



# Specific Technical Requirements STR-17

Date: 5 Aug. 2002 |

## Emergency Power Unit (EPU)

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## CHAPTER 1

### GENERAL

#### 1.1 **PURPOSE AND SCOPE**

- 1.1.1 This document contains a minimum operational performance specification for an airborne emergency power supply (EPU) intended to be used for uninterrupted continuous power supply of an emergency bus in case of main power failure.
- 1.1.2 This minimum operational performance specification defines the minimum performance expected of an aircraft emergency power equipment. The performance of a specific equipment may be enhanced or superior to this specification depending on the intended application and configuration.
- 1.1.3 Chapter 1 describes typical equipment applications and operational objectives and is the basis for the performance criteria specified in Chapter 2 and Chapter 3. Definitions essential to proper understanding of this document are also provided in Chapter 1.
- 1.1.4 Chapter 2 contains general design requirements.
- 1.1.5 Chapter 3 contains the minimum performance specification for the equipment, defining performance under standard operating conditions.
- 1.1.6 Chapter 4 prescribes the environmental test conditions which provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those which may be encountered in actual operations.
- 1.1.7 Chapter 5 describes recommended test procedures for demonstrating compliance with the requirements of this document.
- 1.1.8 Chapter 6 specifies the performance of the installed equipment and guidance for the installation.

#### 1.2 **APPLICATION**

The EPU is intended to be installed into aircraft complying with the requirements of JAR OPS 1.652(l) and (m) and as additional back up power source for various other applications.

- 1.2.1 Compliance with this minimum operational performance specification by manufacturers, installers and users is recommended as a means of ensuring that the equipment will satisfactorily perform its intended functions under the conditions normally encountered in routine aircraft operations.
- 1.2.2 Any regulatory application of this document in whole or in part is the sole responsibility of appropriate government agencies.



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1.2.3 As the measured values of equipment performance characteristics may be a function of the method of measurement, standard test conditions and methods of testing are recommended in this document.

### 1.2.4 Mandating and Recommendation Phrases

- a) „Shall“  
The use of the word SHALL indicates a mandated criterion; i.e. compliance with the particular procedure or specification is mandatory and no alternative may be applied.
- b) „Should“  
The use of the word SHOULD (and phrases such as „IT IS RECOMMENDED THAT ....“, etc.) indicate that though the procedure or criterion is regarded as the preferred option, alternative procedures, specifications or criteria may be applied, provided that the manufacturer, installer or tester can provide information or data to adequately support and justify the alternative.

## 1.3 **DESCRIPTION OF SYSTEM**

The purpose of the EPU shall be the continuous supply for a reasonable time of an emergency power bus in case of Main or Avionic bus failure.

During normal operation this emergency bus is supplied by a separation device directly from the Main or Avionic bus which also supplies the EPU.

The EPU shall consist of a remote unit (RU) or panel-mounted device containing a rechargeable battery pack and an electronic circuitry which takes care of charging, battery temperature, battery state monitoring, current monitoring, system testing and related functions. The batteries are kept fully charged during normal operation independent from surrounding temperature.

An indicator / test switch shall indicate:

- external load applied to the EPU
- the battery status of the EPU

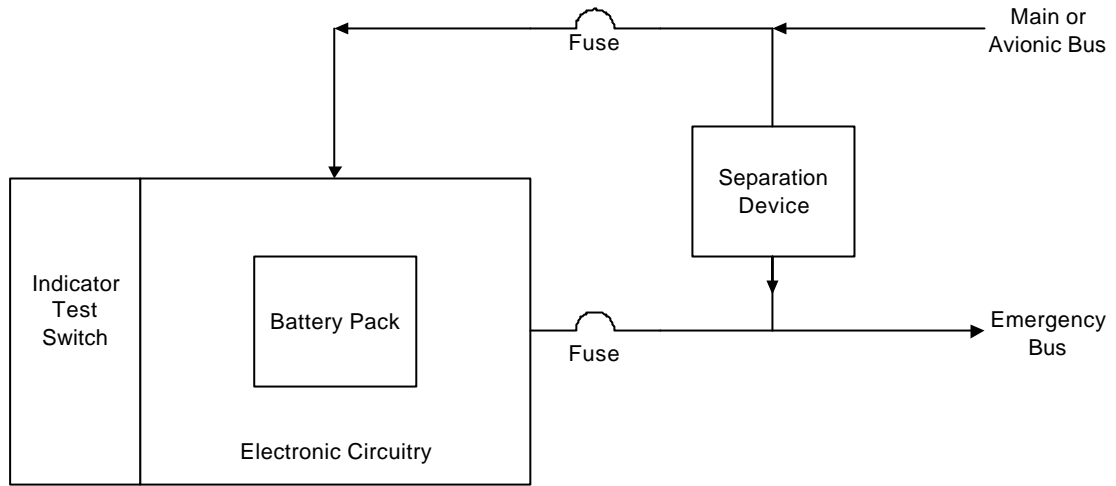
*Note:*

*For maintenance purposes it is recommended that the battery status can be monitored in a more detailed manner from outside of the RU.*



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**Figure 1-1: EPU Block Diagram**



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## CHAPTER 2

### GENERAL DESIGN REQUIREMENTS

#### **2.1 AIRWORTHINESS**

The equipment shall not, under either normal or fault conditions, impair the airworthiness of the aircraft in which it is installed.

#### **2.2 OPERATION OF CONTROLS**

The EPU shall operate fully automatically. There shall be no control other than a test button for pre-flight check.

#### **2.3 EFFECTS OF TESTS**

Unless otherwise provided, the design of the equipment shall be such that, subsequent to the application of the specific tests, no condition exists which would be detrimental to the continued performance of the equipment.

#### **2.4 DIGITAL COMPUTER TECHNIQUES**

If the equipment design is implemented using digital computer techniques, the computer software package should follow guidelines contained in EUROCAE document ED-12B „Software Considerations in Digital Avionics“. The RTCA equivalent document DO-178B, or later editions of both ED-12B and DO-178B, may be used with the agreement of the Approving Authority.

#### **2.5 COMPLEX HARDWARE DEVELOPMENT**

Guidance on the development of complex hardware can be found in EUROCAE document ED-80 (Design Assurance Guidance for Airborne Electronic Hardware) (identical to RTCA-DO-254).



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## CHAPTER 3

### MINIMUM PERFORMANCE SPECIFICATON UNDER STANDARD CONDITION

#### 3.1 GENERAL

The EPU must meet the basic requirements not to interfere with standard-on-board installations and maintain the rated values according to the specification data sheet.

- 3.1.1 The emergency power supply design should be in a way to minimize the risk of causing fire.
- 3.1.2 Storage batteries must be designed and installed as follows:  
Safe battery cell temperatures and pressures must be maintained during any probable charging or discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge)
  - at maximum regulated voltage or power
  - during a flight of maximum duration
  - under the most adverse cooling condition likely to occur in service
- 3.1.3 No explosive or toxic gases or corrosive fluids should be emitted from the batteries during normal operation or as a result of the battery charging system.
- 3.1.4 During failure of the Avionic bus the load of the emergency bus should be continuously supplied by the EPU. After reestablishment of the Avionic bus power the emergency bus load should revert automatically from the EPU to the Avionic bus again. The EPU should automatically return to STBY/CHARGING MODE.

#### 3.2 CAPACITY AND RELATED PARAMETERS

The technical parameters of a battery operated EPU for a standard Avionic bus voltage of 27.5 V DC are as follows:

- 3.2.1 The nominal capacity, based on a constant discharge current for 20 hours, shall be at least 6.5 Ah. This capacity should reach at least 80 % of the values shown on the equipment label during the life span declared by the manufacturer.
- 3.2.2 When the Avionic bus is down, the EPU output voltage shall be 24.0 V DC +/- 1.0 V at full charge state and at least 19.2 V at 20 % capacity.
- 3.2.3 The expected life span of the batteries should be at least 4 years. Presumption for the given life span of the battery is the proper operation of the device according to the manufacturer's handbook.
- 3.2.4 The self discharge rate shall be less than 0.1 % per day.



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- 3.2.5 The maximum current consumption of the EPU during charging shall not exceed 150 % of the current value given by the nominal battery capacity (e.g. if the capacity is 6.5 Ah, this current value should not exceed 9.75 A). This maximum current includes charging (battery 80 % discharged), heating and electronic circuit.
- 3.2.6 The charging time from 20 % to 80 % capacity shall be less than 3 h.
- 3.2.7 The maximum current which can be delivered by the EPU shall not be less than 275 % of the rated capacity Ampere value (i.e. if the capacity is 6.5 Ah, this maximum current is 17.875 A).
- 3.2.8 A separation device between the Main or Avionic bus and the emergency bus shall prevent current flow in the direction from emergency bus to the Avionic bus. The minimum current rating of this device shall exceed eight times the rated battery capacity Ampere value, but at least 60 Ampere. The maximum reverse current shall be less than 30 mA; the maximum break down voltage should exceed three times the Avionic bus voltage.
- 3.2.9 The maximum AC output voltage ripple shall not exceed 0.1 V pp.
- 3.2.10 If the EPU is switched between the operating modes, there shall be no supply interruption.
- 3.2.11 The degradation of emergency bus voltage after Avionic bus failure shall not exceed 30 % of regular Avionic bus voltage during the operating time specified by the manufacturer.

Other capacity values should be defined in an equivalent manner and have to be agreed with the responsible certification authority.

### **3.3 MONITOR**

There should be an indicator showing to the pilot that EPU is delivering power to the connected device(s), this indication can e.g. be derived by measuring the load current.

For pre-flight check a test function is required showing the system function and battery status. The battery is considered sufficiently charged if 80 % of nominal capacity is available. A lamp test should be included in the test sequence.

All indications should be designed in a manner that they can be easily interpreted and misunderstandings are avoided.

*Note: Reasonable in-flight low battery warning indication is recommended.*



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## CHAPTER 4

### MINIMUM PERFORMANCE SPECIFICATION UNDER ENVIRONMENTAL TEST CONDITIONS

#### 4.1 INTRODUCTION

The environmental tests and performance requirements described in this chapter provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those which may be encountered in actual operations.

Some of the environmental tests contained in this chapter do not have to be performed unless the manufacturer wishes to qualify the equipment for that particular environmental condition. These tests are identified by the phrase „If Required“. If the manufacturer wishes to qualify the equipment to these additional environmental conditions, then these „If Required“ tests shall be performed.

Unless otherwise specified, the test procedures applicable to a determination of equipment performance under environmental test conditions are contained in document EUROCAE ED-14D/RTCA DO-160D „Environmental Conditions and Test Procedures for Airborne Equipment“, December 2000 or later editions.

Some of the performance requirements in chapter 3 are not required to be tested to all of the conditions contained in ED-14D/DO-160D. Judgement and experience have indicated that these particular performance parameters are not susceptible to certain environmental conditions and that the level of performance specified in chapter 3 will not be measurably degraded by exposure to these conditions.

#### 4.1.1 PERFORMANCE TESTS

Prior to the following tests, except when otherwise noted, the batteries should be at least 80 % charged and the EPU should be given a reasonable warm-up time of e.g. 1 h.

The applicable sections of the DO-160D are:

##### Section 4 Temperature and Altitude

Low temperature (ED-14D/DO-160D, paragraph 4.5.1)

Whilst the equipment is being subjected to this test:

Establish compliance with the requirements of the following paragraphs:

- 3.2.1 Capacity
- 3.2.2 EPU output voltage
- 3.2.5 Current consumption
- 3.2.7 Current delivered





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### High temperature (ED-14D/DO-160D, paragraph 4.5.2 to 4.5.4)

When the equipment is subjected to the high operating temperature and loss of cooling test:

Establish compliance with the requirements of the following paragraphs:

- 3.2.1 Capacity
- 3.2.2 EPU output voltage
- 3.2.5 Current consumption with batteries discharged to 19.2 V
- 3.2.6 Charge time with batteries discharged to 19.2 V
- 3.2.7 Current delivered

### Altitude (ED-14D/DO-160D, paragraph 4.6.1)

During this test establish compliance with the requirements of the following paragraphs:

- 3.2.1 Capacity
- 3.2.2 EPU output voltage

### Decompression (ED-14D/DO-160D, paragraph 4.6.2), if required

- 3.2.1 Capacity
- 3.2.2 EPU output voltage

### Overpressure Test (ED-14D/DO-160D, paragraph 4.6.3), if required

- 3.2.1 Capacity
- 3.2.2 EPU output voltage

### Section 5 Temperature Variation (ED-14D/DO-160D, paragraph 5.2, 5.3)

Whilst the equipment is being subjected to this test, establish compliance with following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.7 Current delivered

### Section 6 Humidity (ED-14D/DO-160D, paragraph 6.2, 6.3)

After subjection to this test and the application of primary power for 15 minutes, immediately establish compliance with following paragraphs:

- 3.2.2 EPU output voltage

### Section 7 Operational Shocks (ED-14D/DO-160D, paragraph 7.1.1, 7.2)

Following the application of the operational shocks

a) Establish compliance with the requirements of following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.7 Current delivered



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- b) Ensure that all mechanical devices operate satisfactorily and that the mechanical construction remains unharmed.

Following the application of the crash safety shocks, the equipment shall remain in the mounting and no part of the equipment or its mounting shall have become detached and free of the shock test table.

Establish compliance with the following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.7 Current delivered

*Note: The application of this test may result in damage to the equipment. It may therefore, be conducted after the other tests and paragraph 2.3 – Effects of Tests – does not apply.*

### Section 8 Vibration (ED-14D/DO-160D, paragraph 8.2.1.1, 8.2.2, 8.3, 8.4, 8.5)

Whilst the equipment is being subjected to this test:

- a) Establish compliance with the requirement of following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.7 Current delivered

- b) Ensure that all mechanical devices operate satisfactorily and that the mechanical construction remains unharmed.

Following sections according to ED-14D/DO-160D should apply, if required:

- Section 9 Explosion Proofness
- Section 10 Water Proofness
- Section 11 Fluids Susceptibility
- Section 12 Sand and Dust
- Section 13 Fungus Resistance
- Section 14 Salt Spray

After subjection to above tests, establish compliance with the requirement of the following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.7 Current delivered

### Section 15 Magnetic Effect (ED-14D/DO-160D, paragraph 15.1 to 15.3)

Determine the magnetic effect of the equipment and establish that it meets the requirements of the category to which it is declared.

Ensure the magnetic effect category with maximum rated load current.



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### Section 16 Power Input (ED-14D/DO-160D)

For Normal Operation Conditions (paragraph 16.5.2):

The equipment shall meet the requirements of the following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.5 Current consumption with batteries discharged to 19.2 V
- 3.2.5 Charge Time with batteries discharged to 19.2 V
- 3.2.9 AC output voltage ripple
- 3.2.10 Uninterrupted supply

When subjected to the Abnormal Operating Conditions of the power supply (defined in document ED-14D/DO-160D, paragraph 16.5.4) a degradation of the emergency bus supply below the EPU output voltage shall be excluded.

The equipment shall meet the requirements of the following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.5 Current consumption with batteries discharged to 19.2 V
- 3.2.6 Charge time with batteries discharged to 19.2 V
- 3.2.8 Separating device
- 3.2.9 AC output voltage ripple
- 3.2.10 Uninterrupted supply

### Section 17 Voltage Spike (ED-14D/DO-160D, paragraph 17.2 to 17.4)

The equipment shall meet the requirements of the following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.5 Current consumption with batteries discharged to 19.2 V
- 3.2.8 Separating device
- 3.2.9 AC output voltage ripple
- 3.2.10 Uninterrupted supply

### Section 18 Audio Frequency Conducted Susceptibility – Power Inputs (ED-14D/DO-160D, paragraph 18.2 to 18.4)

Whilst the equipment is being subjected to this test, establish compliance with the requirements of following paragraphs:

- 3.2.2 EPU output voltage

### Section 19 Induced Signal Susceptibility (ED-14D/DO-160D, paragraph 19.2 to 19.3)

Whilst the equipment is being subjected to this test, establish compliance with the requirements of following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.9 AC output voltage ripple



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### Section 20 RF Susceptibility (ED-14D/DO-160D, paragraph 20.2 to 20.6)

Whilst the equipment is being subjected to this test, establish compliance with the requirements of following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.9 AC output voltage ripple

### Section 22 Lightning Induced Transient Susceptibility

Whilst the equipment is being subjected to this test, establish compliance with the requirements of following paragraphs:

- 3.2.2 EPU output voltage
- 3.2.7 Current delivered

Following sections according to ED-14D/DO-160D should apply, if required:

### Section 21 Emission of RF Energy

### Section 23 Lightning Direct Effects

### Section 24 Icing

### Section 25 Electrostatic Discharge

- 3.2.2 EPU output voltage
- 3.2.7 Current delivered



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## CHAPTER 5

### ELECTRICAL TEST PROCEDURES

#### 5.1 GENERAL REQUIREMENTS

Electrical test procedures which are covered under environmental test conditions as mentioned in chapter 4 are conducted according to guide line RTCA/DO-160D.

Test procedures which meet specific requirements for the EPU are outlined under 5.2.2.

#### 5.2 GENERAL TEST CONDITIONS

Unless otherwise specified, the following test conditions shall apply:

- a) All tests shall be conducted under conditions of ambient room temperature (except section 4, 5 and 6) and ambient pressure and humidity as outlined in ED-14/DO160D, section 1, paragraph 3.
- b) Unless otherwise specified, the input supply voltage shall be within 10 % of the nominal value at which the equipment is designed to operate.
- c) A reasonable warm-up period for stabilisation is permissible. Battery nominal capacity is defined at 20° C.

##### 5.2.1 SPECIFIC TEST CONDITIONS (ACCORDING TO 3.2 – see fig. 5-1 and 5-2)

###### Battery Capacity

The battery capacity shall be tested as follows:

- a) Nominal capacity with nominal discharge current for 20 hours (e.g.  $I_{20} = C_{20} / 20$  h) or
- b) 80 % nominal capacity with a discharge current of five times  $I_{20}$  or
- c) 60 % nominal capacity with a discharge current of 20 times  $I_{20}$

After cooling of EPU to low operation temperature and remaining there for 3 h, the EPU is connected to 27.5 VDC for a reasonable warm-up time (e.g. 1 h), check nominal capacity.

###### EPU output voltage

1. Check voltage without load.
2. Check voltage when following load is applied:  
This load consists of three parallel components:
  - a) resistor of 50 Ohm
  - b) capacity of: 100 uF
  - c) series resistance of 55 Ohm and inductivity of 1.5 mH

Battery Life Span / Self Discharge Rate (see specification battery manufacturer)

###### Maximum Current Delivered

Not less than 275 % of the rated capacity Ampere value.



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### Maximum AC Output Voltage Ripple

Tested with fully charged batteries.

1. Check voltage without load.
2. Check voltage when following load is applied:  
This load consists of three parallel components:
  - c) resistor of 50 Ohm
  - d) capacity of: 100 uF
  - c) series resistance of 55 Ohm and inductivity of 1.5 mH

### Uninterrupted DC Supply

Tested with fully charged batteries.

### Degradation Of Emergency Bus Voltage

Tested with fully charged batteries with a constant current of  $20 \times I_{20}$  to 19.2 V.

## **5.2.2 SPECIFIC TEST CONDITIONS (ACCORDING TO 3.3)**

- Lamp test: all segments lighted.
- Check load segment on when load is applied.
- Check battery status monitor segments to reflect battery status of 20 vs. 80 % capacity.

## **5.3 ALIGNMENT, ADJUSTMENT AND CALIBRATION PRIOR TO TEST**

If necessary, alignment, adjustment and calibration should be performed prior to test.

## **5.4 CONNECTED LOAD**

Unless otherwise specified, all tests shall be performed with a constant current load of  $10 \times I_{20}$  (A).

To detect any transients and parasitic oscillations a combined ohmic, inductive and capacitive load test should be conducted (see 3.2.2 and 3.2.9).

This load consists of three parallel components:

- a) resistor of: 50 Ohm
- b) capacitor of: 100 uF
- c) series resistance of 55 Ohm and inductivity of 1.5 mH

## **5.5 TEST INSTRUMENT PRECAUTIONS**

Due precautions shall be taken to prevent errors resulting from the improper employment of test instruments. Test equipment used to verify final test results must be calibrated traceable to the National Bureau of Standards. Test equipment accuracy shall be at least 2 %.



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### CHAPTER 6

#### INSTALLED EQUIPMENT PERFORMANCE

The material contained in the following paragraphs is intended as Guidance Material only and does not have direct significance in the Type Certificate of the equipment concerned, nor does it have any mandatory significance in terms of Installation Certification, as the aircraft installation, unless otherwise specified, must comply with the installation requirements of the Installation Approval Authority concerned.

##### **6.1 EQUIPMENT INSTALLATION**

General installation rules such as FAA AC 43.13 should be applied. Special care should be observed in selecting cable diameter, installation of the mounting rack and definition of the emergency power bus with its associated circuit breakers.

These circuit breakers shall ensure that the sum of load current never exceeds 90 % of EPU load circuit breaker. Since the design of the EPU is such that the emergency load is normally supplied by the Avionic bus, and uninterrupted automatic change to EPU supply in case of Avionic bus failure is incorporated, care should be taken for a continuation of supply even in case of short circuit of a partial load.

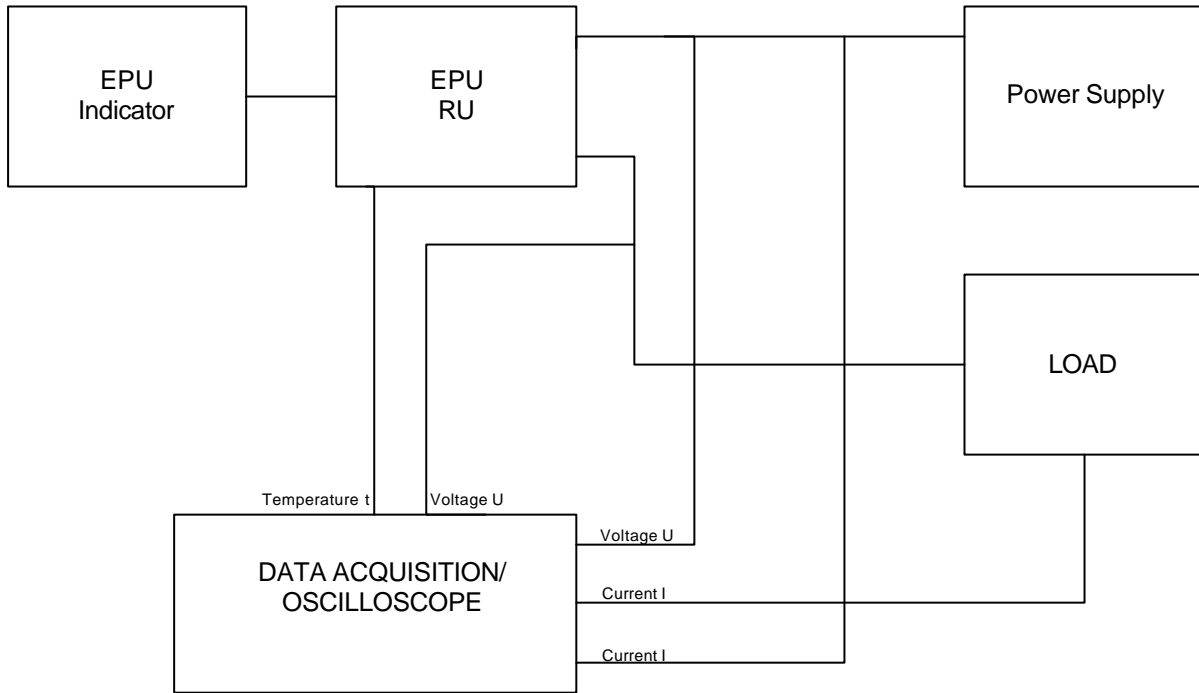
The EPU shall be installed in a manner that a malfunction of the EPU itself does not cause conditions which prevent the safe continuation of the flight.

Due to the importance of the emergency bus, extreme installation care should be taken to prevent any possible short circuit to ground.

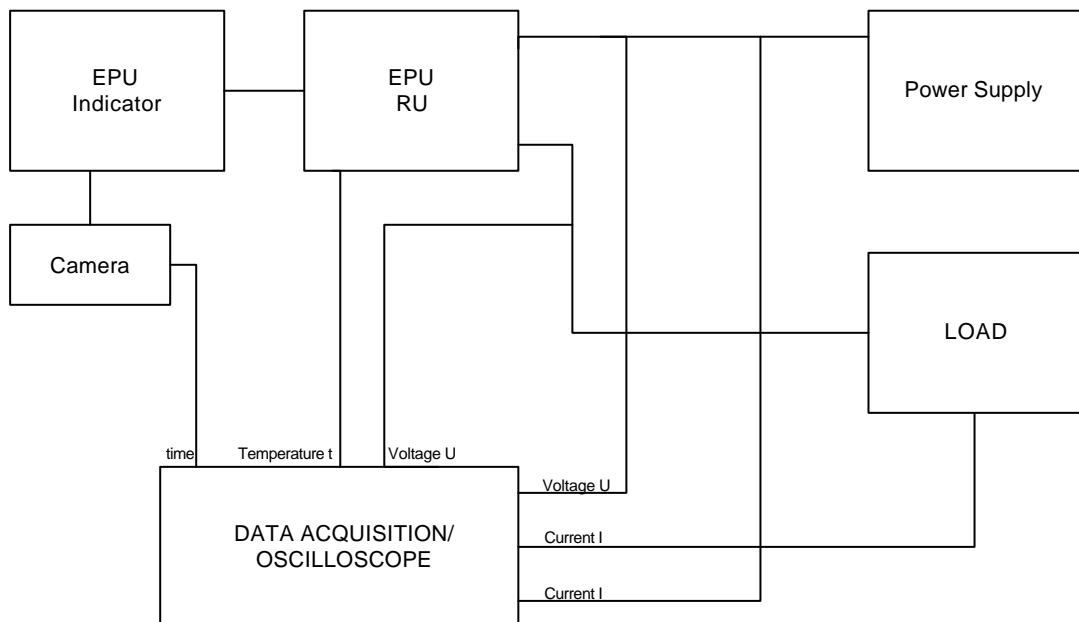
It is recommended that an emergency bus master switch is installed between EPU output and emergency bus circuit breakers to prevent an unintended load application after shut down of the aircraft.

The equipment shall be installed in accordance with the manufacturer's installation instructions.

**APPENDIX**



**Figure 5-1: Test Set-up Battery Capacity - Battery Voltage - Current Consumption - Current delivered**



**Figure 5-2: Test Set-up Indicator - Battery Voltage - Current delivered**