SECTION III
Attitude Hand Controller

<table>
<thead>
<tr>
<th>Sig. Ref.</th>
<th>Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>11</td>
</tr>
<tr>
<td>C2</td>
<td>12</td>
</tr>
<tr>
<td>C3</td>
<td>13</td>
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<tr>
<td>C4</td>
<td>13</td>
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<tr>
<td>C5</td>
<td>13</td>
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<tr>
<td>C6</td>
<td>13</td>
</tr>
<tr>
<td>C7</td>
<td>13</td>
</tr>
<tr>
<td>C8</td>
<td>13</td>
</tr>
<tr>
<td>C9</td>
<td>13</td>
</tr>
</tbody>
</table>

C1, C2, & C3

Source Description

- Source Impedance: $(21 \pm 15\%) + (j 25.5 \pm 10\%)$ RMS
- Out of detent indication: $1 1/4$ degrees $\pm 1/4$ degree
- Null voltage: 30 millivolts RMS max., with 10K OHM load.
- Quadrature voltage: 30 millivolts RMS max. with 10K OHM load.
- Scale factor: 2.5 volts $+0.15$V RMS at $\theta = 10$ degrees
- Rate command: 0.04V hand controller position (soft stop) with 10K OHM load.

- Excitation: See sheet 27.

- Phase Shift: 200 cps (PGNS 300 cps)
- Linearity: $0^\circ \pm 10^\circ$ max. into a 10K OHM load.

5%

Load Description

- Load Impedance: 2K-20K OHMS non-linear. (Effectively 8K OHMS when not reading).
- Quantization: 40 states per 10 degrees.
- Linearity: $\pm 10\%$ for $3^\circ < \theta < 10^\circ$.
- Sample rate: 5-6 per second.

C4 - C9

Signal levels, source and load impedances are specified with respect to the LGC Return (Interface connector P/5 222 Pin 6).

LGC isolation resistors are included in the source impedance.

TPKE 38154  JUN 1.1.1970

INTERFACE CONTROL DOCUMENT

SHEET I CD NO. REV
26 OF 1.14 LJS 370-10004 D
Signals Cl, C2 and C3 will not be present in LM-1 due to the deletion of the Attitude Controller Assy. Each interface will be short circuited at the source (ACA).

Signals C4 - C9 will not be present in LM-1 due to the deletion of the Attitude Controller Assy. Each interface will be left open at the source (ACA).

Cl - C3

Phase relationships are specified with respect to the 28V-600 CPS excitation supplied by POPS (interface connector P/J 310 pin 63(LH) and pin 35 (R)) with Lo as reference.

Signals levels, source and load impedances are measured between high and low, with Lo as reference.

Cl, C2 & C3

Rate Command: (A) For LGC flight programs prior to "Sundance" (prior to LM-3)

\[
\text{Rate Command} = \frac{7.15E \text{ degrees/second}}{\text{V RMS}}
\]

where \( K_r \) = hand controller voltage in volts RMS.

(B) For LGC flight program "Sundance" (LM-3)

\[
\text{Rate Command} = \frac{-K_r (7.15E) \text{ degrees/second}}{\text{V RMS}}
\]

where \( K_r \) = 1 for normal ACA scaling
\( K_r = 0.2 \) for fine ACA scaling
\( B \) = hand controller voltage in volts RMS.

(C) For LGC flight program "Luminary" (LM-4 and subsequent)

\[
\text{Rate Command} = \frac{\left[ 1.43E \text{ degrees/sec} + \frac{2.04E^2 \text{degrees/sec}}{\text{V RMS}} \right]}{\text{V RMS}}
\]

where \( K_r = 1 \) for normal ACA scaling (LM only)
\( K_r = 0.2 \) for fine ACA scaling (LM only)
\( K_r = 0.1 \) for normal ACA scaling (LM/CSM)
\( K_r = 0.02 \) for fine ACA scaling (LM/CSM)
\( B \) = hand controller voltage in volts RMS.

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INTERFACE CONTROL DOCUMENT  SHEET  ICD NO.  REV

ENG 37.3.1-44

125-370-1000b
EFFECTIVITY:
LM-4 & SUB - AS SHOWN.
LM-3 - SAME AS LM-4 EXCEPT SW.
① & ② REPLACED BY JUMPER WIRE.
LM-142 - ACA's 142 REMOVED
& REPLACED BY JUMPER WIRE BETWEEN ③ & ⑥.
SIMILARLY FOR ROLL & YAW.
ITA-8 - SAME AS LM-3 EXCEPT FUSES ③ & ④ REPLACED
BY JUMPER.
<table>
<thead>
<tr>
<th>ID</th>
<th>SIGNAL</th>
<th>FUNCTIONAL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Pitch Rate Command</td>
<td>ACA angular displacement in the right hand positive sense about the +Y LM body axis will result in an 800 cps signal, amplitude proportional to displacement, in phase with the 300 cps reference (high with respect to low) and shall cause rotation in a right handed positive direction about the vehicle + pitch axis (+Y) when PNS is in control and in attitude hold mode. Movement of the ACA in the right hand negative sense about the +Y LM body axis will result in an 800 cps signal, amplitude proportional to displacement, 180° out of phase with the 300 cps voltage reference (high with respect to low) and shall cause rotation in a right handed negative direction about the vehicle -pitch (-Y) axis.</td>
</tr>
<tr>
<td>C2</td>
<td>Roll Rate Command</td>
<td>ACA angular displacement in the right hand positive sense about the +Z LM body axis will result in an 800 cps signal, amplitude proportional to displacement, in phase with the 300 cps reference (high with respect to low) and shall cause rotation in a right handed positive direction about the vehicle +roll (+Z) when PNS is in control and in attitude hold mode. Movement of the ACA in the right hand negative sense about the +Z LM body axis will result in an 800 cps signal, amplitude proportional to displacement, 180° out of phase with the 300 cps voltage reference (high with respect to low) and shall cause rotation in a right handed negative direction about the vehicle -roll (-Z) axis.</td>
</tr>
<tr>
<td>C3</td>
<td>Yaw Rate Command</td>
<td>ACA angular displacement in the right hand positive sense about the +X LM body axis will result in an 800 cps signal, amplitude proportional to displacement, in phase with the 300 cps reference (high with respect to low) and shall cause rotation in a right handed positive direction about the vehicle +yaw axis (+X) when PNS is in control and in attitude hold mode. Movement of the ACA in the right hand negative sense about the +X LM body axis will result in an 800 cps signal, amplitude proportional to displacement, 180° out of phase with the 300 cps voltage reference (high with respect to low) and shall cause rotation in a right handed negative direction about the vehicle -yaw (-X) axis.</td>
</tr>
</tbody>
</table>
Effectivity:
LM-1 & 2 -- Same as above except ACA's 1 & 2 deleted. Wiring left open.
<table>
<thead>
<tr>
<th>ID</th>
<th>SIGNAL</th>
<th>SIGNAL LEVEL DC VOLTS</th>
<th>Z SOURCE OHMS ±10%</th>
<th>Z LOAD OHMS ±10%</th>
<th>FUNCTIONAL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td>+Pitch Pulse Command</td>
<td>28±11 0±2</td>
<td>1K OPEN</td>
<td>22K 22K</td>
<td>The presence of a logic &quot;1&quot; at the interface is a request to PGNCS for a single minimum impulse jet firing which will cause spacecraft right-handed positive angular acceleration about the pitch axis when the PGNCS is in control and in the attitude hold, minimum impulse mode.</td>
</tr>
<tr>
<td>04</td>
<td>HL PDL E1</td>
<td>28±11 0±2</td>
<td>1K OPEN</td>
<td>22K 22K</td>
<td>When the PGNCS is in control and in automatic mode, the presence of a logic &quot;1&quot; at the interface is an indication to the PGNCS that the new desired landing site is nearer to the vehicle than the presently estimated site.</td>
</tr>
<tr>
<td>05</td>
<td>+Pitch Pulse Command</td>
<td>28±11 0±2</td>
<td>1K OPEN</td>
<td>22K 22K</td>
<td>The presence of a logic &quot;1&quot; at the interface is a request to PGNCS for a single minimum impulse jet firing which will cause spacecraft right-handed negative angular acceleration about the pitch axis when the PGNCS is in control and in the attitude hold, minimum impulse mode.</td>
</tr>
<tr>
<td>ID</td>
<td>SIGNAL</td>
<td>SIGNAL LEVEL DC VOLTS</td>
<td>Z SOURCE ±10%</td>
<td>Z LOAD ±10%</td>
<td>FUNCTIONAL DESCRIPTION</td>
</tr>
<tr>
<td>-----</td>
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<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>05</td>
<td>-LPD RL</td>
<td>28±11</td>
<td>1K OPEN</td>
<td>22K</td>
<td>When the PGNS is in control and in automatic mode, the presence of a logic &quot;1&quot; at the interface is an indication to the PGNS that the new desired landing site is farther from the vehicle than the presently estimated site.</td>
</tr>
<tr>
<td>06</td>
<td>Roll Pulse Command</td>
<td>28±11</td>
<td>1K OPEN</td>
<td>22K</td>
<td>The presence of a logic &quot;1&quot; at the interface is a request to PGNS for a single minimum impulse jet firing which will cause spacecraft right handed positive angular acceleration about the roll axis when the PGNS is in control and in the attitude hold, minimum impulse mode.</td>
</tr>
<tr>
<td>07</td>
<td>+LPD AZ</td>
<td>28±11</td>
<td>1K OPEN</td>
<td>22K</td>
<td>When the PGNS is in control and in automatic mode, the presence of a logic &quot;1&quot; at the interface is an indication to the PGNS that the new desired landing site is to the right of the presently estimated site.</td>
</tr>
<tr>
<td></td>
<td>+Roll Pulse Command</td>
<td>28±11</td>
<td>1K OPEN</td>
<td>22K</td>
<td>The presence of a logic &quot;1&quot; at the interface is a request to PGNS for a single minimum impulse jet firing which will cause spacecraft right handed negative angular acceleration about the roll axis when the PGNS is in control and in the attitude hold, minimum impulse mode.</td>
</tr>
<tr>
<td>SIGNAL</td>
<td>LOGIC</td>
<td>DC VOLT</td>
<td>SOURCE</td>
<td>OHMS</td>
<td>LOAD</td>
</tr>
<tr>
<td>--------</td>
<td>--------</td>
<td>----------</td>
<td>--------</td>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>LEVEL</td>
<td>&quot;1&quot;</td>
<td>+10%</td>
<td>&quot;0&quot;</td>
<td>-10%</td>
<td>&quot;1&quot;</td>
</tr>
</tbody>
</table>

**FUNCTIONAL DESCRIPTION**

- **LPD**
- **AZ**
- Pulse Command

When the PONS in automatic mode, an indication to the PONS that the new desired landing site is to the left of the presently established site.

- **X**
- **OPEN**
- **2K**

The presence of either a logic "1" at the interface or a request to PONS for a single minimum impulse jet which will cause spacecraft right handed negative angular acceleration about the yaw axis.

In automatic mode, the presence of a logic "1" at the interface is an indication to the PONS that the new desired landing site is to the left of the presently established site.