

Australian - International Model Solar Challenge



**AUSTRALIAN-INTERNATIONAL
MODEL SOLAR CAR
CHALLENGE**

**2014
REGULATIONS**

Section 8

Car Specification

Issue 2: February 2014

Section 8 (this document) covers the car specifications
Sections 1 to 7 (a separate document) cover the administration of the event
N.B. All eight sections must be read as a single document.

Section 8. Car Specification

A synopsis of Car Specifications is given on page 2 it is essential that you refer to the full specifications in the DETAILED CONTENTS for complete details of all specifications.

DETAILED CONTENTS.

8	CAR SPECIFICATION Synopsis	2
8.1	Test criteria	3
8.2	No commercially built cars	3
8.3	Size limit	3
8.4	Source of power	3
8.5	Solar array and support structure	3
8.6	Array structure removal	3
8.7	Non planar arrays	3
8.8	Solar array wiring	3
8.9	No devices on the array	3
8.10	Power measurement	4
8.11	Temperature correction	4
8.12	Power limit	4
8.13	Array and array support structure weight	4
8.14	Use of electronic devices	5
8.15	Ballast	5
8.16	No energy storage systems	5
8.17	ON/OFF switch	5
8.18	Car wiring	5
8.19	Motors	6
8.20	Wheels	6
8.21	Steering	6
8.22	Drag Plate	6
8.23	Body / Chassis	6
8.24	Side panels	6
8.25	Solar panel cover	6
8.26	School and car name	6
8.27	Non Conformance	7
8.28	Structural Integrity	7

MODEL SOLAR VEHICLE 2014

SYNOPSIS OF CAR SPECIFICATIONS

The following is intended to be used as a quick reference guide only. It contains the important basics but does not cover all the detail. YOU MUST REFER TO THE COMPLETE REGULATIONS FOR FULL DETAILS. Remember that car design and construction is to be the work of students and only students are to undertake the operation and any repairs on cars, penalties for adult input will apply. (See Administration Section)

- **Maximum body dimensions:** 550 mm long, 320 wide, 180 mm high and less than 190 mm from centre line of guide rail at all times.
- **Wheels:** minimum width 1mm or 0.6 mm radius at contact point with track. The car must have four wheels designed to be in contact with the track at all times with a minimum distance of 200 mm between the wheels on each axle.
- **Guiding:** must be on the outside of the guide rail
- **Side panels:** one each side, minimum 100 mm long by 50 mm wide.
- **Cargo space:** room for a cube of 100 mm side within the body and under the solar array. The space required for the cube must remain unoccupied when the car is racing.
- **School & Car name:** visible when racing, letters minimum 10 mm high not on the side panels as designated above.
- **Solar array:** fully removable from car, maximum power 10 watts, silicon technology only and no devices mounted on panel. A single switch may be allowed see 8.9.
- **Wiring:** all wiring and electronics must be visible, otherwise circuit diagram required.
- **ON-OFF switch:** commercial switch required easily visible to the starter, on and off clearly marked. Switch will only be allowed on the solar array if all cells are always connected in series.
- **Energy storage:** not allowed, except capacitors up to 0.2 farad provided they are discharged immediately prior to race starting. Inductors to 1 mH allowed.
- **Electronics:** teams must elect to either use or not use electronics systems at scrutineering on Sunday and stick by this decision for the remainder of the event. The total required minimum weight of the solar array its support structure + ballast will be reduced significantly for cars not using electronics. It will be calculated using the formula below in "ballast".
- **Panel power:** maximum allowed power is 10 watts, panels producing greater than 10 watts will be masked by scrutineers to produce less than 10 watts.
- **Ballast:** If the solar array and its support structure weigh less than the total minimum required by the appropriate formula, additional weight in the form of ballast is required to be carried in order to bring the weight up to the required weight. The total required minimum weight of the solar array its support structure and ballast is determined by the following formula where

P = standardised panel power in watts.

With Electronics: Total Weight = 250P - 900 [grams]

Without Electronics: Total weight = 150P – 650 [grams]

8. CAR SPECIFICATION

8.1 Test criteria.

Unless otherwise specified all references to car behaviour and measurements will assume that the car is on a flat, straight section of the track, and in full racing configuration.

8.2 No commercially built cars

Cars must not use any part of the chassis or body of any commercially available model car. This only refers to the structural frame and body, not to the drive train components such as gears, shafts, wheels, tyres, or to suspension and steering components.

8.3 Size limit

Maximum car size allowed is 550mm long, 180mm high and 320mm wide, at no time may any part of the car extend sideways more than 190mm from the centre of the guide rail.

8.4 Source of power

Only commercially available silicon photovoltaic cells are allowed.

8.5 Solar array and support structure

The solar cells connected together to provide the power which drives the car will be referred to as the array. The complete unit on which the photovoltaic cells (the array) are mounted is the array support structure. The thickness of the array and its support structure must not exceed 30 mm. The structure must be robust enough to enable handling by the scrutineers and officials. The organizers will accept no responsibility for any damage to the solar cells or the solar array.

8.6 Array structure removal

The array and its support structure must be easily and quickly (less than 2 minutes) removable from the car for testing and ballasting purposes. And when removed the car must be capable of free and stable movement.

8.7 Non planar arrays

Curved, stepped or multi-planed arrays must be able to be re-configured such that when placed on the flat light box measuring surface no part of any cell is more than 30 mm away from that surface. The scrutineers will calculate a maximum power value for non conforming panels.

8.8 Solar array wiring.

All wiring on the solar array must be visible. All panels must be presented for scrutineering with a pair of wires of minimum 200mm long marked +ve and -ve for connection to the alligator clips on the power measuring equipment. Teams using panels of their own construction or modified commercial panels **must provide** a wiring diagram which includes the number of cells in each series connected string. Where the panel has multiple individual sections to allow for series and parallel connection, teams must supply pairs of connections as described above for each section of the panel. The power of each section will be measured and the values obtained added together. All wiring must be carried out with standard copper or tinned copper conductors.

8.9 No devices on the array

All mechanical, electrical or electronic devices including the ON/OFF switch and any devices for changing the panel voltage or array configuration must be separate from the array. A plug, socket or terminal block to allow connection of the panel wiring to the car wiring is allowed.

An exception will be granted for cars using a panel permanently wired in series where a single on /off switch will be allowed.

8.10 Power measurement

The power delivered by the solar array will be assessed by the scrutineers using a light box. Solar panels presented for testing must produce no more than 25 volts open circuit or 2.0 amps short circuit when tested at 1 Sun (nominal AM 1.5), otherwise they will be assigned the value:

$$\text{Power} = (\text{open circuit voltage}) \times (\text{short circuit amps}) \times 0.8 \text{ watts.}$$

Scrutineers will measure the power output of all panels at a Sun level expected to be the average over the duration of the event. The power figure obtained will be used to ratio up to the power expected at full Sun. This full Sun figure will then be used for all further calculations.

Ballast requirements will be determined by the highest power reading obtained from the array during the course of the event. If upon retesting a panel returns a power greater than 0.15 watts higher than any previous test that panel will be re-ballasted to that new higher power. Artificial manipulation of Fill Factor is prohibited and will result in disqualification of the team involved.

8.11 Temperature correction

As the power output of a silicon solar cell is affected by temperature, the scrutineers will scan all panels with a non-contact thermometer immediately after power testing. The panel temperature recorded will then be used to standardise the power output to the power expected at a temperature of 25°C using the following formula.

$$P_{\text{standardised}} = P_{\text{measured}} + P_{\text{measured}} \times 0.004 \times (T - 25)$$

Where P = power in watts and T = maximum panel temperature in degrees Celsius. Any ballast required will then be calculated using this standardised power rating.

8.12 Power limit

Panels must register a total corrected power of less than 10 watts at one Sun. Any panel recording a power above 10 watts will have tape applied by the scrutineers covering portion of each cell in the array. Tape will be applied in integral widths of 19 +/- 1 mm until the power is below 10 watts. Fine tuning of final power will not be allowed. Removal of this tape except by the scrutineers is prohibited. Racing without the appropriate tape in place will result in forfeiture of the race and depending on circumstances disqualification.

If a panel has any part of the active surfaces of the cells covered in any way that effects it's power the scrutineers must be satisfied that this covering is secure and cannot be removed during the course of the event. The scrutineers may require any such covering to be removed and replaced with the official masking material used at scrutineering.

Note: The panel will be tested as received at scrutineering and no further changes to any covering material will be allowed.

8.13 Array and array support structure weight.

The minimum required combined weight of the solar array its support structure and ballast **for cars using electronics systems** will be calculated using the formula:

$$W (\text{solar array and ballast}) [\text{grams}] = 250 \times (\text{Standardised Panel Power} [\text{watts}]) - 900$$

The minimum required combined weight of the solar array its support structure and ballast **for cars not using electronics systems** will be calculated using the formula:

$$W (\text{solar array and ballast}) [\text{grams}] = 150 \times (\text{Standardised Panel Power}) - 650$$

The Committee will provide scales to determine array and support structure and ballast weights, measured accurate to +/-5gm.

8.14 Use of electronic devices.

Teams may elect to use electronic circuitry for such purposes as solar panel regulation or motor control. During the time trials (usually held on Saturday) they may decide before each individual race whether to use such devices or not.

At re-scrutineering on Sunday morning teams will be required to indicate their intention to run either exclusively with or without electronics for all subsequent races.

The scrutineers will record the appropriate weight on the car and all cars may be check weighed before or after each race. It is the teams responsibility to ensure their car is correctly ballasted at all times see **8.15**.

8.15 Ballast

Any additional weight required by 8.13 to bring the weight of the solar array and its support structure up to the required minimum is defined as ballast, and must be carried on board the car whenever the car is on the track. Teams should have the correct amount of ballast when presenting for scrutineering. Ballast will not be provided by the scrutineers. Ballast must be suitably contained to prevent possible spillage onto the track. Note, any item or material used as ballast must not perform any function on the car when racing other than acting as the ballast.

It is the responsibility of the team to ensure the car races with the correct ballast on board, the following penalties will be applied for a first offence of racing with underweight ballast.

If the ballast plus panel weight is more than 5% under the requirement the race will be forfeited, up to and including 5% under the car will receive a time penalty of 2% of race time per 1% of ballast plus panel weight error.

A repeat offence will result in exclusion from the event.

Note: There has been some confusion in the past about ballast. The ballast applies only to the solar panel and the quantity of ballast required is dependent on panel power and weight see 8.13 for formula used to calculate required ballast. Car body and chassis weight are not included or considered in any way in the ballasting requirements.

8.16 No energy storage systems

No energy storage system, whether electrical, mechanical or chemical, which assists in the performance of the car, will be permitted. Capacitors of less than 0.2F and inductors less than 1mH are allowed as part of the electrical system. Capacitors above 0.047F must be discharged immediately before the race.

8.17 ON/OFF switch

Each car must be fitted with a commercial 'ON/OFF' switch, the ON and OFF positions must be clearly marked and the switch must be in a location easily visible by the official starter when the car is on the start line. Note: the starter is on the left hand side, so typically the switch would be mounted on the left hand side or on the top.

8.18 Car wiring

Where possible all electrical wiring and electronic modules in the car must be reasonably visible. Teams will be required to explain any wiring going into sealed body areas. A simple block wiring diagram will be required if this condition is not met.

8.19 Motors

There is no restriction to the type, size, or number of motors that may be fitted to the car. However, the motor manufacturer and/or part number must be made available to the scrutineer for data base information.

8.20 Wheels

The car must have at least four wheels generally positioned the same as on the majority of production cars we drive around. The car design must be for all wheels to be in contact with the track during normal operation. The minimum track allowed is 200 mm. (Track is distance between the centre of ground contact area of the wheels on the same axle.) To reduce damage to the track, knife-edge wheels are not allowed. Each wheel must be at least 1mm wide or have a radius of 0.6mm on the running surface.

8.21 Steering

Each car must incorporate a means of steering around the track. The guide rails as described in 4.3 are approximately 16mm wide and 13mm high. The steering mechanism must be designed to operate on the outside of the guide rail.

8.22 Cargo

The car must at all times have room within the body structure and underneath the solar panel for a cube of 100 mm side length (ie.100mm wide, 100mm long and 100mm high). The cube must be fully enclosed by the body and solar array ie. assuming the car structure is opaque, not visible from outside the car. At scrutineering a test cube will be inserted to verify conformance. The space required for the cube must remain unoccupied when the car is racing.

8.23 Body/ Chassis

The bodywork must not form part of the solar array or array support structure. The body may however form all or part of the chassis. The car must have a body, chassis or frame with sufficient structural integrity to allow free and stable movement with the ballast and solar array removed

8.24 Side Panels

The car must have two side panels capable of retaining their shape at all times for attaching numbers and sponsors logos. These must be easily seen by spectators while the car is racing. They will be located one on each side of the car. Each side panel must be capable of supporting a sticker 100mm long and 50mm high. Allowed curvature of the side panels is 20 mm vertically and 15 mm horizontally.

8.25 Solar panel cover.

All teams should provide a suitable opaque cover which will completely shade the active area of their solar array for use at the starting position. The use of the cover is to assist the officials detect and eliminate any hidden illegal energy storage devices. The cover must be a flat sheet of rigid material capable of supporting sponsors logos. The use of flexible items such as clothing, towels or similar will not be accepted.

8.26 School and Car Name

Each entry must have its school name (possibly abbreviated) and car name shown on the car in letters at least 10mm high and visible to officials when racing. These can be attached to any part of the car, other than the area of the side panels as designated in 8.24.

8.27 Non Conformance

If a car fails to conform to the requirements detailed in any section of the regulations it must be modified in order to conform or penalties may be imposed. Penalties will normally be in the form of the requirement to carry additional ballast weight. Minor non conformances will typically attract a 50 g penalty with this increasing to 200 g for more significant breaches of the regulations. The magnitude of penalty will be determined by the chief scrutineer in conjunction with the scrutineering team. In the event that the scrutineers believe the non conformance gives the car a significant advantage unlikely to be negated by the carrying of additional ballast the car will be excluded from the event. Penalty decisions will be final and not open to appeal.

8.28 Structural Integrity

The car must be constructed such that normal handling will not cause damage. No responsibility will be accepted for any damage caused by officials handling the car.