

IGNITION BATTERY MANAGER

Reliable Aircraft Operations With Battery Powered Ignition Systems

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EAA 205021

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I met many people at Oshkosh this year who believe magnetos should go the way of buggy whips and vacuum tubes. Major concerns for everyone contemplating dual electronic ignition was (1) redundant power sources and (2) pilot notification. The "black box"

addressing these concerns does not yet exist although it could in a short period of time. The purpose of this article is to (1) solicit peer review of the concept and (2) put a dipstick into the pool of builder enthusiasm. Look this over carefully, folks, and see if it makes sense.

Introduction

In recent years, new electronic ignition systems designs have partially or even totally replaced magnetos on aircraft engines. Battery powered systems have many advantages over magnetos which include:

1. Increased spark energy during engine cranking.
2. Higher energy and/or long duration sparks for cruising flight (necessary for high efficiency, lean mixture operations).
3. Engine efficiency improved in cruising flight by application of maximum advance of timing consistent with operating conditions.

4. Battery powered ignition systems can take advantage of relatively cheap, but reliable automotive components. Costs are approaching that of magnetos. Repairs by users are simpler. Many repair parts are available from multiple sources.

Significant challenges for incorporation of battery powered ignition systems on aircraft are revealed by failure mode effects analysis (FMEA). The tasks are (1) to design a system wherein no single component failure will disable both ignition systems and (2) ensure ignition system operation (irrespective of alternator condition), allowing comfortable termination of flight. The following will describe hardware and a design philosophy to address both tasks.

Major Components

The proposed system is compatible with most battery powered ignition products. The only limitation being that proposed ignition systems should not be more than 5 amps each in cruising flight. Figure 1 illus-

trates application of a proposed Ignition Battery Management Module (IBMM) and Auxiliary Ignition Battery. Major components of the system are:

Ignition Switches

Power to each ignition system is controlled by a three-position toggle switch. The lower extreme position is OFF which removes power from the respective ignition system. In the middle AUX position power is supplied from an auxiliary ignition battery. The upper ON position feeds the system from the ship's main battery.

Auxiliary Ignition Battery

An auxiliary battery is included to provide a second source of ignition power in addition to the ship's normal d.c. power system. This battery is sized in consideration of d.c. power requirements for each ignition system and the maximum anticipated operating time under failed alternator conditions.

Ignition Battery Management Module (IBMM)

The ignition battery management module is a microprocessor based voltage monitor and warning device which includes an auxiliary battery isolation relay. The device would be about 2.5 by 4.0 by 1.0 inches in size and weigh about 0.4 pounds. The IBMM simultaneously monitors voltages at three different points: (1) the ship's power distribution bus, (2) the voltage applied to the right ignition system and (3) voltage applied to the left ignition system. The IBMM automatically controls an auxiliary battery disconnect relay and develops pilot warnings as follows:

a. Bus voltage is monitored for the purpose of controlling the auxiliary battery isolation relay. For bus voltage greater than 13.0 volts, the alternator is assumed to be operating normally and the isolation relay is held closed. This provides (1) a charging path for the auxiliary battery during normal operations and (2) an alternate path for power to either ignition system.

b. Voltage applied to each ignition system is monitored to provide warning of incipient battery failure during battery-only operations.

The IBMM drives a press-to-test, dimmable indicator lamp assembly which operates in the following manner:

a. When system power is first applied, the IBMM's processor accomplishes an internal self test. Upon successful completion of test, the light will illuminate for 3 seconds and go dark. Immediately following the self

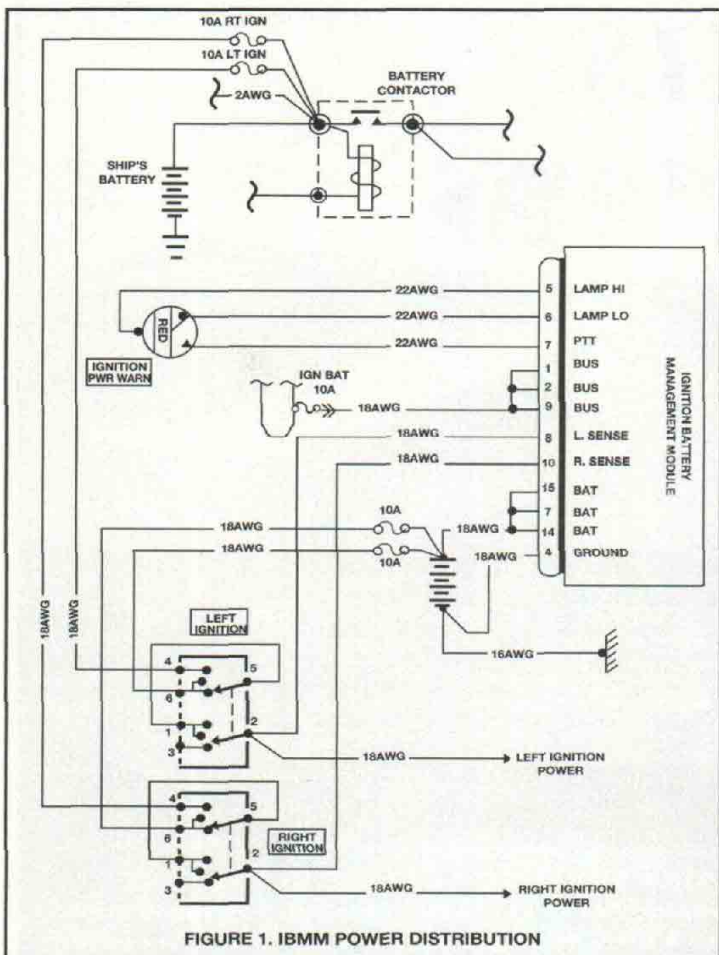


FIGURE 1. IBMM POWER DISTRIBUTION

Alternator Failure

1. IBMM indicator light initiates double-flash indication. No system management actions by pilot are needed. Warning indication may be suppressed for 5 minutes by pressing the light fixture.

2. If during alternator-out operations the IBMM indicator light displays a steady flashing, observe ship's voltmeter to determine whether the ship's battery or auxiliary ignition battery has discharged below 11.0 volts.

a. If ship's battery is still above 11.0 volts, place both ignition switches in the ON position.

b. If ship's battery is below 11.0 volts, pilot has option of switching both ignition systems to AUX or loading the ignition battery with only one system to maximize flight time on available battery power.

Summary

The proposed system permits dual battery powered ignition systems to operate normally from the ship's main power distribution system with automatic changeover for one ignition system to the auxiliary battery in case of a catastrophic failure of main power. Two independent batteries are charged from a single alternator, however, the second battery is automatically protected from premature discharge by back-flow of energy into a failed ship's system. The pilot is offered immediate notification of change of status for critical system supply voltages. Power switching for both ignition systems is accomplished through simple switches and minimum-component pathways to each battery.

A detailed failure mode effects analysis of this system indicates that no single failure will cause loss of engine ignition power. Redundancy is achieved without a second alternator and adds approximately 6 pounds to the electrical system weight.

Bibliography

The author may be contacted directly at 316/685-8617 or Compuserve 72770,552. Written coverage and real-time consulting services on this and other electrical systems topics are available from the AeroElectric Connection, 6936 Bainbridge Rd., Wichita, KS 67226-1008. \$42 USD buys all materials in print (13 chapters, lots of illustrations, 5 appendices, 200+ pages) plus one year's subscription to newsletters and the next issue of chapters on specific topics. Overseas subscribers add \$20 USD for airmail postage. MasterCard and Visa are accepted. ♦

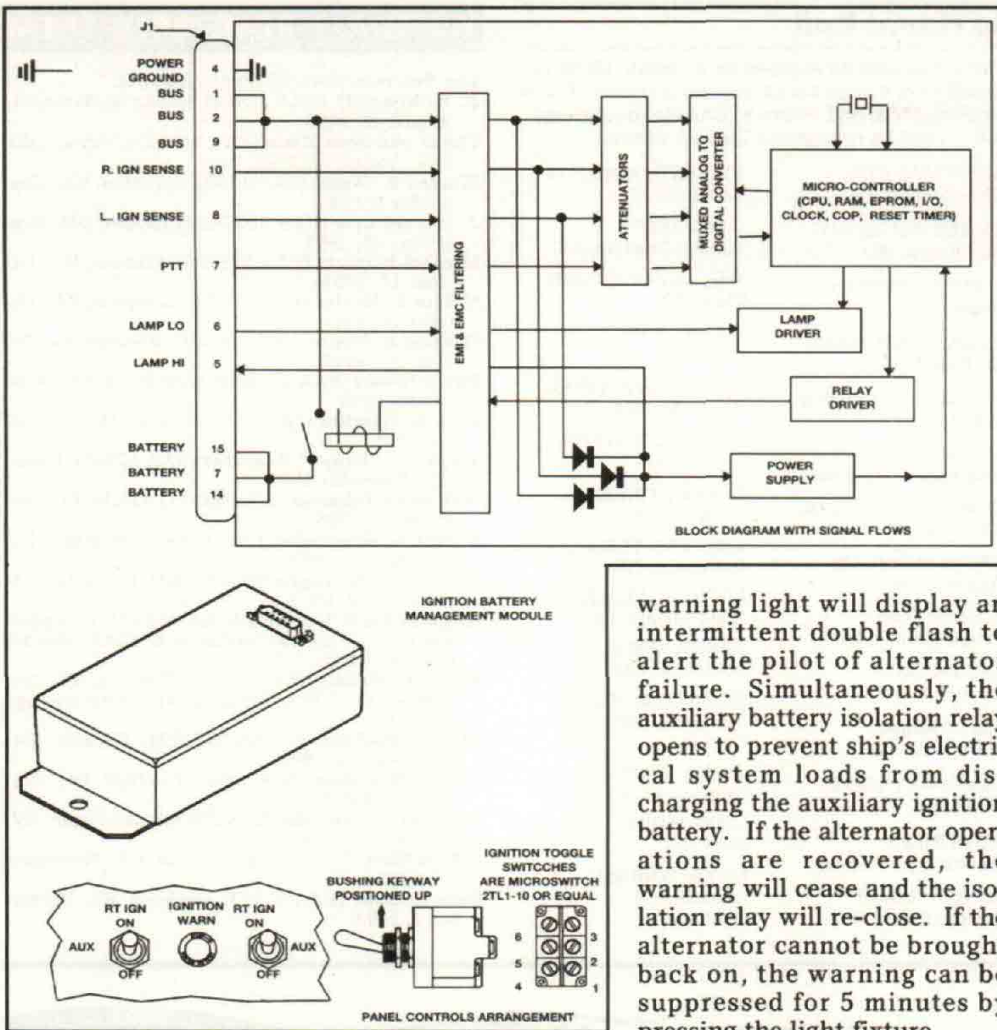


FIGURE 2. BLOCK DIAGRAM AND PHYSICAL DETAILS

test, if both ignition system supply voltages are greater than 13.0 volts, the light will stay dark. If either system supply voltage is between 11.0 and 13.0 volts the lamp will display short double flashes at 1 second intervals. If either voltage drops below 11.0 volts, the lamp will flash continuously with a uniform on/off duty cycle.

b. Pressing the light fixture dome initiates a self test which will illuminate the lamp for 3 seconds followed by a suppression of any current warnings for a period of five minutes. After five minutes, if normal alternator operations have not been restored, the light will again resume flashing the current worst-case warning as described above. Pressing the fixture will initiate warning suppression for an additional five minute interval.

c. For normal operations with alternator producing power, the indicator light will be dark. During this time, the battery isolation relay will be closed for ignition battery charging. Either or both ignition systems may receive power through the battery charging path by placing their respective control switch in the AUX position.

d. If the alternator fails to maintain system voltage above 13.0 volts, the

warning light will display an intermittent double flash to alert the pilot of alternator failure. Simultaneously, the auxiliary battery isolation relay opens to prevent ship's electrical system loads from discharging the auxiliary ignition battery. If the alternator operations are recovered, the warning will cease and the isolation relay will re-close. If the alternator cannot be brought back on, the warning can be suppressed for 5 minutes by pressing the light fixture.

e. If either ignition system supply voltage falls below 11.0 volts, the warning light will initiate continuous flashing. Ignition switches may be adjusted to transfer the system receiving low voltage to a higher voltage source. Or, at pilot option, the ignition battery may be conserved by leaving one ignition feed connected to the "failing" battery. Imminent battery failure warnings may be suppressed for 5 minutes by pressing the light fixture.

Preflight Operations

1. Battery Master - ON
2. Alternator Field - OFF
3. Both ignition switches - AUX (IBMM indicator light illuminates for 3 seconds then initiates double-flash indication.)
4. Prime engine and crank. After engine starts . . .
5. Alternator Field - ON (IBMM indicator light goes out.)
6. Left ignition switch - ON
7. Right ignition switch - leave on AUX
8. Complete engine run-up with usual mag checks then continue normal flight operations with one ignition switch at ON; the other at AUX.