

**GRUMMAN AIRCRAFT ENGINEERING CORPORATION**  
**BETHPAGE, L. I., NEW YORK**

SECTION III

Attitude Hand Controller

Sig. Ref.      Figure

C1	12	Pitch Rate Command
C2	12	Roll Rate Command
C3	12	Yaw Rate Command
C4	13	+Pitch Pulse Command (+LPD EL)
C5	13	-Pitch Pulse Command (-LPD EB)
C6	13	+Roll Pulse Command (+LPD AZ)
C7	13	-Roll Pulse Command (-LPD AZ)
C8	13	+Yaw Pulse Command
C9	13	-Yaw Pulse Command

C1, C2, & C3

Source Description

Source Impedance:	(21 ± 15%) + (j 25.5 ± 10%) OHMS
Out of detent indication:	1 1/4 degrees ± 3/4 degree
Null voltage:	30 millivolts RMS max. with 10K OHM load.
Quadrature voltage:	20 millivolts RMS max. with 10K OHM load.
Scale factor:	2.8 volts +0.14v RMS at θ = 10 degrees -0.00v hand controller position (soft stop) with 10K OHM load.
Rate command:	See sheet 27.
Excitation:	200 cps (PGNS 300 cps)
Phase Shift:	0° ± 10° max. into a 10K OHM load.
Linearity:	5%

Load Description

Load impedance:	2K-20K OHMS non-linear. (Effectively 8K OHMS when not reading).
Quantization:	42 states per 10 degrees.
Linearity:	±10% for $3/4^\circ < \theta < 10^\circ$ .
Sample rate:	5-8 per second.

C4 - C9

Signal levels, source and load impedances are specified with respect to the LGC Return (interface connector P/J 222 Pin G).

LGC isolation resistors are included in the source impedance.

TDRK 38154

JUN 11 1970

INTERFACE CONTROL DOCUMENT

SHEET  
26 OF 14

ICD NO.

LIS 370-10004

REV

D

**GRUMMAN AIRCRAFT ENGINEERING CORPORATION  
BETHPAGE, L.I., NEW YORK**

Signals C1, 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).

C1 - C3

Phase relationships are specified with respect to the 28V 800 CPS excitation supplied by PGNS (interface connector P/J 219 Pin 63(HI) and pin 38 (LO) ) with Lo as reference.

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

C1, C2 & C3

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

$$\text{Rate Command} = \frac{7.15E \text{ degrees/second}}{\text{VRMS}}$$

where E = hand controller voltage in volts RMS.

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

$$\text{Rate Command} = \frac{K_1 (7.15E) \text{ degrees/second}}{\text{VRMS}}$$

where  $K_1 = 1$  for normal ACA scaling

$K_1 = 0.2$  for fine ACA scaling

E = hand controller voltage in volts RMS.

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

$$\text{Rate Command} = K_2 \left[ \frac{1.43E \text{ degrees/sec} + 2.04E^2 \text{ degrees/sec}}{\text{VRMS}} \right] \frac{1}{\text{V}^2 \text{RMS}}$$

where  $K_2 = 1$  for normal ACA scaling (LM only)

$K_2 = 0.2$  for fine ACA scaling (LM only)

$K_2 = 0.1$  for normal ACA scaling (LM/CSM)

$K_2 = 0.02$  for fine ACA scaling (LM/CSM)

E = hand controller voltage in volts RMS

# 4

TDRE 38154

JUN 11 1970

GRUMMAN AIRCRAFT ENGINEERING CORPORATION  
BETHPAGE, L. I., NEW YORK

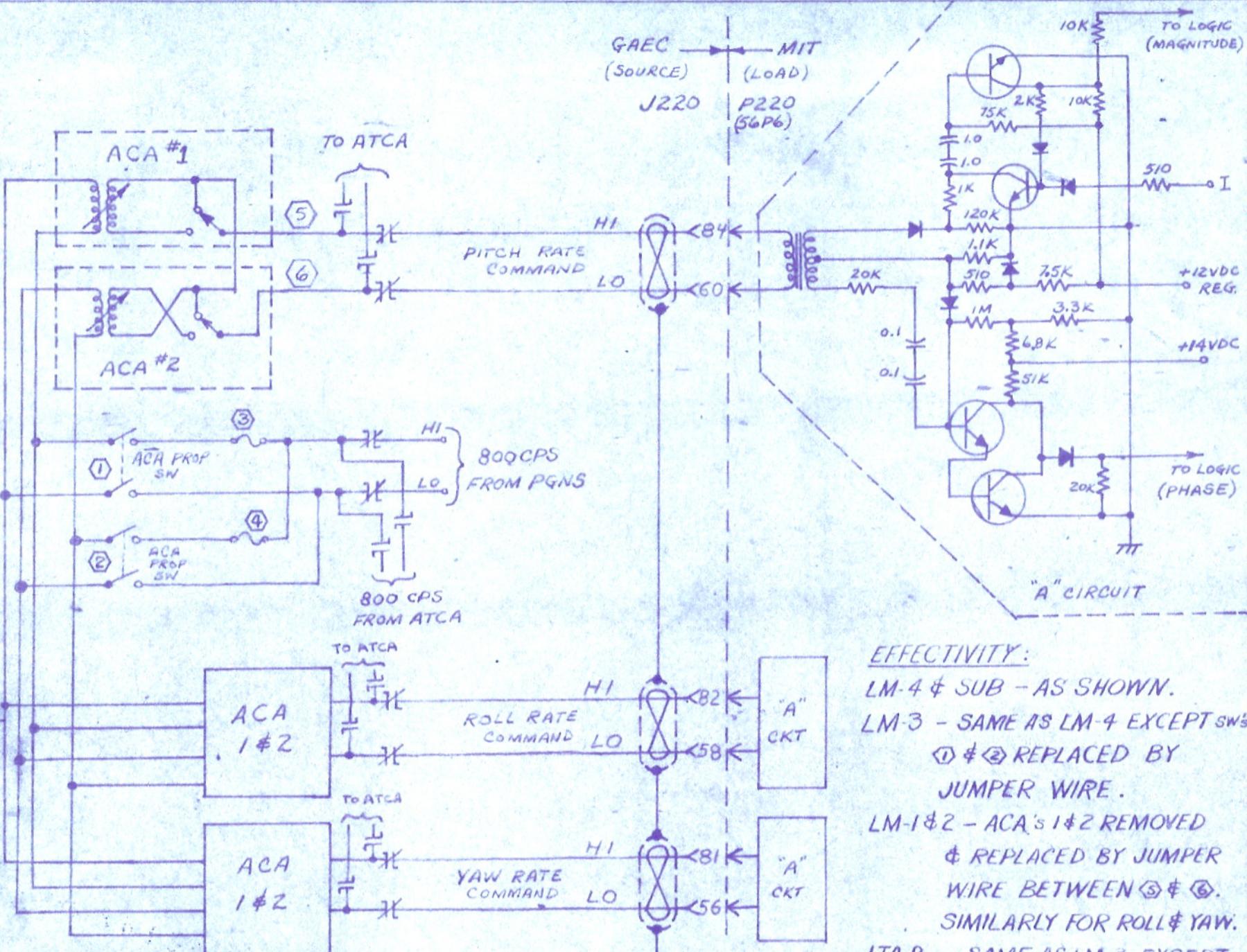
114169

INTERFACE CONTROL DOCUMENT

SHEET 28 OF 14

ICD NO. LIS 370-10004

CDRR 38154  
REV D



EFFECTIVITY:

LM-4 & SUB - AS SHOWN.

LM-3 - SAME AS LM-4 EXCEPT SW's  
① & ② REPLACED BY  
JUMPER WIRE.

LM-1&2 - ACA's 1#2 REMOVED  
& REPLACED BY JUMPER  
WIRE BETWEEN ⑤ & ⑥.  
SIMILARLY FOR ROLL & YAW.

ITA-8 - SAME AS LM-3 EXCEPT  
FUSES ③ & ④ REPLACED  
BY JUMPER.

Fig. 12

RATE COMMANDS  
JUN 11 1970

**GRUMMAN AIRCRAFT ENGINEERING CORPORATION  
BETHPAGE, L.I., NEW YORK**

INTERFACE CONTROL DOCUMENT	ID	SIGNAL	FUNCTIONAL DESCRIPTION
		ICD NO.	REV
	01-	Pitch Rate Command	<p>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 800 cps reference (high with respect to low) and shall cause rotation in a right handed positive direction about the vehicle +pitch axis (+Y) when PGNS is in control and in attitude hold mode.</p> <p>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 800 cps voltage reference (high with respect to low) and shall cause rotation in a right handed negative direction about the vehicle +pitch (+Y) axis.</p>
	02-	Roll Rate Command	<p>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 800 cps reference (high with respect to low) and shall cause rotation in a right handed positive direction about the vehicle +roll (+Z) when PGNS is in control and in attitude hold mode.</p> <p>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 800 cps voltage reference (high with respect to low) and shall cause rotation in a right handed negative direction about the vehicle +roll (+Z) axis.</p>
	03	Yaw Rate Command	<p>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 800 cps reference (high with respect to low) and shall cause rotation in a right handed positive direction about the vehicle +yaw axis (+X) when PGNS is in control and in attitude hold mode.</p> <p>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 800 cps voltage reference (high with respect to low) and shall cause rotation in a right handed negative direction about the vehicle +yaw (+X) axis.</p>

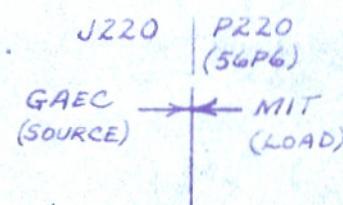
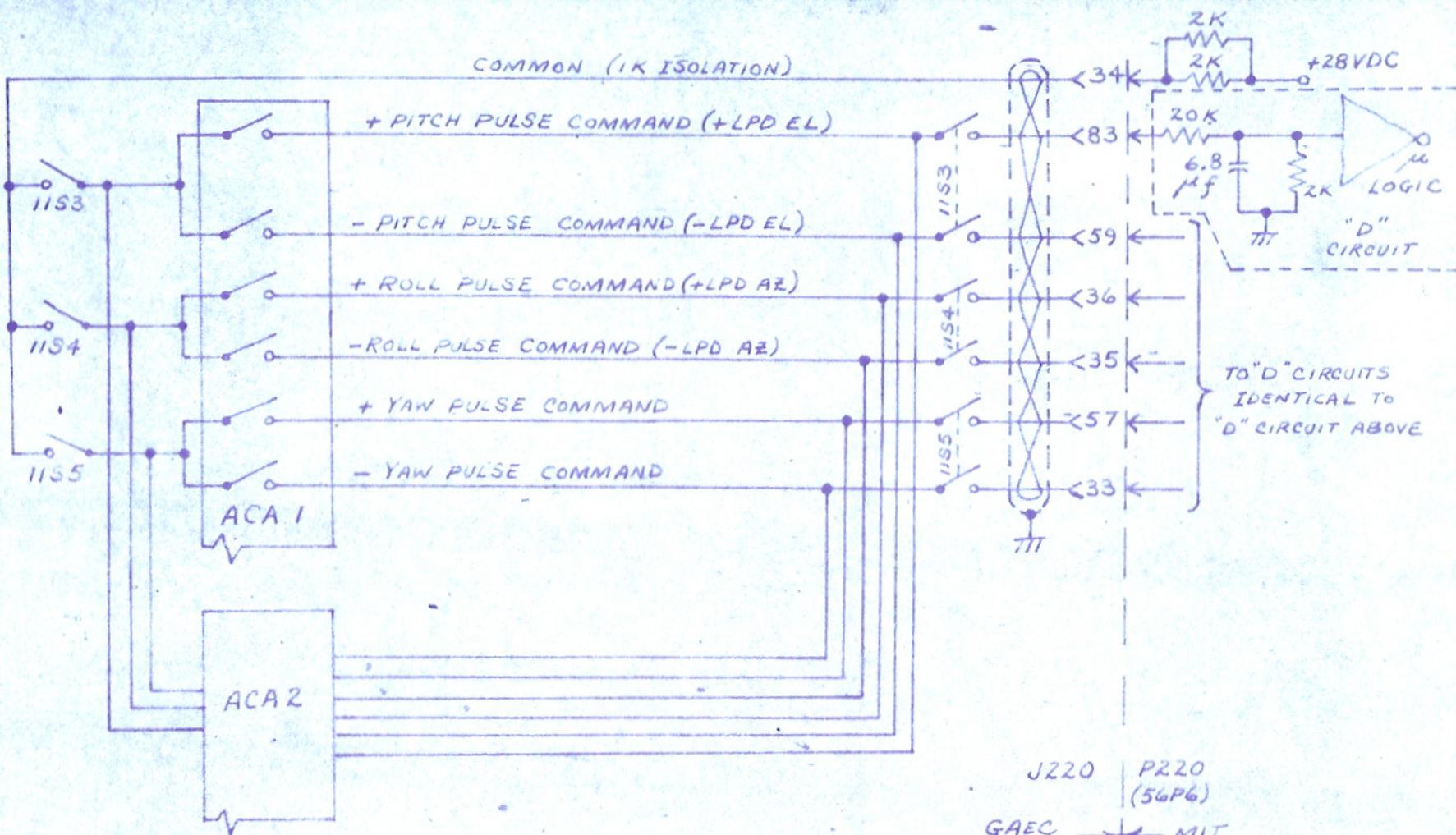
SHEET OF 14

D

TDRR 38154

JUN 1 1970

GRUMMAN AIRCRAFT ENGINEERING CORPORATION  
BETHPAGE, L.I., NEW YORK



Effectivity:  
ITA- 8 & LM-3 & SUB. -- As shown

LM-1 & 2 -- Same as above except ACA's 1& 2 deleted. Wiring left open.

FIG. 13  
PULSE COMMANDS

JUN 11 1970

UDRR 38154

ID	SIGNAL	SIGNAL LEVEL DC VOLTS		Z SOURCE OHMS + 10% - 10%		Z LOAD OHMS + 10% - 10%		FUNCTIONAL DESCRIPTION
		LOGIC	"1"	"0"	"1"	"0"	"1"	
C4	+Pitch Pulse Command	28±11	0±2	1K	OPEN	22K	22K	The presence of a logic "1" 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.
C4	+LPD EL	28±11	0±2	1K	OPEN	22K	22K	When the PGNCS is in control and in automatic mode, the presence of a logic "1" 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.
C5	-Pitch Pulse Command	28±11	0±2	1K	OPEN	22K	22K	The presence of a logic "1" 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.

**GRUMMAN AIRCRAFT ENGINEERING CORPORATION  
BETHPAGE, L.I., NEW YORK**

ID	SIGNAL	SIGNAL LEVEL DC VOLTS		Z SOURCE OHMS $\pm$ 10%		Z LOAD OHMS $\pm$ 10%		FUNCTIONAL DESCRIPTION	
		LOGIC	"1"	"0"	"1"	"0"	"1"		
05	-LPD EL		28±11	0±2	1K	OPEN	22K	22K	When the PGNS is in control and in automatic mode, the presence of a logic "1" 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.
06	+Roll Pulse Command		28±11	0±2	1K	OPEN	22K	22K	The presence of a logic "1" 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.
06	+LPD AZ		28±11	0±2	1K	OPEN	22K	22K	When the PGNS is in control and in automatic mode, the presence of a logic "1" at the interface is an indication to the PGNS that the new desired landing site is to the right of the presently estimated site.
07	-Roll Pulse Command		28±11	0±2	1K	OPEN	22K	22K	The presence of a logic "1" 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.

INTERFACE CONTROL DOCUMENT	ID	SIGNAL	SIGNAL	LEVEL	Z SOURCE	Z LOAD	FUNCTIONAL DESCRIPTION			
			LOGIC	DC VOLTS	OHMS $\pm 10\%$	OHMS $\pm 10\%$				
	C7	-LPD AZ	"1"	28±11	0±2	1K	OPEN	22K	22K	When the PGNS is in control and in automatic mode, the presence of a logic "1" at the interface is an indication to the PGNS that the new desired landing site is to the left of the presently estimated site.
	C8	+YAW Pulse Command	"1"	28±11	0±2	1K	OPEN	22K	22K	The presence of a logic "1" 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 +Yaw axis when the PGNS is in control and in the attitude hold, minimum impulse mode.
	C9	-YAW Pulse Command	"1"	28±11	0±2	1K	OPEN	22K	22K	The presence of a logic "1" 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 -Yaw axis when the PGNS is in control and in the attitude hold, minimum impulse mode.
TDRE 38154		JUN	1 1970							
SHEET 03 OF 14	ICD NO. LIS-370-10004	REV D								