Operation manual for the Black Brant V plasma probe experiment

McNamara, A.G.

Report (National Research Council of Canada. Radio and Electrical Engineering Division : ERB), 1965-03

ERB-693

UNCLASSIFIED

NATIONAL RESEARCH COUNCIL OF CANADA

RADIO AND ELECTRICAL ENGINEERING DIVISION

OPERATION MANUAL FOR THE BLACK BRANT V PLASMA PROBE EXPERIMENT

A. G. McNAMARA

OTTAWA

MARCH 1965

ABSTRACT

Assembly, checkout, and countdown procedures for the Black Brant V plasma probe experiment are described. Normal preflight voltages, currents, and output signal characteristics are given to enable diagnostic decisions to be made concerning the package. The preflight probe check and calibration procedure is outlined.

CONTENTS

FIGURES

OPERATION MANUAL

FOR THE

BLACK BRANT V PLASMA PROBE EXPERIMENT

- A.G. McNamara -

MOUNTING OF PACKAGE

The entire electronics portion of the experiment is contained in a $5'' \times 5'' \times 2\frac{1}{2}''$ box with mounting flanges. Any mounting orientation is permissible. The entire contents of the box are potted in a light-weight foam for mechanical and thermal protection.

ELECTRICAL POWER FOR THE PACKAGE

No internal power sources are contained in the package. No internal power switches are present; the experiment is operative when the external power is applied.

A positive power source nominally of +28 volts is required. At this voltage the package draws 17 ma. The lower and upper limits on the power supply voltage for proper operation are 19 volts and 35 volts.

A negative source nominally of -6 volts is required. The tolerable voltage limits are -7 volts and -4.5 volts. An average current of -2 ma is drawn, with short-duration (0.5 sec) periodic increases to approximately 6 ma.

INPUT/OUTPUT CONNECTIONS

A Microdot coaxial cable connects the sensing probe to the electronics box. The coaxial braid of this cable carries a varying bias potential, and care must be taken not to ground it.

A 15-pin Cannon connector provides all the umbilical connections and the signal outputs to the telemetry. Table I gives the connector details.

CONTINUITY TEST AND CALIBRATION

After assembly of the nose cone shroud to the instrumentation frame, the probe connection must be checked for leakage and continuity. To facilitate the checks, a special probe checkout device is provided. A

TABLE I

PLASMA PROBE CONNECTOR

Cannon DA-15S on probe chassis, DA-15P on cable

Pin No.	Connection	Function
1	40-kc/s SCO	Probe d-c signal
3	Commutator bar	Probe bias/sweep monitor
6	Commutator bar	Range switch monitor
7	CBA +28 v supply	Positive power source for experiment
9	CBA -6 v supply	Negative power source for experiment
12	Rocket ground	Ground reference potential

sketch of this device is contained in "Operating Manual for the BB III/IV Plasma Probe Experiment", NRC Report ERB-692 (Fig. 3).

The checkout device consists of a metal can, internally insulated, which slips over the probe on the tip of the nose cone. The metal surface of this can makes contact with the metal skin of the rocket (i.e., it is at rocket ground potential) and provides an electrostatic screen over the probe to exclude interference pickup (e.g., at 60 c/s).

With the device shielding the probe, the d-c signal level on the 40-kc/s subcarrier oscillator (SCO) should not have changed significantly from the value before the probe was connected. A shift in level generally indicates leakage resistance.

To check the continuity of the probe connection and to calibrate the signal, the button on the top of the can is pressed. This connects a calibrated resistor between the probe and rocket ground. As a result, a series of waveforms should be seen on the output of the 40-kc/s SCO. These are illustrated in Fig. 1.

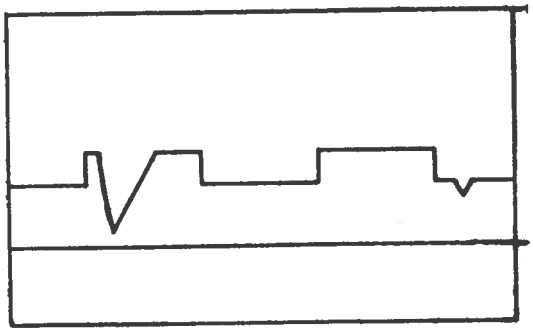

Fig. 1 40-kc/s SCO signal with test/calibrator

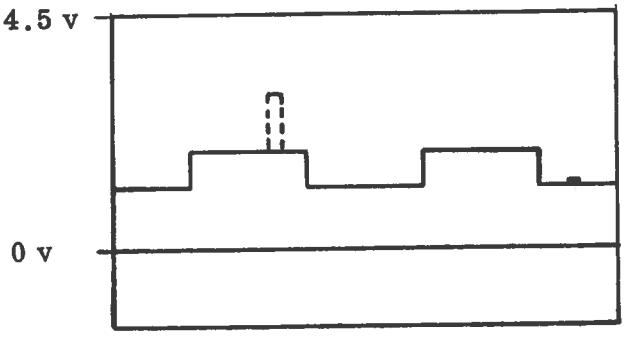

Fig. 2 40-kc/s SCO signal

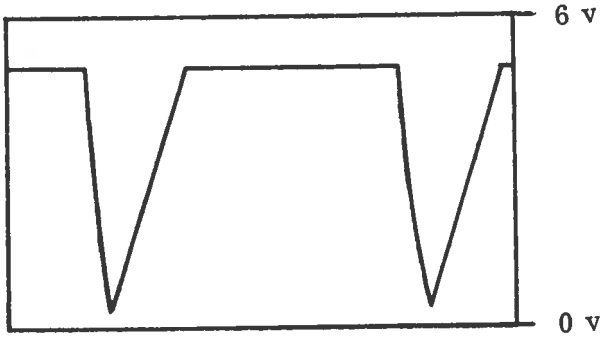

Fig. 3 Sweep monitor waveform applied to 70-kc/s SCO

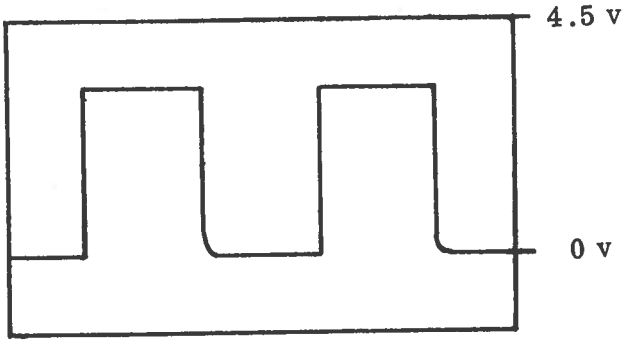

Fig. 4 RS/+ monitor waveform applied to 70-kc/s SCO

The above operation with the checkout device should be performed during assembly in the blockhouse. Another short calibration check should be made with the rocket on the launcher during the horizontal checkout. At this time the telemetry CEC recorders should be run at slow speed to record the results of the check.

D-C LEVELS OF OUTPUT SIGNALS

40-kc/s SCO: The d-c level alternates in a square waveform between the limits 1.1 to 1.9 volts, approximately.

The probe bias/sweep monitor channel on the commutator remains near the 5-volt level, but drops periodically to near zero volts.

The range switch monitor signal is an alternating square waveform between the limits +3.5 volts and 0 volts. The upper limit is directly proportional to the positive supply voltage.

WAVEFORMS OF OUTPUT SIGNALS

Proper operation of the experiment can be ascertained best by viewing the d-c probe signal (40-kc/s SCO) on an oscilloscope with a free-running sweep of 0.5 sec/cm. The typical preflight waveform of the 40-kc/s SCO is shown in Fig. 2. The normal condition of this signal is interrupted briefly (for about 0.2 seconds) every 6 seconds by an internal in-flight calibration signal.

The sampled probe bias/sweep monitor signal displayed on the commutator is derived from the continuous waveform shown in Fig. 3. Similarly, Fig. 4 indicates the range switch monitor waveform which is sampled on the commutator.

PRECAUTIONS IN HANDLING PLASMA PROBES

The operation of a plasma probe depends upon the collection of minute currents of electrons and ions from the ionized medium. Hence the condition of the collecting electrode surfaces and the insulation resistances are critical, and extreme cleanliness must be observed in handling techniques. These precautions manifest themselves in three areas:

i) Probe electrode surface This must be a completely conducting, non-oxidizing surface with stable work function. The presence of contaminating fingerprints and greases will modify the area, the work

function, and set up areas of static charge. The only satisfactory cleaner is a clean rag soaked with pure ethyl alcohol. Extreme care should be exercised to avoid contaminating the electrode with any silicone grease or compound, as the resulting film is very difficult to remove. A rag used to wash the rest of the nose cone should not be used to clean the electrode or insulator.

ii) Probe insulator Since a resistance of 10^{12} ohms is required of the insulator, it should be protected at all times from dirt and fingerprints. If necessary, it should be cleaned only with a clean rag and ethyl alcohol. Any protective cover over the probe and insulator should be checked for removal before launch. Similar care and cleanliness should be observed in handling the coaxial cable and its connectors.

iii) Nose cone surface The clean metallic surface of the cone and rocket body is used as a return electrode to transmit the collected ion current to the medium. To accomplish this, it must present as large a conductive surface as possible. On the launcher, all protective covers are removed and a final alcohol cleaning is given.