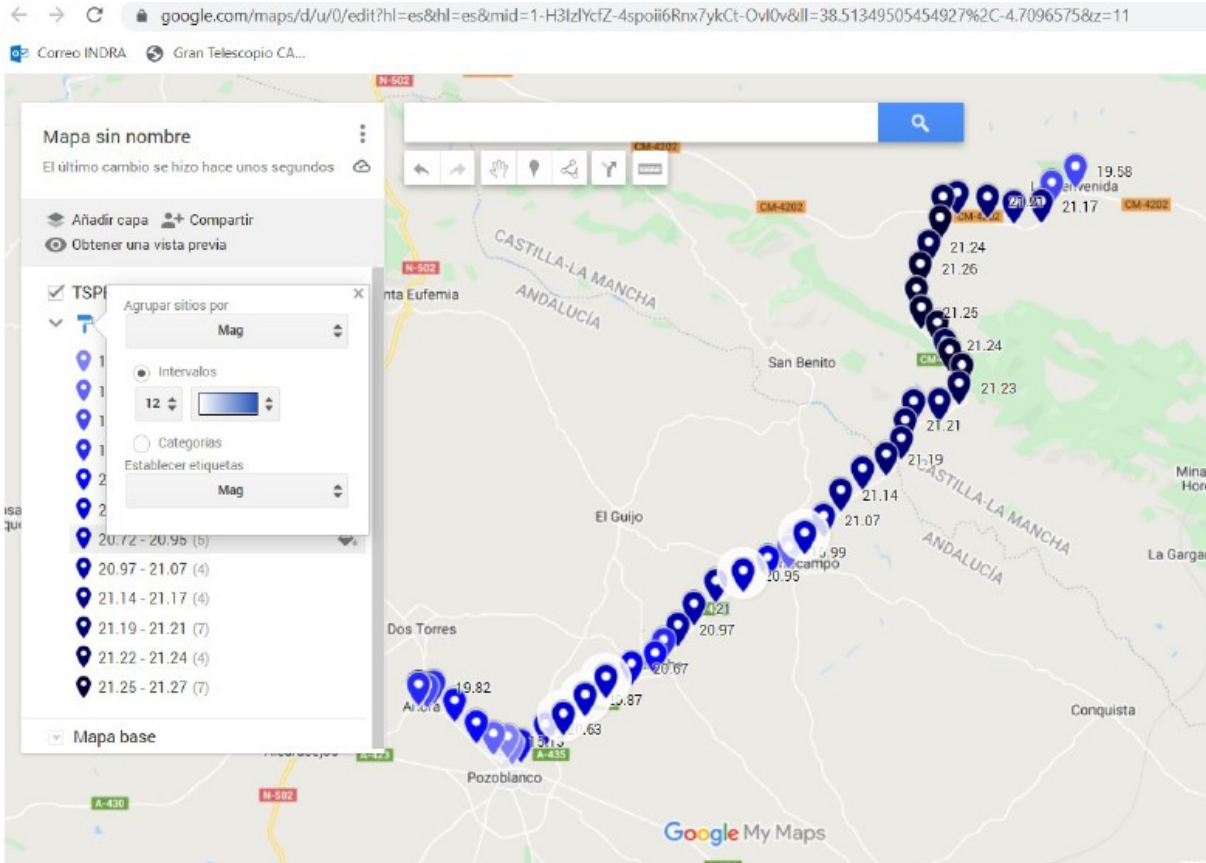


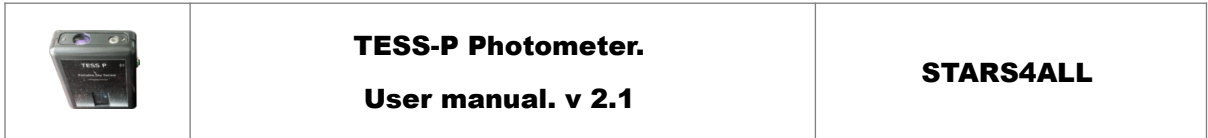
Ilustración 10: Adjusting the presentation with blue palette. [Link to this map.](#)

The color of each marker can be a function of any of the variables, the normal is to assign it according to the brightness.
 Maps offers several palettes, with a maximum of 12 colors each.
 Clicking on a particular marker shows the rest of the measurement information.
 The appearance of the presentation can be edited from Maps at any time and can be shared via a link.

3.1..7 Acoustic alarm by brightness or IR temperature.

It is possible to activate acoustic alarms for significant changes in bright and/or IR temperature. Just by pressing the buttons we can activate or inactivate these alarms. The level of shot is updated when the alarm is activated and it is shown in the log line.

The alarm automatically sounds for changes of $\pm 2^{\circ}\text{C}$ in the IR temperature, and for changes of $\pm 0,5$ in bright magnitudes. These values have been chosen because they dramatically change the quality of the sky, which is usually provoked by clouds.



3.2 Tess Windows Program.

TESS-P is destined for manual use, however, for punctual measures if it is connected and feeded by USB it allows to obtain the evolution of the brightness in one night.

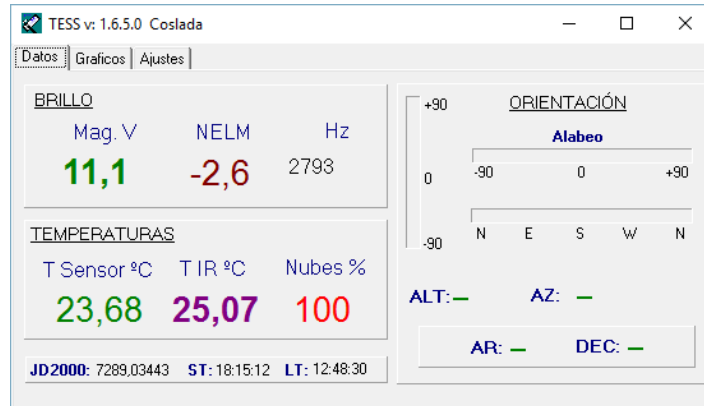


Illustration 11: Windows program tess.exe

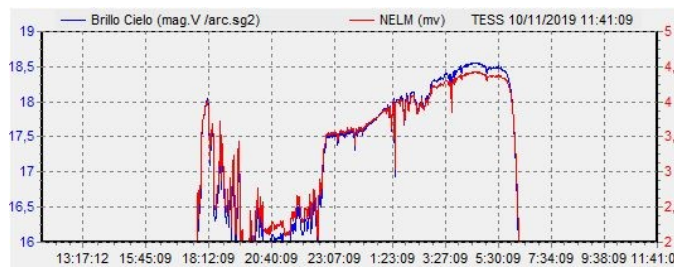


Illustration 12: Brightness curve with the Tess Windows program.

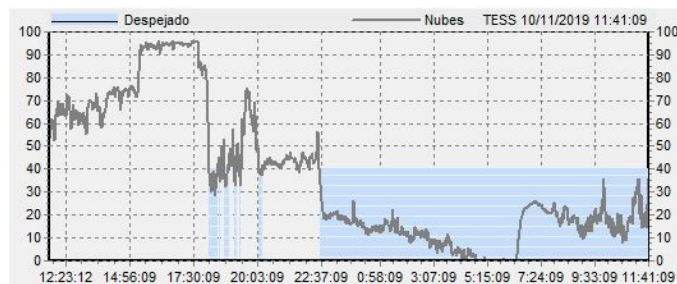



Illustration 13: Cloud curve in the Tess Windows program. It is obtained by combining room temperature and infrared.


The classic program Tess for Windows is intended for a fixed installation. This program, in

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addition to storing the data in a file, generates graphs with the measurements in real time and adjustable alarms depending on the measurements.

The program can be downloaded here:

<http://www.observatorioremoto.com/tess/tess.zip>.

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4 ANNEX.

4.1 Capture and settings thorough serial port.

It is possible to connect TESS to a PC through the USB connector and a terminal program series of 9600 baudios. In this way it is possible to get the measures, save the calibration and update the firmware.

4.1..1 Capture thorough seria port.

With any terminal serie we can get two chains of this type in a periodic way, each second:

```
<fH 01398><tA 02727><tO 02735><aX -0025><aY -0010><aZ 00950><mX -0001><mY -0095><mZ -0352>
```

```
{"seq":222, "rev":3, "name":"TSP8C6", "ci":20.18, "freq":1398.60, "mag":12.32, "tamb":27.27, "tsky":27.35, "vbat":4.93, "alt":1.51, "azi":84.00}
```

The first one is the TESS raw chain without calibration, it is compatible with the PC program. We can get from it the frequency, the temperature and the three axes of the magnetometer and the accelerometer.

There are two scales for the frequencies, we have hertz with “fH”. For low frequencies, it appears with “fm”, thousandths of Hz are shown, for example:

```
<fm 01832> = 1.832 Hz
```

The second chain contains more information, it is sent through BT. Its format is JASON, it can be easily interpreted. It contains a number of measure sequence, a number of sensor, instrumental variable, calibrated bright, temperatures and the direction of pointing.

4.1..2 Calibration settings.

The device is delivered calibrated and the user does not have to change this parameter.

Moreover, it is also possible to know the version of the firmware, the complete MAC and the calibration with a terminal series at 9600, sending a question mark: ?


We obtain data in this format:

```
Compiled Nov 10 2019 10:14:53
```

```
MAC: 8C5B9DBF713C
```

```
TSP SN: TSP8C5
```

```
Actual CI: 20.45
```

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The value CI is charged using a chain of this type:

CI2045

The answer will be: The answer will be:


New CI: 20.45

Write EEPROM done!

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5 GLOSARY

Term	Description
TESS	Telescope Encoder & Sky Sensor.
TAS	TESS Auto Scan.
MQTT	MQ Telemetry Transport. (IoT protocol, internet of things)
LICA	Laboratorio de Instrumentación Científica Avanzada

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6 Bibliography and References.

Links:

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