

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 EL)
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:	$(21 \pm 15\%) + (j 25.5 \pm 10\%) \text{ OHMS}$
Out of detent indication:	1 1/4 degrees $\pm$ 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 $\pm 0.14\text{V}$ RMS at $\theta = 10$ degrees $-0.00\text{v}$ hand controller position (soft stop) with 10K OHM load.
Rate command:	See sheet 27.
Excitation:	300 cps (FGNS 300 cps)
Phase Shift:	$0^\circ \pm 10^\circ$ max. into a 10K OHM load.
Linearity:	5%

Load Description

Load impedance:	2K-20K OHMS non-linear. (Effectively 8K OHMS when not reading).
Quantization:	48 states per 10 degrees.
Linearity:	$\pm 10\%$ 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.

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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(HE) 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)

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

where E = hand controller voltage in volts RMS.

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

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

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)

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

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

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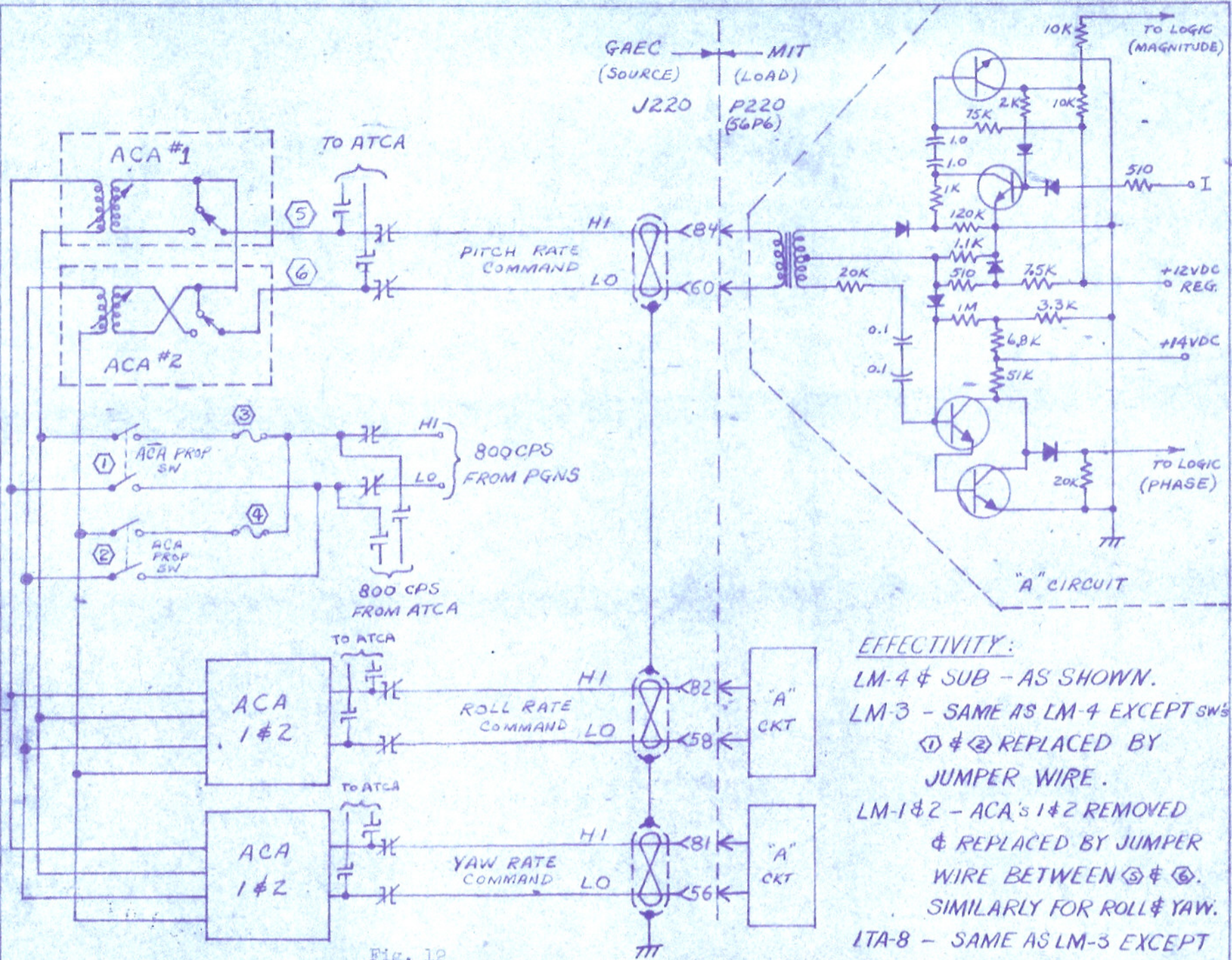


Fig. 12 RATE COMMANDS

**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.



FUNCTIONAL DESCRIPTION

ID	SIGNAL	FUNCTIONAL DESCRIPTION
C1	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>
C2	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>
C3	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>

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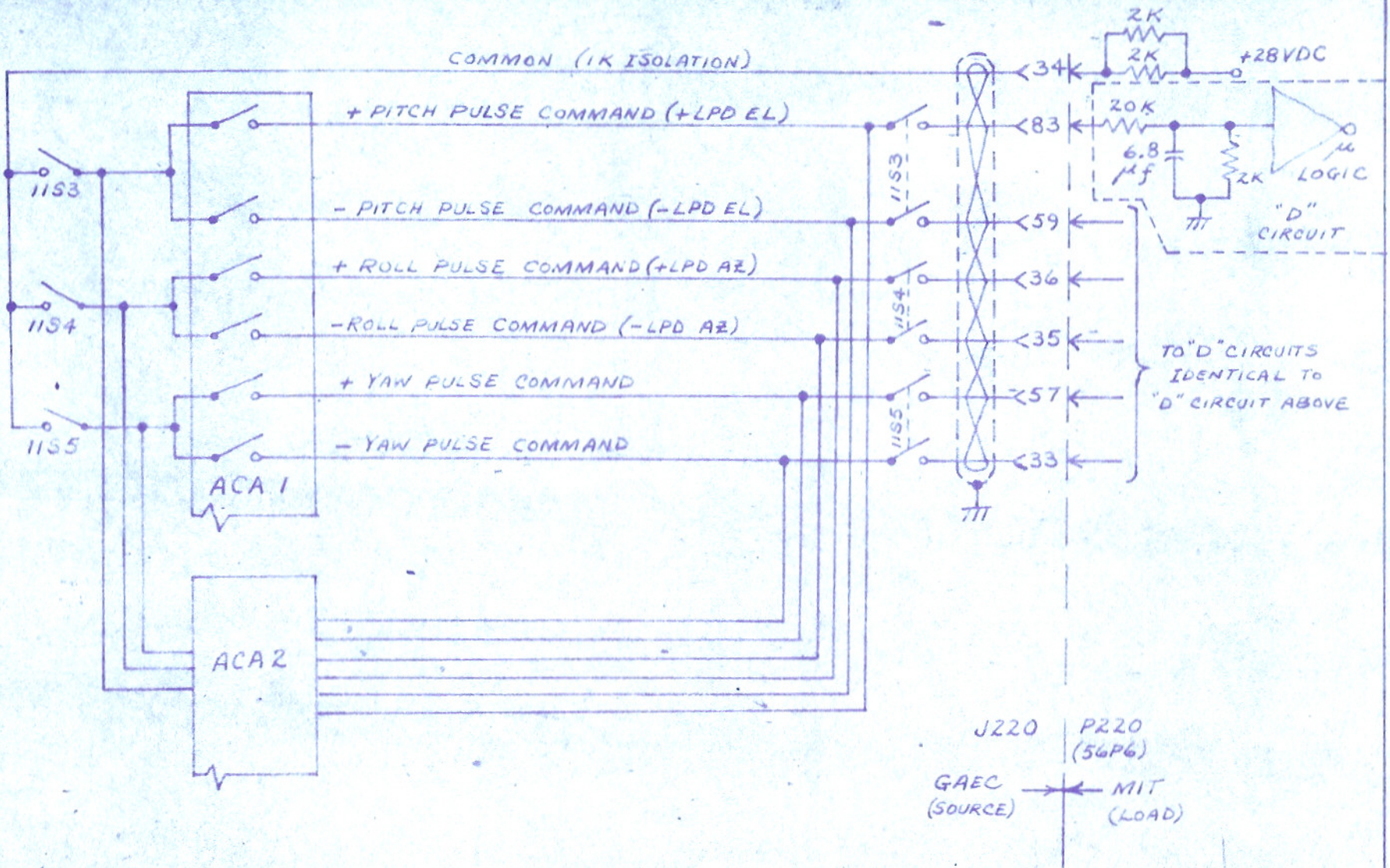


FIG. 13  
PULSE COMMANDS

Effectivity:  
 LTA- 5 & LM-3 & SUB. -- As shown  
 LM-1 & 2 -- Same as above except ACA's 1 & 2 deleted. Wiring left open.

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ID	SIGNAL	SIGNAL LEVEL DC VOLTS		Z SOURCE OHMS $\pm 10\%$		Z LOAD OHMS $\pm 10\%$		FUNCTIONAL DESCRIPTION	
		LOGIC	"1"	"0"	"1"	"0"	"1"		"0"
04	+Pitch Pulse Command		28±11	0±2	1K	OPEN	22K	22K	The presence of a logic "1" at the interface is a request to PGNCB for a single minimum impulse jet firing which will cause spacecraft right handed positive angular acceleration about the +pitch axis when the PGNCB is in control and in the attitude hold, minimum impulse mode.
04	+LPD EL		28±11	0±2	1K	OPEN	22K	22K	When the PGNCB is in control and in automatic mode, the presence of a logic "1" at the interface is an indication to the PGNCB that the new desired landing site is nearer to the vehicle than the presently estimated site.
	-Pitch Pulse Command		28±11	0±2	1K	OPEN	22K	22K	The presence of a logic "1" at the interface is a request to PGNCB for a single minimum impulse jet firing which will cause spacecraft right handed negative angular acceleration about the +pitch axis when the PGNCB is in control and in the attitude hold, minimum impulse mode.

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ID	SIGNAL	SIGNAL LEVEL DC VOLTS		Z SOURCE OHMS $\pm 10\%$		Z LOAD OHMS $\pm 10\%$		FUNCTIONAL DESCRIPTION	
		LOGIC	"1"	"0"	"1"	"0"	"1"		"0"
05	-LPD RL		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.

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ID	SIGNAL	SIGNAL LEVEL DC VOLTS		Z SOURCE OHMS $\pm$ 10%		Z LOAD OHMS $\pm$ 10%		FUNCTIONAL DESCRIPTION	
		LOGIC	"1"	"0"	"1"	"0"	"1"		"0"
C7	-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 left of the presently estimated site.
C8	+YAW 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 +Yaw axis when the PGNS is in control and in the attitude hold, minimum impulse mode.
C9	-YAW 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 -Yaw axis when the PGNS is in control and in the attitude hold, minimum impulse mode.

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