**ELECTRICAL SYSTEM DESCRIPTION AND ELECTRICAL LOAD ANALYSIS**

 (Example document for LSA applicants – v1 of 17.02.16)

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| Date of issue: DD/MM/YYYYDocument reference: ABCD-SDE-24-00 |

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|  | **Approval data** |  |  |
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| **Function** | Design Engineer |  | Design Manager |

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| **Record of Revision** |
| **Rev. #** | **Issue date** | **Description of change** |
| 0 |  | Initial issue |
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## Introduction

This document describes the electrical system and provides the electrical load analysis (ELA) of the ABCD aircraft and demonstrates compliance to the requirements as defined in the certification basis and in the certification programme (Ref.1).

This ELA is based on ASTM std. F2490-05. *(Note: This ASTM standard is not required by the CS-LSA, although it gives good guidelines to prepare that document).* The aim of ELA is to demonstrate that the capacity of the electrical system of the ABCD Airplane is sufficient to support the expected electrical loads in all foreseeable conditions.

To do this, all the electrical loads (average and maximum) are taken into account. The analysis accounts for operations in normal, abnormal and emergency conditions. This document should be maintained throughout the lifetime of the aircraft type and updated in case of changes to the electrical system.

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| **NOTICE**The aim of this document is to provide an example of an Electrical system description and load analysis document for an aircraft type certificate application in accordance with CS-LSA. This document is intended to assist applicants in applying for an LSA RTC/TC and therefore demonstrating compliance of the design to the requirements but it does not substitute, in any of its parts, the prescriptions of Part-21 and its amendments.The document should not be read as a template and it should not be used as a form to fill. The final content of the document is under responsibility of the user.The required information can be presented entirely in this document, or in additional documents appropriately identified and referred to.Comments and notes to the user are provided throughout the document *with “blue highlighted and italic text”.***IMPORTANT: All the statements and/or conclusions provided in this guideline can be considered realistic and have a reasonable technical basis but the designer is solely responsible of each of the statements that he/she will provide** |

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## References

1. Certification Programme ABCD-CP-00
2. FAA Advisory Curricular, AC43.13
3. ASTM F2490-05

## Abbreviations used in this document

AC – Alternating Current

Ah – Ampere- hour

CB – Circuit Breaker

COM – Communications Equipment (Radio)

DC – Direct Current

EFIS – Electronic Flight Information System

ELA – Electrical Load Analysis

GPS – Equipment using Global Positioning System

NAV – Navigation equipment

RPM – Revolutions per minute

VHF – Very High Frequency (in this case, VHF COM equipment)

## List of requirements

*(NOTE: at the time of issue of this template, the CS-LSA amdt 1 is in place which includes the ASTM F2245-12d. If later amendments of the CS-LSA or ASTM are in place, they should be considered. The structure of the document remains the same, but the requirements defined in the certification basis agreed with the Agency shall be considered).*

| **Requirement****CS-LSA**.15, 29th July 2013 amendment 1(ASTM F2245-12d) | **Subject of requirement** | **Referenced chapter** |
| --- | --- | --- |
| 8.4.1 | If installed, an electrical system shall include a master switch and overload protection devices (fuses or circuit breakers). | 4 |
| 8.4.2 | The electric wiring shall be sized according to the load of each circuit. | 4 |
| 8.4.4 | Battery containers shall be vented outside of the airplane. |  |

| **Requirement**ASTM F2490-5 | **Subject of requirement** | **Referenced chapter** |
| --- | --- | --- |
| 6.6.1.1 | The ELA summary should provide evidence that for each operating condition, the available power can meet the loading requirements with adequate margin for both peak loads and maximum continuous loads. This should take into account both the normal and abnormal (including emergency) operating conditions. | 5 |
| 6.6.2 | *Conclusions* – The conclusions should include statements that confirm that the various power sources can satisfactorily supply electrical power to necessary equipment during normal and abnormal operation under the most severe operating conditions as identified in the analysis. You should confirm that the limits of the power supplies are not exceeded. | 5 |

## Electrical System General Description

The primary DC electrical source is an alternator with 14V DC output, rated at 40 Amperes at 2500 RPM of propeller speed. During normal conditions it recharges the battery. The alternator starts to provide voltage output above 1200 RPM.

The alternator and the battery are connected to the electrical bus in order to energize the electrical system.

Secondary DC power is provided by a lead type battery which provides the energy necessary for feeding the essential electrical loads in the event of the alternator failure. The battery also provides electrical energy for engine start.

For ground starting an external power socket is provided. Each electrical supply is connected to a circuit breaker.

All the electric cables installed to the instrument panel comply with the MIL-C-27500 standards.

*(NOTE: For LSA aircraft, automotive industry cables, e.g. wiring conforms SAE AS 22759/186 standards are also acceptable. Cable sizing also could be classified by AWG numbers.)*

Some aircraft systems (e.g. avionics) have a separate master switch. The architecture of the Electrical system, sizing of cables and fuses is shown in Figure 1. For sizing of cables and fuses of the avionics subsystem see Table 1. These have been sized according to [2].

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| *(NOTE: the document should be complemented with a list of the P/N’s of the components)* |

**Figure 1** – Electrical power schematic diagram

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Type** | **Unit** | **Max. Current (A)** | **Continuous current (A)** | **CB rating (A)** | **Wire Gauges** |
| Radio (VHF/NAV/GPS) | GPSCOM 400 | 3.5 | 0.3 | 5 | AWG20 |
| Transponder | XPNDR 123 | 3.7 | 2 | 5 | AWG20 |
| Intercom | IC 2000 | 0.2 | 0.2 | 2 | AWG20 |
| Position light | PLIGHT1 | 1 | 1 | 2 | AWG20 |
| Flap motor | CR22x50 | 7 | 0.5 | 10 | AWG16 |
| Fuel pump | FC480 | 2 | 1.6 | 3 | AWG20 |
| Engine instrumentation | CHT 001OP 0001OTI 123VM 12345FQI 678AM 1234MPI 456Revol 001 | 1 | 1 | 3 | AWG20 |
| AOA indicator | AOA001 | 0.2 | 0.2 | 2 | AWG20 |
| EFIS | G3XXX | 1.5 | 1 | 3 | AWG20 |

**Table 1** – Avionics subsystem cables and CB/Fuses sizing

## Load Analysis

## Electrical power sources

Following table contains a summary about all the electrical power sources.

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| **Electrical power source data** |
| **Item** | **DC Generator** | **Battery** |
| Number of units | 1 | 1 |
| Continuous rating | 25 A | N/A |
| Capacity | N/A | 15 Ah |
| Voltage | 14 V | 14 V |
| Frequency | N/A | N/A |
| Frequency limits | N/A | N/A |
| Power factor | N/A | N/A |
| Manufacturer | GenMan | BatMan |
| Model | GEN14 | BA15\_14 |

**Table 2** – Electrical power sources

## Analysis

The list of the electrical consumptions can be found in the table below.

The electrical current rates below are taken from the corresponding data sheets.

|  |  |  |  |
| --- | --- | --- | --- |
| **Type** | **Unit** | **Max. Current (A)** | **Continuous current (A)** |
| Radio (VHF/NAV/GPS) | GPSCOM 400 | 3.5 | 0.3 |
| Transponder | XPNDR 123 | 3.7 | 2 |
| Intercom | IC 2000 | 0.2 | 0.2 |
| Position light | PLIGHT1 | 1 | 1 |
| Flap motor | CR22x50 | 7 | 0.5 |
| Fuel pump | FC480 | 2 | 1.6 |
| Engine instrumentation | CHT 001OP 0001OTI 123VM 12345FQI 678AM 1234MPI 456Revol 001 | 1 | 1 |
| AOA indicator | AOA001 | 0.2 | 0.2 |
| EFIS | G3XXX | 1.5 | 1 |
| ***Total*** | ***20.1*** | ***7.8*** |

**Table 3** – Load analysis

The maximum electrical power needed for all the equipment is 20.1 Amperes and is below the continuous rating of the alternator.

In case of generator failure, the instruments could run on battery. To provide backup power for at least 30 minutes, the required minimum battery capacity is 10.05 Ah. The battery capacity is 15 Ah, considering the aging of the battery.

##  Emergency conditions assessment

The capacity of the 15 Ah battery is assumed conservatively 75% of the full capacity iaw. paragraph 6.5.8.1 of ASTM F2490-05 [3].

75% of the 15Ah capacity is 11.25 Ah. It means 675 A-min (Ampere-minutes.)

With 20.1 A electric demand, (675/20.1 = 33.58) it means 33.58 minutes continuous operation (which is above 30 minutes) without load shed.

The calculation above is conservative since the flap motor and the electrical fuel pump are not operated continuously, therefore the real capacity could be a bit longer.

*NOTE: Not all the equipment loads should be calculated for the emergency conditions assessment.*

## Compliance Statements

Compliance statements are shown below:

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| **Requirement reference** | **Subject** |
| CS-LSA F2245-12d 8.4.1 | 8.4.1 If installed, an electrical system shall include a master switch and overload protection devices (fuses or circuit breakers). |
| **Statement of compliance** | The master switch is installed. Circuit breakers and fuses are also provided and sized accordingly. Detailed description of the electrical system scheme is in document ABCD-SDE-24-00 “System description – Electrical system”.Fuses are appropriately sized in accordance with FAA Advisory Curricular 43-13 chapter 11 [2]. This is summarized in table 0 |

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| **Requirement reference** | **Subject** |
| CS-LSA F2245-12d 8.4.2 | 8.4.2 The electric wiring shall be sized according to the load of each circuit. |
| **Statement of compliance** | Wiring are of aeronautical standards and appropriate sizing in accordance with FAA Advisory Curricular 43-13 chapter 11 [2]. This is summarized in Figure 1 and Table 1. |

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| **Requirement reference** | **Subject** |
| CS-LSA F2245-12d 8.4.4 | 8.4.4 Battery containers shall be vented outside of the airplane. |
| **Statement of compliance** | The battery is vented as shown in drawing ABCD-XXX. |

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| **Requirement reference** | **Subject** |
| F2490-56.6.1.1 | 6.6.1.1 The ELA summary should provide evidence that for each operating condition, the available power can meet the loading requirements with adequate margin for both peak loads and maximum continuous loads. This should take into account both the normal and abnormal (including emergency) operating conditions. |
| **Statement of compliance** | The alternator provides a higher continuous power than required by peak loads and maximum continuous loads. During emergency conditions the battery is able to supply power for more than 30 minutes at peak load requirements. See chapter 5. |

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| **Requirement reference** | **Subject** |
| F2490-56.6.2 | 6.6.2 *Conclusions –*The conclusions should include statements that confirm that the various power sources can satisfactorily supply electrical power to necessary equipment during normal and abnormal operation under the most severe operating conditions as identified in the analysis. You should confirm that the limits of the power supplies are not exceeded. |
| **Statement of compliance** | Most severe operating conditions have been assumed for the electrical load analysis. The alternator provides a higher continuous power than required by peak loads and more than half of maximum continuous loads. See chapter 5. |