



General Exterior Lighting Product Specification

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Design and Functional Requirements for Exterior Lighting Components in Tesla Vehicles



General Exterior Lighting Product Specification

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Revision: 1.0

Document History

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1. Scope

This document defines the product specification, design and functional requirements for exterior lighting components used in Tesla vehicles.

Suppliers must use this document to execute exterior lighting products to achieve the program and product objectives set forth by Tesla.

Any deviation from a requirement or specification requires written approval by Tesla Engineering.

This document is written without prejudice to the general terms and conditions agreed by the supplier and Tesla at time of sourcing.



2. Program Overview

2.1 Program Timing and Team

The supplier is responsible to achieve the program milestones and objectives.

The supplier must demonstrate and execute a plan to achieve the program milestones and objectives.

The plan must be provided at time of sourcing and maintained throughout the program.

The supplier must demonstrate they have sufficient personnel to support the program by means of a mountain chart or similar. Onsite support at Tesla is required upon request.

If the supplier, limited to their actions and contracted 3rd parties, is not able to achieve a program milestone or objective are responsible for all costs necessary to execute a recovery plan. These costs include but are not limited to; prototype tools, additional engineering resources and expedited shipping.

During product development, if Tesla provides guidance that risks the supplier's ability to achieve a program milestone or objective the supplier must immediately notify Tesla.

The supplier is responsible for maintaining an open issue and action tracking file throughout the program.

3. Milestones, Objectives and Deliverables

The purpose of this section is to communicate the major program milestones, the objectives of each milestone and the suppliers responsibilities and deliverables.

It is expected with this information and the program build dates the supplier can develop a timing plan to execute the program.

The milestones are presented in chronological order.

3.1 A-Class Surface Release – External Surfaces

Objective

Studio CAD release of the external customer-facing surfaces (typically outer lens and first flange).

Requirements

Freeze surface development with design studio.



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Vehicle build objectives (gap and flush targets) complete.

GD&T definition complete (official release not yet required).

Supplier Responsibilities

The supplier is required to iterate the lamp design verifying the design can achieve the engineering, performance and reliability requirements whilst enabling the styling theme.

Verify and validate the lamp conforms to the applicable homologation requirements and Tesla photometric requirements.

The supplier will be required to attend the Tesla Design Studio upon request.

Deliverables

The supplier must provide all engineering and manufacturing requirements to Tesla Engineering and Design.

3.2 A-Class Surface Release – Internal Surfaces

Objective

Studio CAD release of the internal customer-facing surfaces (typically bezels, lenses and reflectors).

Requirements

Freeze surface development with design studio.

Bezel gap and flush targets frozen.

Verify and validate the lamp conforms to the applicable homologation requirements and Tesla photometric requirements.

Kinematic definition and analysis of internal components (reflectors and modules) complete.

Supplier Responsibilities

The supplier is required to iterate the lamp design verifying the design can achieve the engineering, performance and reliability requirements whilst enabling the styling theme.

Support and confirm the optical photometric performance through CAE simulations of each function.



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The supplier will be required to attend the Tesla Design Studio upon request.

Deliverables

The supplier must provide all engineering and manufacturing requirements to Tesla Engineering and Design.

3.3 Verification Model Review

3.3.1 Design Verification Lamp

Objective

To physically verify the lamp production-intent design and assembly process with respect to A-class surfaces, unlit / lit appearance and perceived quality requirements prior to design release. The lamps will be assessed installed on an engineering buck and/or vehicle.

Requirements

Design freeze complete.

Photometry specification complete.

Supplier Responsibilities

The supplier is required to complete the production-intent design and manufacture the verification lamp for assessment by Tesla Engineering and Design Studio.

Deliverable

The lamps must represent CAD data and production BOM.

Tesla Engineering must authorize the CAD data prior to the manufacture of the lamps.

The lamps must represent both the lit and unlit appearance.

The lamps must meet the production intent functional requirements (adjusters, fans, LED arrays, etc.).

The lamps must demonstrate all construction details to provide a product that 100% represents the production tooled, processed and assembled lamps. Valve gates, approval markings, internal fasteners,

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lens legs, snap features (legs and holes), retractor marks/lines, weld attachment features/boil-out, etc. must be represented.

The lens should not be permanently attached so that it is possible to inspect and interchange internal components.

The lamps must be designed so they may attach to the design intent vehicle and remain lit for up to 30 minutes without concern or degradation.

The supplier must provide Tesla with one vehicle set of lamps.

The cost of the lamps must be included in the supplier quote.

3.3.2 Optical Verification Lamp

Objective

Physical verification of low beam, high beam and front fog functions with respect to Tesla performance targets. The lamps will be assessed installed on an engineering buck and/or vehicle.

Requirements

Optical design freeze complete.

Photometry specification complete.

Supplier Responsibilities

The supplier is required to deliver one set of lamps that demonstrates the functional performance defined by the photometric specification with production intent technology (including advanced functions where applicable). The lamp performance will be assessed dynamically on a road course agreed by Tesla and the supplier. For these reasons the test vehicle will be agreed by both Tesla and the supplier in order to best replicate the customer experience.

Deliverable

The purpose of the Optical Verification Lamp is to physically verify the illuminating function performance with respect to Tesla performance targets.

The lamp is required for any low beam, high beam or fog lamp function. All other lamp function optical performance and appearance must be verified by the design verification lamp.

The photometry specification must be released prior to the manufacture of the lamp.

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The lamp must be capable of installation on a Tesla Engineering vehicle or Supplier demonstration vehicle at the intended vehicle position.

The lamp must represent the entire production intent optical system including the outer lens. Bezels and non-functional surfaces may be excluded from the lamp unless they impact the beam performance.

The supplier must demonstrate the lamp design meets the performance specification by means of simulation prior to manufacture of the lamp.

Tesla Engineering must authorize the CAD data prior to manufacture of the lamp.

The supplier must objectively demonstrate the lamp achieves the photometry specification by means of physical optical measurements. Iso-candela plots, test reports, birdseye lux plots and simulated data will be accepted.

The lamp will be installed on a Tesla engineering or supplier vehicle and assessed dynamically on road course including advanced functions.

The supplier is responsible for rectification of any performance deficiency identified during the objective and subjective reviews.

The supplier must provide Tesla one set/pair of lamps.

The cost of the lamps must be included in the supplier quote.

3.3.3 Volumetric Verification Lamp

Objective

The purpose of the volumetric verification lamp is to physically verify clearance between the lamp and adjacent or interfacing components and the assembly load path.

Requirements

Design freeze complete.

GD&T definition complete (official release not required).

Supplier Responsibilities

The supplier is required to deliver one set of lamps that reproduces the external geometry including any volumetric effects due to the manufacturing process such as plastic welding and adhesives. The lamps must be fit for purpose.



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Deliverable

The lamp external surfaces and attachments must represent the released CAD data.

The lamp must demonstrate all construction details to provide a product that accurately represents the production tooled, processed and assembled lamp.

The lamps will be installed and removed from a vehicle or buck several times and must therefore be of good construction and fit for purpose.

Tesla Engineering must authorize the CAD data prior to manufacture of the lamp.

The lamp must meet the series production dimensional requirements.

The supplier must provide Tesla one set/pair of lamps.

3.4 Design Release

Objective

First data release prior to tooling kickoff. All design changes post design release will be subject to Tesla change control process.

Requirement

Design review complete.

Agreed action items from verification model milestones must be incorporated in the design release.

Electrical Interface Control Document (ICD) released.

DFMEA complete.

Applicable DV simulation tasks complete per DVP&R.

GD&T and lamp assembly dimensional analysis complete.

Supplier Responsibilities

The supplier is responsible for demonstrating that the design meets Tesla's requirements.

Deliverable

CAD data for each part number.



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CAD must meet the design standards provided in this document.

3.5 Tool Design Review

Objective

Validate the tool design in preparation for production tool kick-off.

Requirement

Design release complete.

Tesla tool design checklist complete.

Molding axes defined.

Gate and parting line locations defined.

Mold flow complete.

Grain map and texture definition released.

Production assembly design including equipment, simulated capacity and process flow.

Supplier Responsibilities

Demonstrate the tool design will enable the part quality necessary to achieve Tesla's requirements.

Deliverable

Tool CAD of all molded components (made or purchased) and supporting analyses must be provided to Tesla.

3.6 Tool Kick Off

Objective

Decision point to instruct supplier to commence manufacture of production tools.



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Requirement

Design release complete.

Tool design review complete and all open items closed or assigned a resolution plan.

Supplier Responsibilities

Commence manufacture of tools.

3.7 RC1

Objective

Initial non-salable vehicle build.

Lamps will be used to validate vehicle-manufacturing process.

Lamps will be used for vehicle integration validation and vehicle durability validation.

Deliverable

Lamps must be manufactured with off-tool parts.

Lamp must be functional per the production released design specification.

Lamp assembly on production manufacturing line is preferred.

25% maximum deviation from photometry specification permitted.

200% maximum deviation from dimensional tolerance specification permitted.

The supplier must meet the material requirements forecasted by Tesla.

3.8 RC2 (if program applicable)

Objective

Non-salable vehicle build.

Lamps will be used to validate vehicle-manufacturing process and assess resolution of open items identified at RC1 build.



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Deliverable

DV complete.

Lamps must be assembled using the production manufacturing line.

The production rate must be no less than 50% of the contracted capacity

10% maximum deviation from photometry specification permitted.

150% maximum deviation from dimensional tolerance specification permitted.

3.9 Pilot

Objective

Initial saleable build, vehicles will be sold to customers.

Deliverable

Lamps must be homologated.

Meet or exceed photometry specification.

Meet or exceed dimensional capability.

PV complete

AAR complete

PPAP complete.

Lamps must be assembled on the production manufacturing line at the contracted rate.

*Note: lamp homologation may be aligned with Tesla's regional market releases.

3.10 SOP

Start of production, the supplier is producing lamps per Tesla's quality standards and meeting material requirements with normal shipping methods.



3.11 Electronic Development

3.11.1 A-Samples

Objective

Verify electrical loads and interfaces by means of prototype components.

Requirement

A-sample loads complete

ICD released

Preliminary electrical specification released

- Representative LED part numbers and strings
- LED bins and associated drive currents
- Auxiliary load (fans, motors etc.) specification
- Device pinout and schematic

Deliverable

A-samples are typically prototype PCBA's populated with production or production representative components. They must meet the production representative electrical characteristics as documented by the electrical specification.

A-samples include all production intent electrical components including wire harness with connectors, light sources, NTC's, fans and stepper motors.

A-samples must be housed in an enclosure that protects the device but enables observation of the device in operation.

The supplier must provide Tesla no less than 5 sets of A-samples.

The cost of A-samples must be included in the quote.

3.11.2 B-Samples

Objective



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Verify the production-intent electronic design, functionality of control modules, electrical loads, interfaces and its integration with the vehicle.

Requirement

B-Sample electrical specification released.

Electrical production form factor required.

Deliverables

The B-samples are prototype PCBA's per the production intent design populated with production intent components. The B-samples meet the production intent electrical characteristics as documented by the electrical specification.

The B-samples must include all production intent electrical components including wire harness with connectors, light sources, NTC's, fans and stepper motors.

The B-samples must be housed in an enclosure that protects the device but enables observation of the device in operation.

The supplier must provide Tesla no less than 15 sets of B-samples.

The cost of B-samples must be included in the quote.

3.11.3 C-Samples

Objective

Lamp and control module assembly level Reliability testing, system validation and EMC testing.

Requirement

Production electrical specification released

Non-saleable lamp assemblies.

Deliverable

The C-sample is the non-qualified production lamp assembly.

C-samples will be fitted to engineering vehicles.



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Tesla will advise the C-sample material requirements.

The cost of C-samples must be included in the quote.

4. General Requirements

4.1 Homologation

Lamps must meet the component homologation requirements for the applicable regions listed in Table 1 of the Program Summary.

The supplier is responsible for the component homologation certification.

The supplier is responsible for all component homologation certification costs.

The supplier must provide Tesla component homologation drawings, test reports and certificates.

The supplier is responsible for maintaining component homologation for the life of the program.

The supplier must meet the homologation plan provided by Tesla.

4.2 Computer Aided Design

CAD files must be created in a Catia Tesla Start Part and will be provided by Tesla.

The supplier must provide CAD in native Catia format. Current version V5-6R2019 SP3.

GD&T must be executed using the FT&A workbench.

The arrangement and organization of the product and part tree is at the discretion of Tesla. Requirements will be agreed with the supplier on a project basis.

All components must be explicitly represented in CAD by solid bodies. If a component is proprietary it can be represented by a simplified body that does not impinge the supplier's intellectual property but must correctly represent its geometry.

In addition to the geometry the CAD must include:

- Die draw vectors for the main demolding axis, retractors and slides.

- Parting, slide, retractor, insert and ejector lines.

- Injection gates.



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Grain, metallization, and other localized surface treatment areas.

SPC points and measurement vectors.

Homologation Markings.

Annotations

Fiducial markings (Headlamps and fog lamps only refer to requirements in Appendix 4).

The supplier must provide the tool CAD for each molded component. The CAD must be maintained throughout the life the program and subsequent revisions released to Tesla.

The CAD model must be assigned an accurate assembly mass and maintained throughout the life of the program.

Plastic welding - Any change of the nominal geometry due to the manufacturing process, limited by Tesla Design requirements, must be represented in the CAD model such as hot plate weld boil out.

Kinematic model - the lamp assembly must include an instance of all kinematic components in the extreme and critical positions. Kinematic components must be free of interference and must rotate/translate freely without obstruction throughout the range of travel. The kinematic model must be validated at each engineering change.

4.3 CAD Data Transfer

The supplier must use the Tesla data transfer system for receiving data. The supplier may use this system for sending data to Tesla.

Suppliers may use their secure transfer system to send CAD provided authorization is granted by Tesla.

4.4 Photometry Data

The supplier must provide photometry data and image renderings upon request.

The file types include ISO candela plots, LUX plots and source data exported in excel.

The specific data requirements will be agreed at request.

4.5 Issue Tracking

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Suppliers must use the Tesla JIRA web-based issue tracking management tool.

Homologation documentation, DVP&R items and general issues will be ticketed and tracked through this tool at the discretion of Tesla.

The supplier is not authorized to close tickets.

Tesla encourages the supplier to make use of this system and initiate tickets

Tesla will provide the supplier with an account and grant user access.

4.6 Dimensional Data Transmission

The supplier must transfer lamp dimensional data via the Tesla CM4D database.

The data transfer cadence and quantities shall be agreed by both parties during product development per application.

Refer to *TS-0003403 Dimensional Data Transfer* for the applicable requirements.

4.7 Part Labelling and Traceability

The lamp part label must conform to Tesla *BMS-0000007 Part Labeling Specification* and the referenced documents.

The supplier must implement traceability grade 'A' as defined by BMS-0000151 for all lamps. This requirement supersedes any other lamp traceability classification provided in this specification.

4.8 Engineering Change Support

Engineering changes prior to design freeze are executed without change control.

Engineering change post design freeze must be executed per the Tesla Change Action process. If the change affects fit, form or function an iteration of the design suffix is required. See **Figure 1: Tesla Part Number Structure** and BMS-0000356 Part Number Definition for further detail.

1234567 -00 -A | 01



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Base Part #	Style code	Pedigree	Revision
Part Number			

Figure 1: Tesla Part Number Structure

Timing for the implementation of any change is required prior to Change Action release.

Tesla requested change:

The supplier must acknowledge the change request within 24hrs of receipt of proposal.

Feasibility, cost, and timing feedback must be provided within 10 working days of receipt of proposal.

Supplier requested change:

All change requests must be approved by Tesla.

Feasibility and timing must be provided with change request.

The supplier will be responsible for all costs.

4.9 Cost reduction

The supplier must support all quality and cost reduction initiatives throughout the life of the program.

The supplier is encouraged to identify cost reduction opportunities throughout the life of the program.

4.10 Defect Root Cause Analysis

The supplier must implement immediate corrective action to maintain a saleable product within 24 hours of notification.

A complete root cause analysis and corrective action plan must be completed and submitted for review within 5 days.

The supplier must implement the plan with agreement from Tesla.

4.11 Tooling, Grain and Textures

Tool design must conform to Tesla's *Supplier Based Tooling Guidelines*.



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The grained and textured surfaces must conform to requirements specified by Appendix 3 Surface Finish and Grain Map.

Grained and textured surfaces must be executed by a Tesla-approved source.

The supplier must receive pre-grain approval by Tesla Design Quality prior to implementation of grained or textured surface.

The supplier must receive post-grain and texture approval by Tesla Design Quality to be eligible for PPAP.

The supplier must include the grain and texturing costs in the tool quote.

4.12 Electrical

The vehicle interfacing connector is specified by Tesla.

The supplier must complete the Interface Control Document (ICD).

The lamp switching behavior must conform to Appendix 2 Function Layout (where applicable).

The supplier must develop, maintain and release an electrical specification to Tesla. The electrical specification shall be used to design interfacing components, modules and electrical validation.

The electrical specification must include, but is not limited to:

- Device schematics
- LED part numbers and data sheets
- LED bins and drive currents
- Thermal derating tables
- NTC and other sensor data sheets
- Actuator specification and data sheets
- Wiring diagrams for the entire lamp assembly
- Data bus communication protocol

Upon request, the supplier must complete a cost analysis for both discrete function switching and LIN (or other network bus). The design interface will be at the discretion of Tesla.



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4.13 Mass

Tesla and the supplier shall agree on lamp mass targets at time of sourcing.

The supplier must report the lamp mass at the following milestones:

Design Release

RC1/T0 shots

SOP

Change Action

Where physical parts are available, they shall be used for mass reporting.

The masses must be reported for the total assembly and individual components. Clips and fasteners may be grouped as commodities.

The supplier must identify opportunities to reduce lamp and component masses during the program.

The supplier must consider and evaluate mass reduction proposals from Tesla.

5. GD&T and Check Fixture Gages

5.1 General Dimensions & Tolerances

The supplier is responsible for executing the GD&T as specified in the Appendix 1 General Dimensions & Tolerances.

Tesla will release the SPC coordinates and measurement vectors to the supplier.

3D model is the master source of geometry data.

Lamp assemblies must confirm to the following dimensional requirements:

CPK=1.33

Datum feature of size = +/- 0.1 mm

The following Tesla standards apply:

TS-0002978 Dimensional Standards for Design

TS-0004915 Dimensional Drawing Standard



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TS-0007821 Dimensional Drawing Standard check sheet

BMS-0000023 Drawing Block and Notes Standard

5.2 Dimensional Check Fixtures

Check fixtures are required for all lamps.

The supplier is design responsible for check fixtures.

The supplier is responsible for the cost of the check fixtures and must be included in the quote.

Check fixtures must be certified by a third party.

Check fixtures must be designed to gauge a subset of no less than ten gap and ten flush SPC points. Specific points will be agreed by both Tesla and the supplier.

Checkrails (interfacing simulators that represent the adjacent vehicle surfaces) must be built to a nominal 3mm gap and 0mm flush. Refer to Figure 4 *TS-0003139 Gauge and Check fixture standard*.

Check fixture construction may commence only after the final design review and authorization from Tesla. Refer to *TS-0003687 Gauge and Check fixture buyoff check sheet*.

The following Tesla standards apply:

TS-0003139 Gauge and Check fixture standard

TS-0003413 Measurement Systems Analysis Standard

TS-0003687 Gauge and Check fixture buyoff check sheet

TS-0003544 Gauge Repeatability Data Collection Sheet

TS-0003552 Gauge Repeatability and Reproducibility Data Collection Sheet

TS-0003686 Dimensional Inspection Standard

TS-0003986 MDSS - Manual Data Submission Sheet

5.3 Vibration Fixtures

Vibration fixtures are required for all lamps.

The supplier is design responsible for vibration fixtures.

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The supplier is responsible for the cost of the vibration fixtures.

The lamp must rigidly fasten the vibration fixture at the vehicle attachments points.

Vibration fixture resonance frequency must be no less than 3X the lamp first order resonance frequency.

6. Design Requirements

The supplier is design and engineering responsible for the lamp.

The supplier is warranty responsible for the lamp per the General Terms and Conditions.

6.1 Clearance

The minimum clearance to surrounding components where there is no direct mechanical attachment is 8mm.

The minimum clearance to surrounding components where there is a direct mechanical attachment is 3mm. Datums, net pads, vehicle attachments and defined cut lines are exempt from this requirement.

The supplier is responsible to verify in CAD that the lamp can be installed and removed from the vehicle. Environment CAD data of surrounding components will be provided by Tesla.

6.2 Fasteners and Attachments

Tesla shall provide the fastener and attachment concept.

All injection molding tools must be designed so that datum features are located on tool inserts for effective modification.

6.3 Vents

Lamps must be vented by oleophobic membranes unless sealed to the vehicle body.

Lamps must achieve a minimum Internal Protection rating of IP65 according to IEC 60529 standard.



6.4 Appearance

The lamp must conform to the *Tesla Design Quality Appearance Guidelines*.

The lamp appearance, surface quality, color, execution of grain and textured surfaces is at the discretion of Tesla Design Quality and Tesla Engineering.

The lamp must conform the A-class surfaces released by Tesla.

The outer lens must be free of refractive optical elements.

Unlit Appearance

Gates, snaps, rat holes and other engineering features must not be visible.

Engineering features must not disrupt the appearance of non-opaque surfaces.

Lit Appearance

The lamp must conform to the requirements specified in Appendix 2 Function Layout.

Functions labeled as homogenous must appear to be diffuse. The luminance gradient across the light emitting surface should not be perceivable.

Functions labeled as homogenous must appear homogenous at all viewing angles when the lamp is installed in car position.

Hotspots from light sources must not be visible at all viewing angles when the lamp is installed in car position.

There must not be light bleed.

The color of each function shall be coordinated by Tesla with the support of the supplier.

6.5 Injection Molding Gates

Injection molding gates should not be located on A-class or visible surfaces.

When gates must be located on A-class or visible surfaces upon agreement with Tesla Engineering, the following applies:

Edge gates – runners must be trimmed so that the gate is smooth and meet a tolerance of +/-0.25mm from the nominal design surface.



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Valve gates - must not be larger than 2.00mm in diameter, free of flash and any resultant depression from the nominal surface and meet a tolerance = +0.0mm/-0.25mm.

6.6 Parting, slide, retractor and ejector lines

Parting, slide, retractor and ejector lines must not be visible on A-class or visible surfaces.

The lamp must conform to the *Tesla Design Quality Appearance Guidelines*.

6.7 Photometry

The supplier must achieve no less than 30% margin of safety for all regulated photometric test points.

Headlamp and fog lamp illumination performance must conform to the performance metrics provided by the applicable Tesla Performance Appendix.

6.8 Regulatory Markings

Regulatory markings should be located so that they are only visible when the hood or trunk are open. The marking must be indelible but inconspicuous.

If markings cannot be located under the hood or trunk, they should be placed in an inconspicuous location.

The marking is subject to appearance approval at the discretion of Tesla Engineering and Tesla Design Quality.

Unless mandated by regulation, no supplier name nor supplier number may be placed on lamps.

The lamp must conform to the requirements set forth by ECE R133. The material markings shall be placed on the lamp housing.

6.9 Materials

All lamp assemblies and lamp components must conform to the requirement BMS-0000147 International Hazardous Material Compliance and Environmental Protection.

All lamp assemblies and lamp components must be lead and mercury free.



6.10 Coatings

Hard coat

Outer lenses manufactured in PC must be hard coated.

Anti-fog

The supplier must apply anti-fog coating to headlamp outer lenses.

6.11 Tapes and Films

Tapes and adhesive films must conform to Tesla material requirements TM-5030 Adhesive Tapes and Films.

6.12 Electronic Design

All vehicle interfacing electrical connectors must be USCAR approved.

Light sources must be automotive qualified and meet the requirements of AEC-Q102.

Lamp assemblies and lamp components must conform to TS-0000425-05 Tesla Electrical Requirements for Components.

Lamp assemblies and lamp components must conform to TS-0000048-07 Tesla EMC Requirements for Electrical and Electronic Components Including Motors.

Electrical devices interfacing with a Tesla designed control module requiring bin based current selection must not implement resistors for bin traceability. At the point of lamp manufacture, the control module must be coded with the bin values.

Power de-rating of any lit function must not commence below ambient temperatures of 40°C.

6.13 Mechanical Design

The lamp shall meet Tesla's perceived quality standards:

When a 10mm diameter flat surface applies a force of 50N normal to the lamp surface within 25mm of the outside profile, the resultant displacement must be less than 0.50 mm.



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There must be no beam flutter from lamps mounted to vehicles.

Any lamp mounted fascia support bracket must deflect no more than 1mm in Z when a uniformly distributed load of 4kg is applied to the supporting features.

6.14 Noise Vibration Harshness

Self-Generated Noise

Tesla's noise, vibration and harshness requirements are more stringent compared to internal combustion engine vehicles. Noise transmission from the lamp is often difficult to predict due to emission frequency, amplitude and component interaction. The supplier must identify noise sources, minimize and/or isolate noise sources and support Tesla to resolve any objectionable concerns.

Tesla prefers design solutions consisting of passive cooling systems, however, if the supplier demonstrates a fan is required to meet the performance and reliability requirements effort must be made to minimize noise emission. Strategies include:

- Fan design where the number of blades is of a prime number to avoid multi-order frequencies.

- Decoupling of noise sources and emitters using damping materials.

The first order resonance frequency of lamp assemblies must be greater than 50 Hz.

Exterior lighting systems installed on the vehicle must not generate any type of self-generated noise (pop, click, squeak, rattle, creak, etc.) that may be audible from inside the passenger compartment or outside the vehicle.

Vehicle Level Interaction

The interaction of the lamp with the vehicle must not result in or contribute to any squeak, rattle or similar annoyances.

Noise performance must not degrade for the duration of durability testing.

6.15 Serviceability

Fasteners deemed serviceable must be equivalent to Tesla preferred part numbers.

Lamp components deemed serviceable will be assigned a unique Tesla part number. These components will be structured below the top-level assembly part number.

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7. Reliability

7.1 Lamp Validation

The supplier must demonstrate lamp reliability by successful completion of DVP&R test plan.

The supplier must submit test plans to Tesla Engineering for approval prior to commencing validation testing.

7.2 LED Thermal Reliability

The supplier must demonstrate LED junction temperatures meet the LED manufacturers requirements when subject to the thermal environments outlined in the DVP&R. The supplier must demonstrate conformance with this requirement prior to design release.

The supplier must verify the LED junction temperatures meet the LED manufactures requirements prior to SOP using a statistically significant lamp sample size.

If junction temperatures exceed 90% of the LED manufacturer's Tmax threshold, the supplier must implement a sampling verification process. The sampling process and frequency must be recorded on the process control plan.

7.3 NTC Thermistors

Where NTC thermistors for LED power management are implemented;

The supplier must demonstrate correlation between the NTC and heat source using simulation tools prior to tool kick off and for a statistically significant sample of lamps manufactured using the production process prior to SOP.

The correlation shall be used to characterize the control module de-rating parameters.

The supplier must implement a production sampling process to ensure the NTC correlation is in control for the duration of the program. The sampling process and frequency must be recorded on the process control plan.



7.4 Joints

The supplier must demonstrate robustness of plastic welds and adhesives.

Destructive testing or other means must be used to demonstrate joint quality. Failure must occur at the substrate, not at the joint interface.

Leak tests do not guarantee or validate weld quality.

8. Manufacturing Requirements

8.1 Leak Verification

The supplier must leak test all lamps to verify the lamp assembly is sealed.

The leak test pressure must be no less than 7kPa.

The leak test control limits and process parameters must be statistically derived so that the test discriminates between leaking and non-leaking parts. Parameters and process requirements must be agreed between both parties.

The supplier must document the leak test on the process control plan including system calibration requirements and calibration frequency.

8.2 Function Verification

The supplier must verify all lit functions of each lamp assembly at the end of the manufacturing process.

The supplier must check all kinematic functions are free of obstructions and achieve the minimum adjustment range. If the supplier is able to demonstrate process capability for the adjustment range the kinematic check may be reduced.

The supplier must document the functional check on the process control plan including system calibration requirements and calibration frequency.

8.3 Photometry Verification

The supplier must verify lamp photometry meets regulatory and Tesla requirements in production.



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The supplier must verify all functions for no less than 1 lamp per part number per shift.

The requirement must be documented on the process control plan.

8.4 Injection Molding

The supplier should conform to BMS-0000432 Thermoplastic Injection Molding Practices.

8.5 Dimensional Verification

The supplier must verify the lamp dimensional quality for the duration of the program.

The supplier must verify every SPC point for all lamps prior to demonstrating dimensional capability.

The supplier must continue to verify dimensional capability, however, the inspection frequency will be agreed with Tesla SIE.

These requirements must be documented on the process control plan.

8.6 Beam Alignment

Where the superposition of multiple light sources form a beam;

DV

The supplier must provide Tesla the relative beam alignment specification for the contributing light sources.

The supplier must demonstrate the design conforms to the photometric specification across the beam alignment range using a multivariate simulation such as Monte Carlo method or similar.

PV

The supplier must complete R&R for all production equipment photometric devices.

The supplier must verify beam alignment capability with respect to the beam alignment specification.



9. Other Deliverables

9.1 Aim Calibration Lamps

The purpose of the Aim Equipment Calibration Lamps is to verify the capability of the production and service equipment beam detection algorithm. The lamps are required for any low beam and/or fog lamp function.

The lamps must be manufactured using production off tooled components, must meet nominal photometry performance and be aimed nominally unless requested otherwise.

The lamp aim adjusters must function normally and provide full range of motion.

Where the superposition of multiple light sources form a beam; Tesla may request lamps at the alignment specification limits.

The supplier must provide photometric test reports for the lamps that includes the measured beam gradients.

The supplier must place indelible fiducial markings on the lens so that a third part may identify the center of reference in both the vertical and horizontal planes.

The supplier must provide Tesla at least three sets of lamps.

The cost of the volumetric verification lamps must be included in the quote.

9.2 Ped Pro CAE Mesh Model

Lamps located in a pedestrian protection zone are subject to crash analysis and simulation.

The supplier of lamps located in these zones must provide Tesla a mesh model at various times during the program development that conforms to Tesla's *Crash and Safety CAE Modeling Guideline & Quality Criteria*.

9.3 Photometry Data Files

The supplier must provide Tesla photometric simulation data for all lighting functions on all lamps exported in IES standard format file for all functions.

Typically Tesla requires Type A and Type C file formats.



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