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# DC-TO-DC POWER SUPPLY FOR LIGHT AIRCRAFT FLIGHT TESTING

A DC-to-DC power supply has been designed and fabricated to operate the prototype Loran-C receiver and data collection system currently in use at Ohio University. The supply is designed to operate from an aircraft electrical system.

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## I. INTRODUCTION

The NASA Joint University Program at Ohio University is currently involved in the development of a low-cost Loran-C receiver for use in general aviation aircraft. A DC-to-DC power supply has been built to operate the prototype receiver and data collection system in a light general aviation aircraft. The power supply can be connected directly to the aircraft's electrical system, and is compatible with either 14 or 28 volt electrical systems. Previously, on all flight tests in Ohio University's DC-3 aircraft N7AP, power for the receiver came from a DC-to-AC inverter, wich in turn powered an AC-to-DC power supply. Economical flight tests utilizing a light aircraft are now possible. The DC-to-DC power supply is substantially lighter than the inverter-AC supply combination which is an important factor in light aircraft flight tests.

## II. DESIGN SPECIFICATIONS

The design specifications for the DC-to-DC power supply are as follows:

1. Input - 14 or 28 VDC so that the power supply is compatible with light aircraft and with the DC-3 electrical system.

2. Output - +5 VDC at 5 amps, +12 VDC at 1 amp, and -12 VDC at 0.1 amp, each voltage to be regulated.

3. Power connection - The supply must be interfaced to a standard 4-pin MS connector (already installed in aircraft used for test flights) or a cigar lighter (for use in aircraft or automobile not equipped with the MS connector).

4. Each of the outputs is to be fused individually to protect the aircraft, the power supply, and the receiver.

5. An ammeter will be provided on the +5 V output to monitor the operation of the receiver.

## III. CIRCUIT DESIGN

The circuit of the DC-to-DC power supply is straightforward (refer to figure 1), and it closely resembles a standard AC-to-DC power supply except for the absence of transformers or rectifiers. Monolithic, three-terminal regulators are used for the regulated outputs due to their reliability and the large range of input voltages they can accommodate. When the TO-3 regulator package is utilized, these units can dissipate power in excess of 25 watts, if properly heat sinked.

The positive outputs are obtained with the following regulators: the µA784056 is a +5 volt regulator with current cabability of up to 5 amps. The input voltage range is from 7 to 24 VDC. The LM340 is a +12 volt regulator with current cability of up to 1 amp. Input voltage range is from 14 to 32 VDC. When 14 volts input is used, the voltage can be

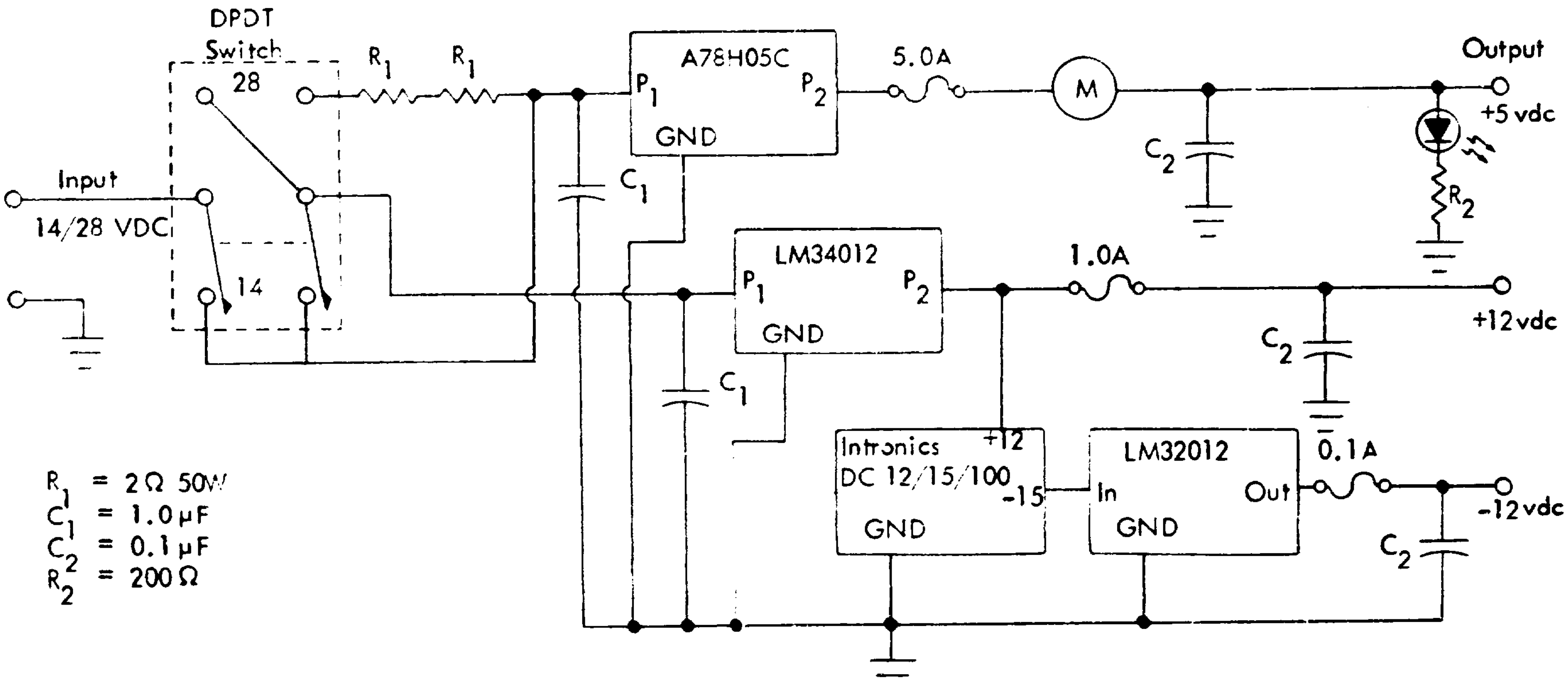


Figure 1. Schematic for DC-DC Power Supply. The power supply presented above was specifically designed to operate the Ohio University Loran-C receiver and signal processor. The supply was designed to operate directly from an aircraft's electrical system, hence the input of 28 or 14 volts DC. The outputs are respectively: +5V at 5A, +12V at 1A, -12V at 0.1A. The DPDT switch allows the 2 ohm resistors to be connected in series with the 5 volt regulator for 28 volt operation, bypasses the resistors for 14V operation (the maximum input voltage of the regulator is 24V), and serves as a power-off switch.

routed directly to the regulators, but for 28 volts input, a power resistor must be provided in the input to the 5-volt regulator to drop the voltage to a level below 24 volts. In the circuit for this power supply, a DPDT switch is utilized to connect two 2-ohm, 50 watt resistors in series with the 5-volt regulator for 28-volt operation and disconnect these resistors for 14-volt operation. The DPDT switch also serves as a power off switch for the supply. The 5-volt and 12-volt regulators are mounted on a large heat sink as are the two 2-ohm power resistors.

To obtain negative voltage for the -12 volt output, the Intronics 12/15/100 converter is connected directly to the +12 volt regulated output. The output of the converter is -15 volts and a LM320 -12 volt regulator is connected to it. The current cabability of the Intronics converter is 0.1 amp, and the specs of the LM320 are the same as those of the LM340. 1 µF capacitors are connected across the regulator inputs and 0.1 µF capacitors are connected across the outputs to filter high frequency noise and avoid regulator oscillation. Each of the three outputs is protected with fuses of appropriate capacity. An ammeter is connected to the +5 volt output as well as an LED which serves as a power-on indicator. Two power connection cables are available for this supply--one with a 4-pin MS connector, the other with a cigar lighter adapter. Photographs of the unit appear in figure 2 and 3.

## IV. TEST RESULTS

When the construction of the supply was completed it was bench tested at no-load. The purpose of this test was to observe the outputs over a range of $\pm 5$ volts from the specified input voltage. With 14 VDC input, the outputs were as specified (+5V, +12V). As the input voltage was decreased to less than 13VDC, the LM340 +12 VDC regulator no longer functioned (as expected) and the output voltage was 0.5V lower than the input voltage. The LM320 -12VDC regulator stopped functioning at an input voltage of 11 VDC. (This is due to the Intronics converter which produces -15VDC output from +12 VDC input.) There was no change in the $\pm 5$ VDC output as the input was decreased to 9VDC. When the input voltage was increased to 19VDC, the outputs remained within the design specifications. With 28VDC input, the outputs again were as specified. As the input voltage was decreased to 23 VDC, the outputs remained constant. The same results were obtained when the input was increased to 33 VDC.

The power supply was then connected to the prototype Loran-C receiver and tested in the same manner described in the preceding paragraph. The receiver functioned well across both of the input voltage ranges (9 to 19 and 23 to 33) but 9V is the lowest voltage at which the receiver will function correctly. When operated in the 28V mode, the regulators and power resistors become quite hot, but their respective heat sinks are sufficient to dissipate this heat. An important conclusion from these tests is that although the outputs of the power supply deteriorate when the input falls below 13V, this reduction in output voltage does not affect the performance of the receiver until the voltage is reduced to a level that will probably never be encountered in a flight test.

The DC-DC power supply was given its first flight test on 11 November, 1980, in a Piper Cherokee 180. The power supply performed well, as did the prototype Loran-C receiver. The power supply was operated with an input of 14 V. The operation of the

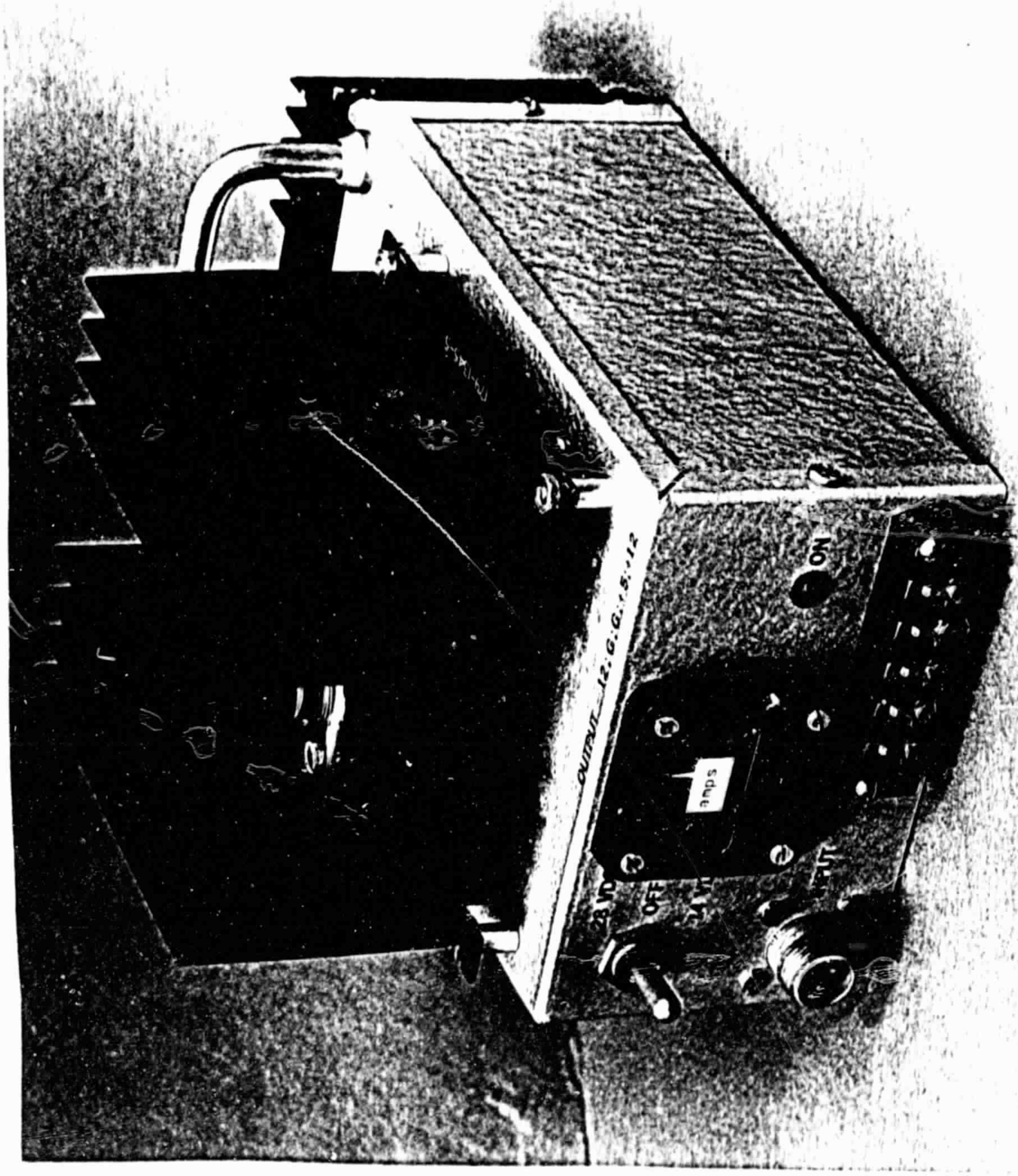


Figure 2. DC-to-DC Power Supply. (Photograph by J. Nickum)

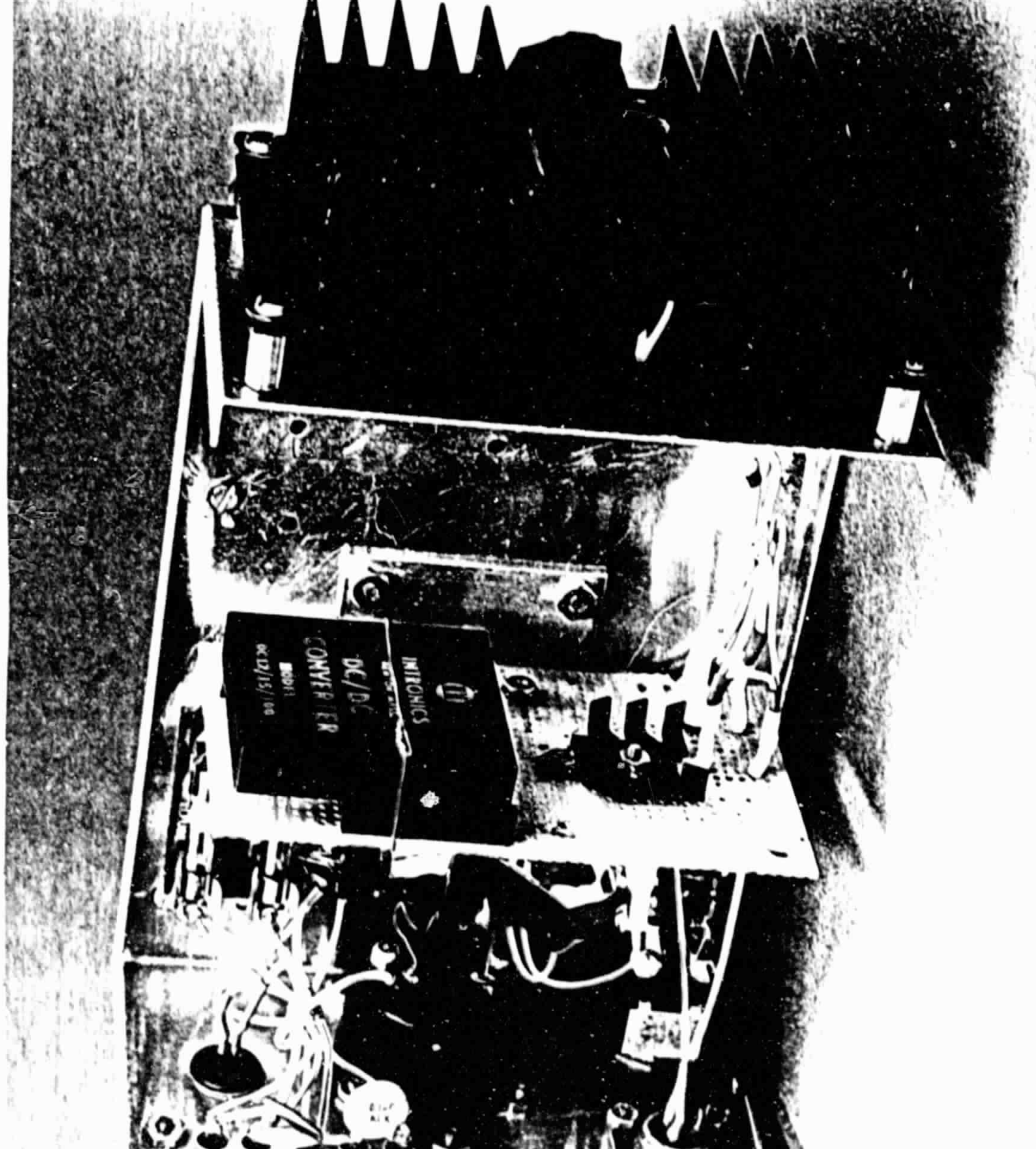


Figure 3. DC-to-DC Power Supply, inside view.

receiver had no adverse effect on the airplane's electrical system. This was the first time this receiver had been flight tested in a light aircraft. Previously, all flight testing was done with the DC-3 using the inverter-AC supply combination for power.

## V. SUMMARY

The DC to DC power supply was designed specifically to operate the prototype Loran-C receiver and data collection system. It has replaced the inverter-AC supply combination which had been a source of power supply problems on previous test flights with this receiver. In the two flight tests to date utilizing the DC-to-DC power supply, it has performed well and eliminated the power problems observed with the inverter-AC supply combination. The use of the new supply will make more flight tests with light aircraft possible and realize a substantial cost reduction over the use of the DC-3.

## VI. ACKNOWLEDGEMENTS

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