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DESIGN OF A SIMULATED CRUISE SCENE VISUAL ATTACHMENT

VOLUME II

MAJOR AND CRITICAL COMPONENT SPECIFICATIONS

D3-8464-2

DECEMBER 1970

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THE **BOEING** COMPANY
WICHITA DIVISION - WICHITA, KANSAS, 67210

IG701009

**DESIGN
OF A
SIMULATED CRUISE SCENE
VISUAL ATTACHMENT**

VOLUME II

**MAJOR AND CRITICAL COMPONENT
SPECIFICATIONS**

D3-8464-2

**THE BOEING COMPANY
WICHITA DIVISION, WICHITA, KANSAS**

ABSTRACT

Volume II provides the specifications of major and/or critical components selected as design guides. The hardware used to assemble the system is compatible with the components listed and where a parameter is critical to the performance of the system it is noted by an asterisk.

PREFACE

Volume II presents specifications of major and critical components required to construct the simulator cruise scene visual attachment described in the design report (Volume I, D3-8464-1) and the assembly and detail drawings report (Volume III, D3-8464-3). These three volumes form a complete report on all work conducted by the Wichita Division of The Boeing Company under Task III of NASA-Ames Contract NAS2-5524, "Visual Attachment for Simulated Cruise Scene." The National Aeronautics and Space Administration Technical Monitor was Mr. John C. Dusterberry of the Simulation Science Division. The Boeing Company Project Leader was Mr. C. Rodney Hanke of the Stability, Control and Flying Qualities Organization, Wichita Division.

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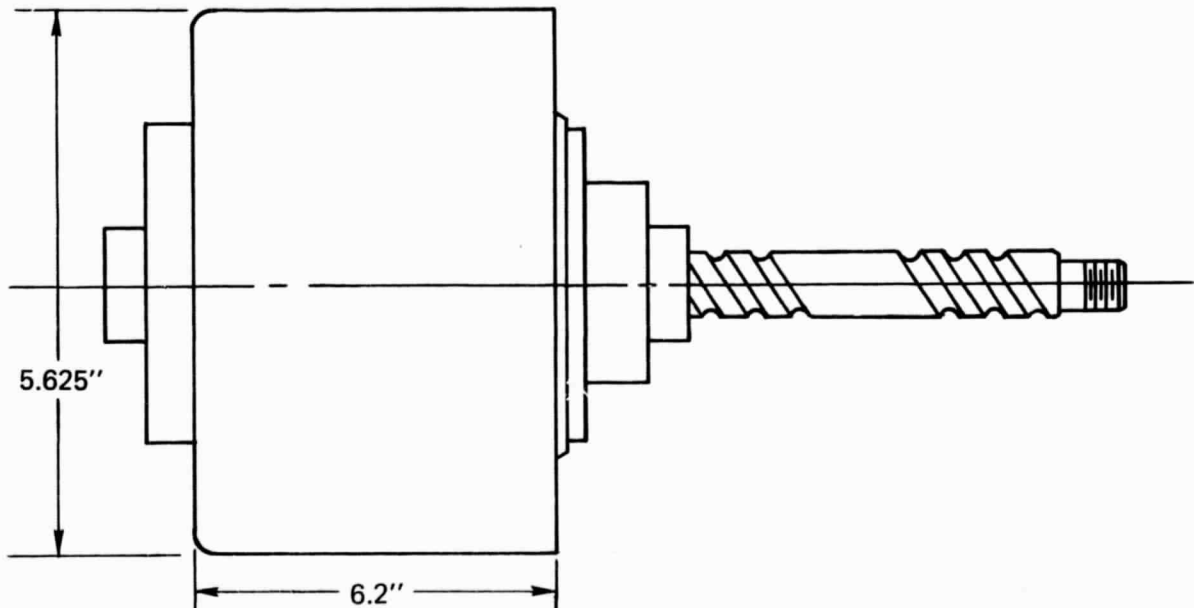
ACTUATOR, LINEAR PITCH

Magnetic Technology Company

Model No. GA 5125-220-590 with 5125B-058 tachometer

Parameter	Unit	Value
Lead	Inches	.590
Thrust @ T_p	Pounds	598 *
Max. Screw Loads	Pounds	2000
No Load Linear Speed	In/Sec	2 *
Acceleration @ T_p	In/Sec ²	290
Power Input @ T_p	Watts	140
Electrical Time Constant	Sec	.003

Motor specifications and tachometer specifications are listed separately.



* Critical to application — if equivalent components are used, variations in these parameters can cause significant system changes.

AMPLIFIERS, HEADING AND PITCH AXES

Control Systems Research

Model 500 PRA

PARAMETERS:	UNITS:	VALUE:
Power Output	Watts	500
Current, Max (i_a)	Amps	± 25 *
Output Voltage (V_a)	Volts	± 25 *
Supply Voltage	Volts (AC)	115
Drift	μ Volts/ $^{\circ}$ C	20
Type of Construct.	Chassis	—
Gain (Open Loop)	dB	100
Gain (Closed Loop)	Externally Adjustable	— *
Temperature Limits	$^{\circ}$ C	0-50
Output Impedance	Ohms	.05
Output Current Limits	Heading, Amps	± 25 *
	Pitch, Amps	± 6.75 *

*Critical to application – if equivalent components are used, variations in this parameter can cause significant system changes.

AMPLIFIER, ROLL AXIS

**Control Systems Research
Model 500 PMA**

PARAMETERS:	UNITS:	VALUE:
Power Output	Watts	200
Current, Max (i_a)	Amps	± 8.5 *
Output Voltage (V_a)	Volts	± 23 *
Supply Voltage	Volts (AC)	115
Drift	μ Volts/ $^{\circ}$ C	20
Type of Constr.	Modular	—
Gain (Open Loop)	dB	100
Gain (Closed Loop)	Externally Adjustable	— *
Temperature Limits	$^{\circ}$ C	0-50
Output Impedance	Ohms	.05
Output Current Limit	Amps	± 8.47 *

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CAMERA, VIDICON

Maryland Telecommunications, Inc.

Model VC-21 Vidicon Camera Specifications

Electrical

Scanning Rates:

Horizontal: 525 lines, 2:1 interlace 15,750 Hz scanning frequency.

Vertical: 30 frames/sec with 60 Hz scanning rate.

Resolution:

* Horizontal: minimum of 800 TV lines in center, 600 TV lines in corners.

* Vertical: 375 TV lines.

Video Bandwidth:

10 MHz.

Sensitivity:

Provides minimum of 800 line resolution from 0.5 footcandles Vidicon faceplate illumination.

Vidicon Type:

MTI Type V-440, separate mesh, low heater power, manufactured per MTI drawing number 46-11158-1.

Sweep Linearity:

1% or better overall.

Geometric Distortion:

Limited by lens.

Video Output:

Black negative, 1.0 volt p-p composite with sync equal to 30% or 1.4 volt p-p.

Video Output Impedance:

75 ohms \pm 5%

CAMERA, VIDICON

Gray Scale:

10 shades of gray.

Quantum Light Sensor:

Automatically maintains constant video level over light level changes of 4000:1 with only nominal change over light level changes of 20,000:1, manual override provided for setting by operator as required.

Vidicon Protection:

Fully transistorized, constant horizontal and vertical sweep sampling, biasing vidicon to cut off in the event of either sweep failure.

Input Power:

100 to 130 VAC, 60 Hz, approximately 38 watts.

Set Up (Pedestal):

Fully automatic pedestal control to compensate for variations in vidicon dark current.

Vidicon Filament:

Over voltage protected and current regulated.

Operating Temperature Range:

0°C to 55°C.

Mechanical

Size:

Camera: 10.3 inches long x 2.75 inches high x 2.75 inches wide (overall dimensions).

C. C. U.: 5.25 inch high front panel with 17 inch wide chassis for mounting in a standard 19 inch equipment rack x 14.5 deep (overall dimensions).

Weight:

* Camera: 3.5 pounds (less lens).

C.C.U.: 17.5 pounds.

CAMERA, VIDICON

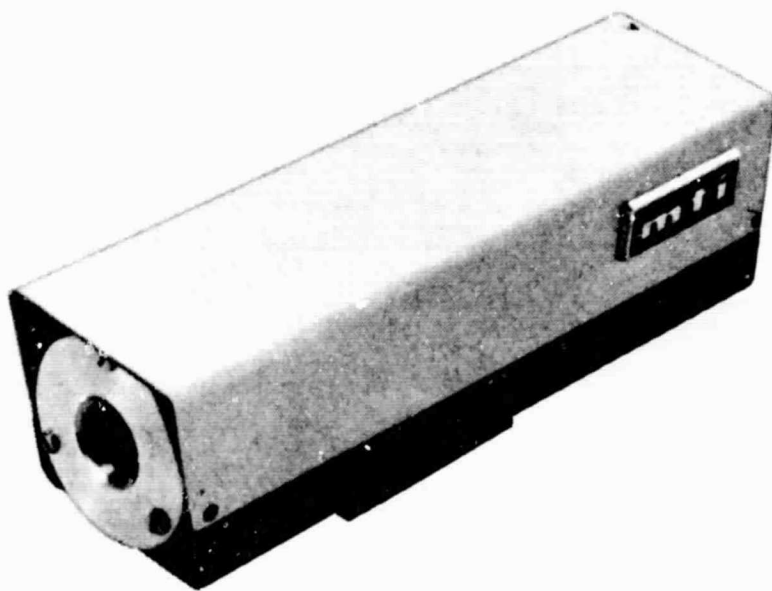
Mounting:

Camera: standard 1/4 inch x 20 tapped steel insert.

C.C.U.: standard 19 inch equipment rack.

Lens Mount:

- * Standard "C" mount for a single 16mm lens.



* Critical to application – if equivalent components are used, variations in these parameters can cause significant system changes.

LAMP, SCENE ILLUMINATION

G. E. Model 1383, R-12 Bulb

PERFORMANCE DATA

PARAMETER:	UNIT:	VALUE:
Illumination	Candle Power	225 *
Power	Watts	20
Rated Voltage	Volts	13
Rated Life	Hours	300
Base	S. C. Bayonet	—
Filament	C-8	—
Length	Inches	2-5/8"
Illumination Angle @ 3.4dB	Degrees	$\pm 50^{\circ}$ *
Bulb Type	Frosted	—

* Critical to application – if equivalent components are used, variations in these parameters can cause significant system changes.

LENS, VIDICON CAMERA
Angenieux Corporation of America
Wide Angle R-7

PARAMETER:	UNIT:	VALUE:
Focal Length	mm	5.9 *
Speed	—	f/2.5
Coverage	mm	16 *
Mount	—	"C" *
Horizontal Field-of-View	degrees	80°
Vertical Field-of-View	degrees	60°
Transmission	percent	79
Weight	oz	14
Distortion	percent	< 5

* Critical to application – if equivalent components are used, variations in these parameters can cause significant system changes.

MOTOR, HEADING AXIS**D. C. Torque Motor
Inland Motor Corporation
Model T-5730-A**

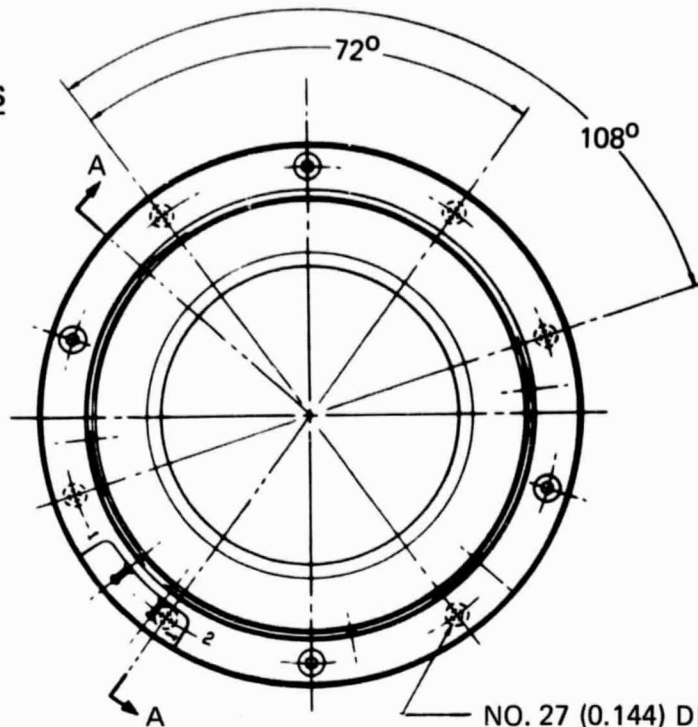
PERFORMANCE DATA		
PARAMETER:	UNIT:	VALUE:
Peak Torque (T_p)	oz-in	1350 *
Power at T_p (W_p)	watts	260 *
No Load Speed (ω_H)	rad/sec	27 *
Total Breakaway Torque (T_F)	oz-in	13.50
Ripple Torque (T_N)	% (avg to pk)	4
Ripple Frequency	cycles/rev	79
Temperature Rise	$^{\circ}\text{C}/\text{watt}$	2.0
Max. Allowable Winding Temperature	$^{\circ}\text{C}$	105
Moment of Inertia (I_H)	oz-in-sec ²	0.96
Weight	oz	116
Damping Factor (F_D)	oz-in/rad/sec	50.0
Elect Time Constant (τ_e)	sec	0.0027
Mech Time Constant (τ_m)	sec	0.020
Motor Constant (K_M)	oz-in/ $\sqrt{\text{watts}}$	83
Max. Theoretical Acceleration (α_H)	rad/sec ²	1400
Max. Power Rate (\dot{P})	oz-in/sec ²	9600

MOTOR, HEADING AXIS

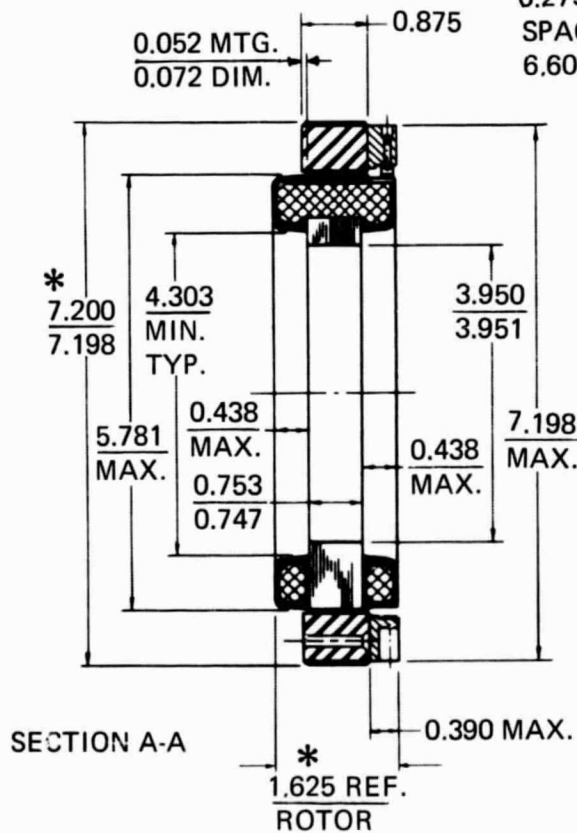
WINDING CONSTANTS

Motor			
PARAMETER:	UNITS:	TOL:	VALUE:
Resistance* (R_a)	ohms	$\pm 12.5\%$	1.5 *
Voltage at T_p (V_p)	volts	ref	19.8 *
Current at T_p (i_a)	amps	rated	13.2 *
Torque Sensitivity (K_T)	oz-in/amp	$\pm 10\%$	102
Back E.M.F. (K_B)	volts/rad/sec	$\pm 10\%$	0.72
Inductance (L_a)	millihenries	$\pm 30\%$	5.0

MOTOR, HEADING AXIS



NO. 27 (0.144) DIA. THRU
COUNTERSINK 82° TO
0.275 MIN. DIA. (6) HOLES
SPACED AS SHOWN ON
6.600 DIA. B.C.



* Critical to application – if equivalent components are used, variations in these parameters can cause significant system changes.

MOTOR, PITCH AXIS
Magnetic Technology
Model No. 5125-220-008

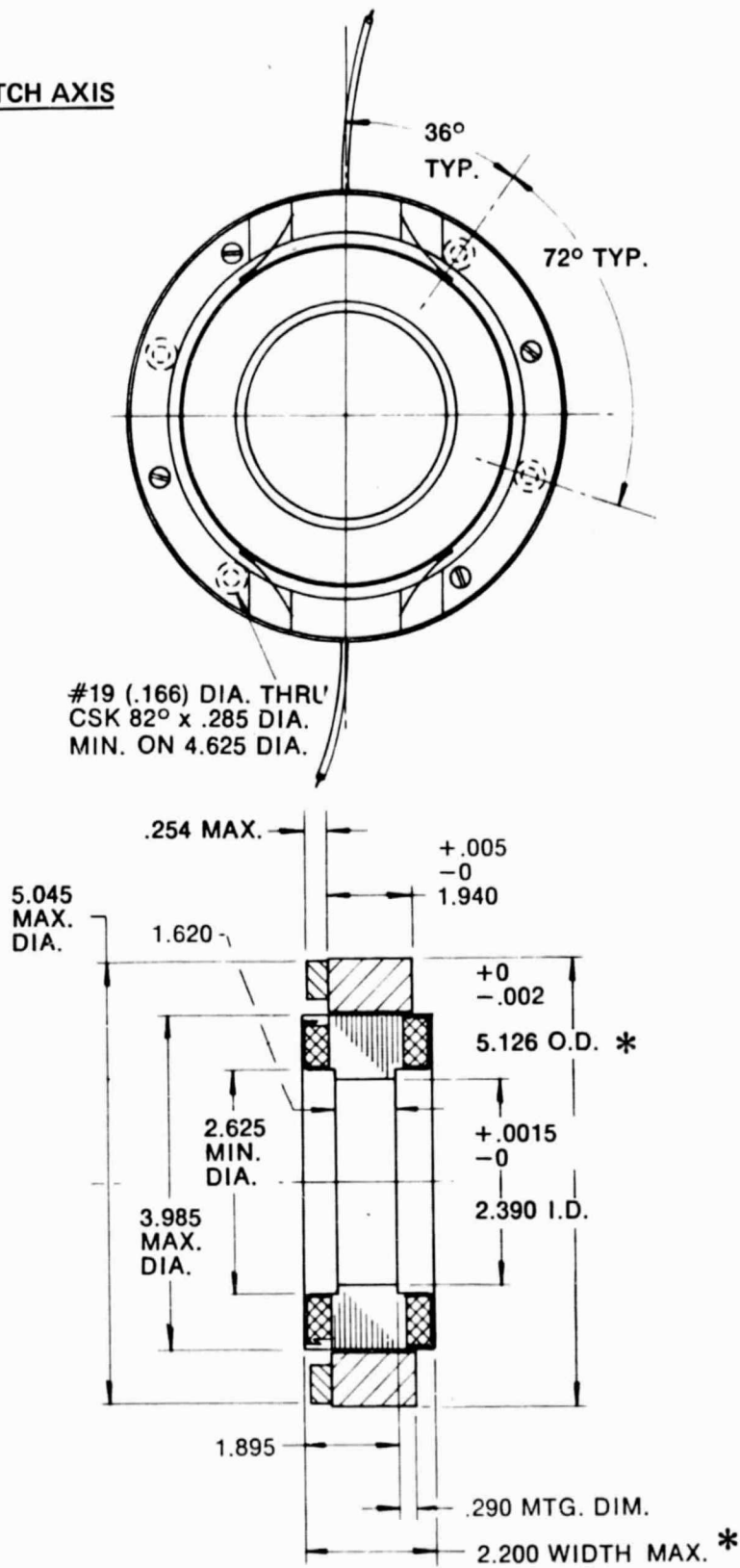
PERFORMANCE DATA		
PARAMETER:	UNIT:	VALUE:
Peak Torque (T_p)	oz-in	1000 *
Power at T_p (W_p)	watts	140 *
No Load Speed (ω_{NL})	rad/sec	19 *
Total Breakaway Torque (T_F)	oz-in	20
Ripple Torque (T_N)	% (avg to pk)	5
Ripple Frequency	cycles/rev	51
Temperature Rise	$^{\circ}\text{C}/\text{watt}$.8
Max. Allowable Winding Temperature	$^{\circ}\text{C}$	130
Moment of Inertia (I_p)	oz-in-sec ²	.36
Weight	oz	122
Damping Factor (F_D)	oz-in/rad/sec	52.6
Elect Time Constant (τ_e)	sec	.003
Mech Time Constant (τ_m)	sec	.007
Motor Constant (K_M)	oz-in/ $\sqrt{\text{watts}}$	84.7
Max. Theoretical Acceleration (α_p)	rad/sec ²	2780
Max. Power Rate (\dot{P})	oz-in/sec ²	2,780,000

MOTOR, PITCH AXIS

WINDING CONSTANTS

Motor			
PARAMETER:	UNITS:	TOL:	VALUE:
Resistance (R_a)	ohms	$\pm 12.5\%$.80 *
Voltage at T_p (V_p)	volts	ref	10.7 *
Current at T_p (i_a)	amps	rated	13.4 *
Torque Sensitivity (K_T)	oz-in/amp	$\pm 10\%$	74.5
Back E.M.F. (K_B)	volts/rad/sec	$\pm 10\%$.53
Inductance (L_a)	millihenries	$\pm 30\%$	2

MOTOR, PITCH AXIS



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MOTOR, ROLL AXIS
Magnetic Technology
Model No. 5125-220-023

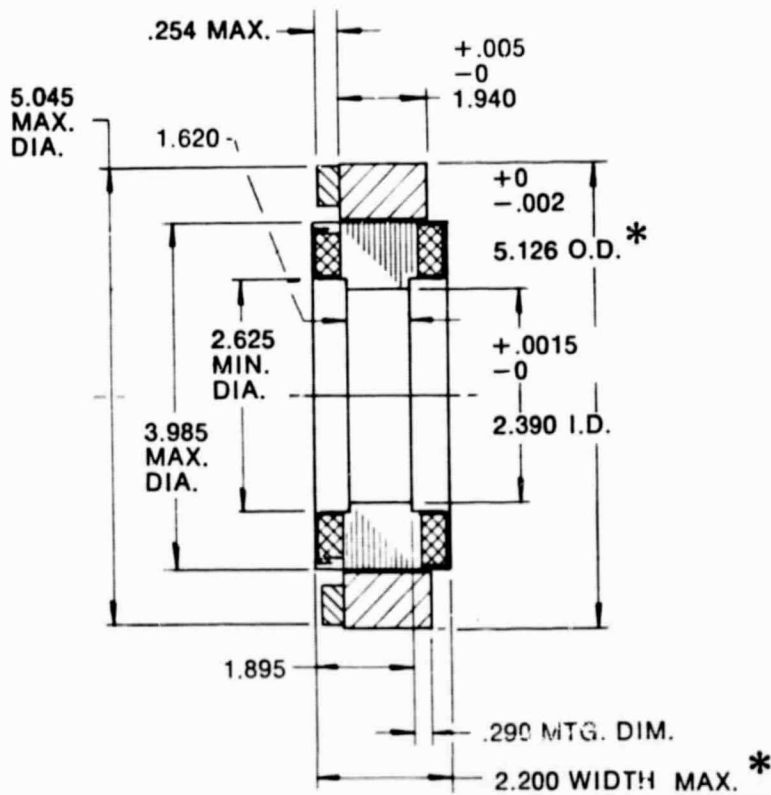
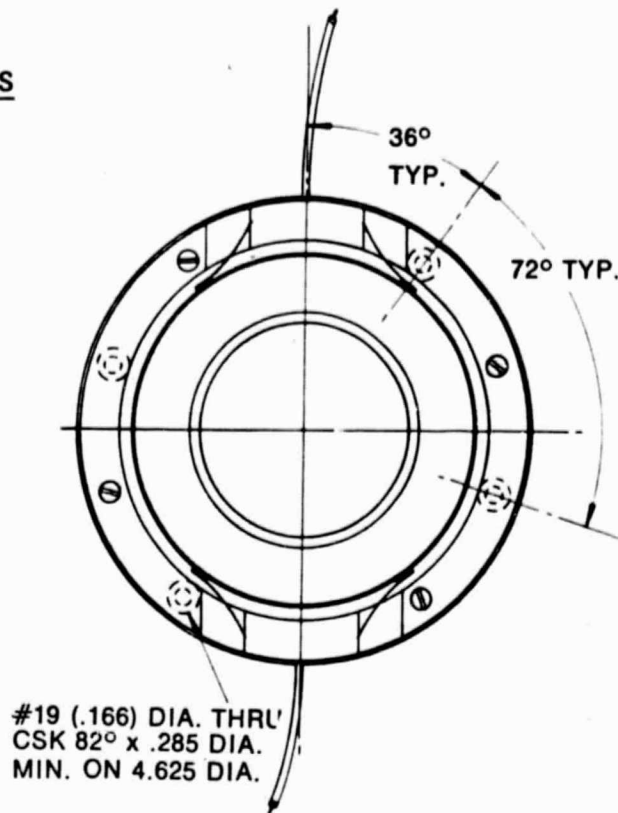
PERFORMANCE DATA		
PARAMETER:	UNIT:	VALUE:
Peak Torque (T_p)	oz-in	1000 *
Power at T_p (W_p)	watts	140 *
No Load Speed (ω_R)	rad/sec	19 *
Total Breakaway Torque (T_F)	oz-in	20
Ripple Torque (T_N)	% (avg to pk)	5
Ripple Frequency	cycles/rev	51
Temperature Rise	$^{\circ}\text{C}/\text{watt}$.8
Max. Allowable Winding Temperature	$^{\circ}\text{C}$	130
Moment of Inertia (I_R)	oz-in-sec ²	.36
Weight	oz	122
Damping Factor (F_D)	oz-in/rad/sec	52.6
Elect Time Constant (τ_e)	sec	.003
Mech Time Constant (τ_m)	sec	.007
Motor Constant (K_M)	oz-in/ $\sqrt{\text{watts}}$	84.7
Max. Theoretical Acceleration (α_R)	rad/sec ²	2780
Max. Power Rate (\dot{P})	oz-in/sec ²	2,780,000

MOTOR, ROLL AXIS

WINDING CONSTANTS

Motor			
PARAMETER:	UNITS:	TOL:	VALUE:
Resistance (R_a)	ohms	$\pm 12.5\%$	2.0 *
Voltage at T_p (V_p)	volts	ref	16.9 *
Current at T_p (i_a)	amps	rated	8.47 *
Torque Sensitivity (K_T)	oz-in/amp	$\pm 10\%$	118.0
Back E.M.F. (K_B)	volts/rad/sec	$\pm 10\%$.84
Inductance (L_a)	millihenries	$\pm 30\%$	6

MOTOR, ROLL AXIS



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POTENTIOMETER, HEADING AND ROLL AXES

**Computer Instruments Corporation
Model 205**

SPECIFICATIONS:

ELECTRICAL:

Resistance Range $\pm 10\%$
 Independent Linearity or Conformity
 Electrical Function Angle $\pm 3^\circ$
 Electrical Contact Angle $+ 2^\circ - 3^\circ$
 Maximum No. of Taps
 Power Dissipation (at 25°C.)

STANDARD

50K *
 0.10% *
 350°
 356°
 —
 4 Watts

Operating Temperature Range

-55° to $+150^\circ\text{C}$

Dielectric Strength

750V RMS

MECHANICAL:

STANDARD

Mechanical Rotation

360°
 Continuous

Starting Torque in-Oz. (Max.)/Cup

0.3

Max. Weight in Oz. (Single Cup)

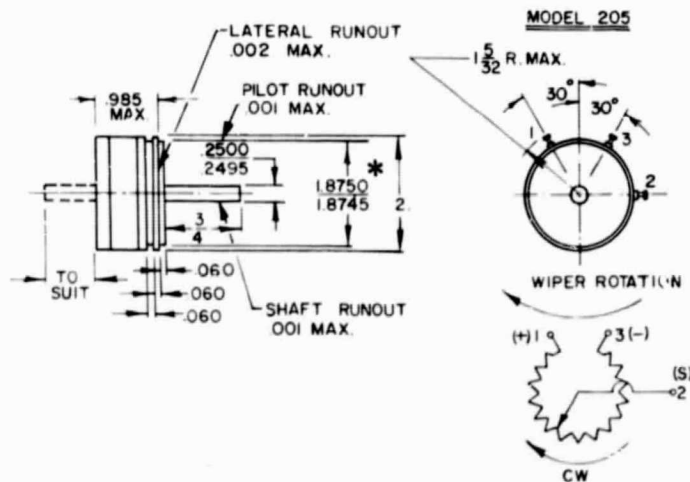
4

Additional Length Per Cup (Max.)

—

Max. Weight in Oz. (Additional Cup)

—



* Critical to application — if equivalent components are used, variations in these parameters can cause significant system changes.

POTENTIOMETER, PITCH AXIS
Computer Instruments Corporation
Model 78

SPECIFICATIONS:

ELECTRICAL:

Resistance $\pm 10\%$
 Independent Linearity or Conformity
 Electrical Function Angle $\pm 3^\circ$
 Electrical Contact Angle $\pm 3^\circ$
 Maximum No. of Taps
 Power Dissipation (at 25°C.)

STANDARD

50K *
 0.15% *
 320°
 354°
 —
 2 Watts

Operating Temperature Range

−55° to +150°C

Dielectric Strength

750V RMS

MECHANICAL:

STANDARD

Mechanical Rotation

360°
 Continuous

Starting Torque in-Oz. (Max.)/Cup

0.15

Max. Weight in Oz. (Single Cup)

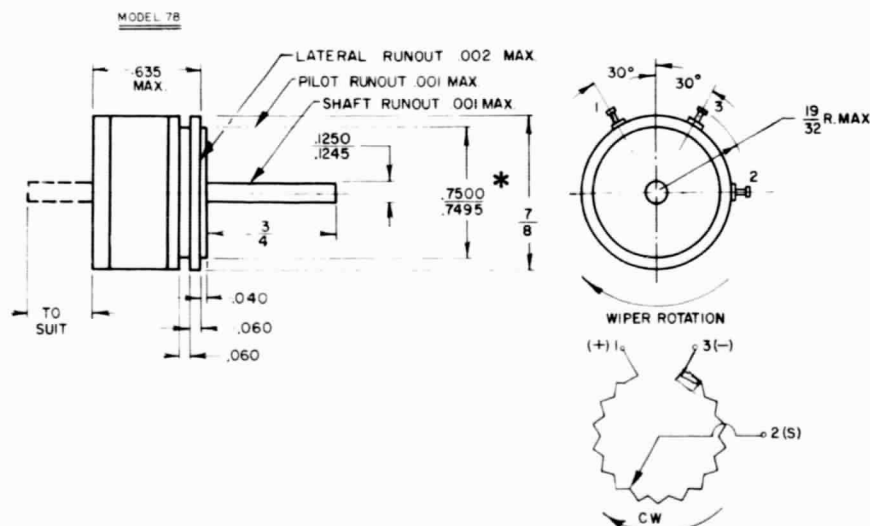
3/4

Additional Length per Cup (Max.)

—

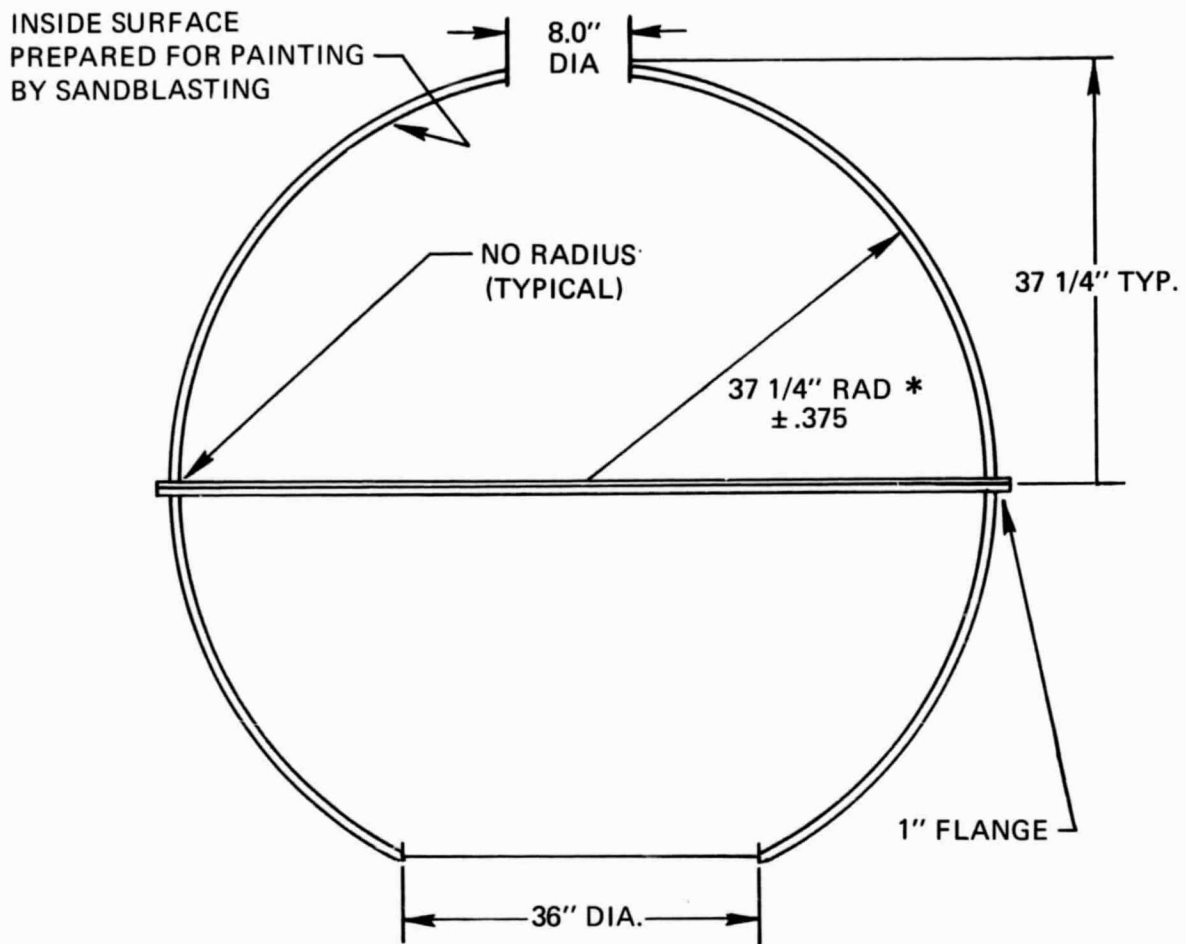
Max. Weight in Oz. (Additional Cup)

—



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SPHERE, HEADING SCENE
Ray Products



MATERIAL: 1/4" OPAQUE WHITE PLEXIGLAS

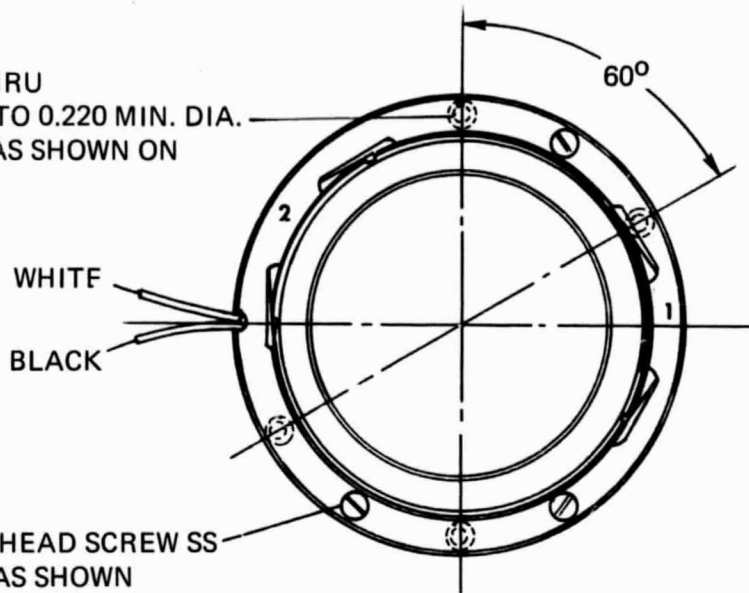
* Critical to application – if equivalent components are used, variations in these parameters can cause significant system changes.

TACHOMETER, HEADING AXIS
Inland Motor Corporation
Model TG-2801-C

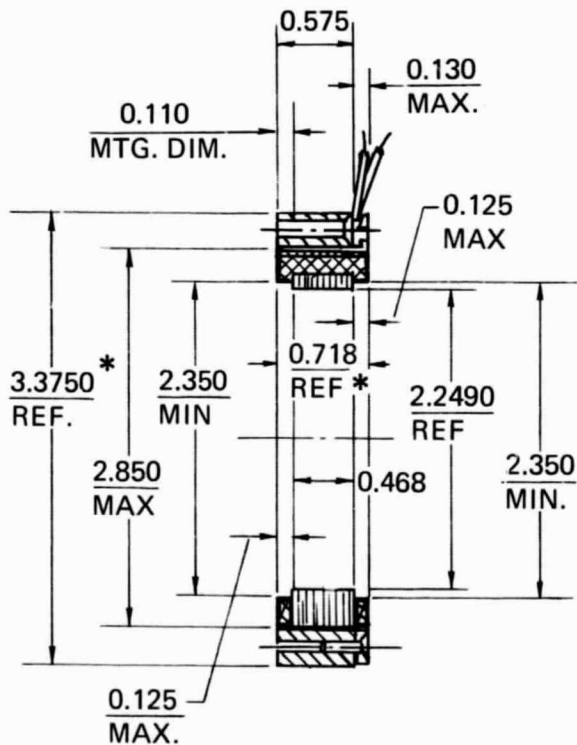
TACHOMETER GENERATOR SIZE CONSTANTS				
	UNITS		SYMBOL	VALUE
Tach generator friction torque	oz-in		T_F	2.0
Ripple voltage, average to peak	percent		E_R	4 *
Ripple cycles per revolution	cycles/rev		—	71 *
Rotor moment of inertia	oz-in-sec ²		—	0.028
Tach generator weight	oz		—	12
TACHOMETER GENERATOR WINDING CONSTANTS				
	UNITS	TOL	SYMBOL	VALUE
DC resistance (25°C)	ohms	±12.5%	R_a	108
Voltage sensitivity	volts/rad/sec	±10%	K_g	0.635
Inductance	henries	±30%	L_a	0.11
Min load resistance	ohms	nom	$R_{L(min)}$	11K
Max operating speed	rad/sec	nom	$\omega_{H(max)}$	140
Volts @ max operating speed	volts	nom	$V_a(max)$	89

TACHOMETER, HEADING AXIS

0.124 - 0.130 DIA. THRU
 82° COUNTERSINK TO 0.220 MIN. DIA.
 (4) HOLES SPACED AS SHOWN ON
 3.125 DIA. BC.



NO. 2-56 X 5/16 FLATHEAD SCREW SS
 (3) SCREWS SPACED AS SHOWN
 NO. 50 (0.070) DR 0.38 DP
 TAP NO. 2-56 X 0.25 DP MIN IN STATOR

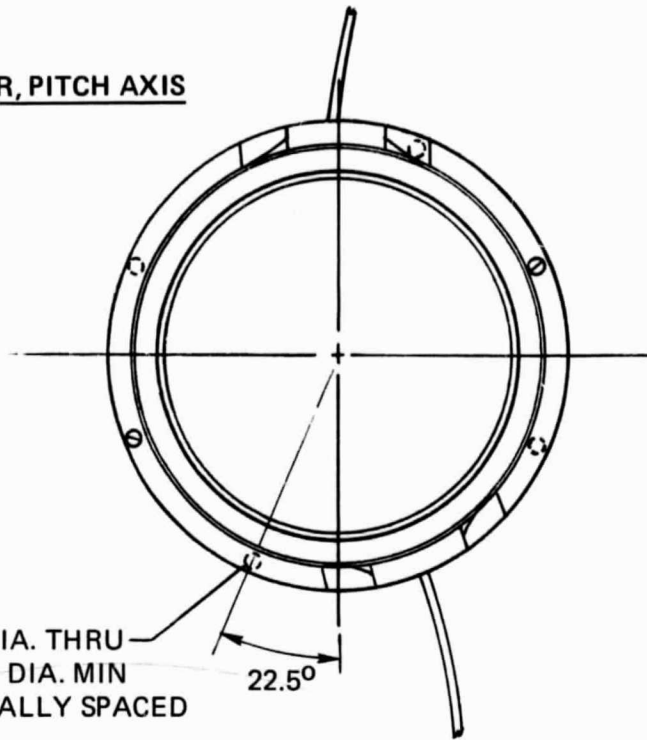


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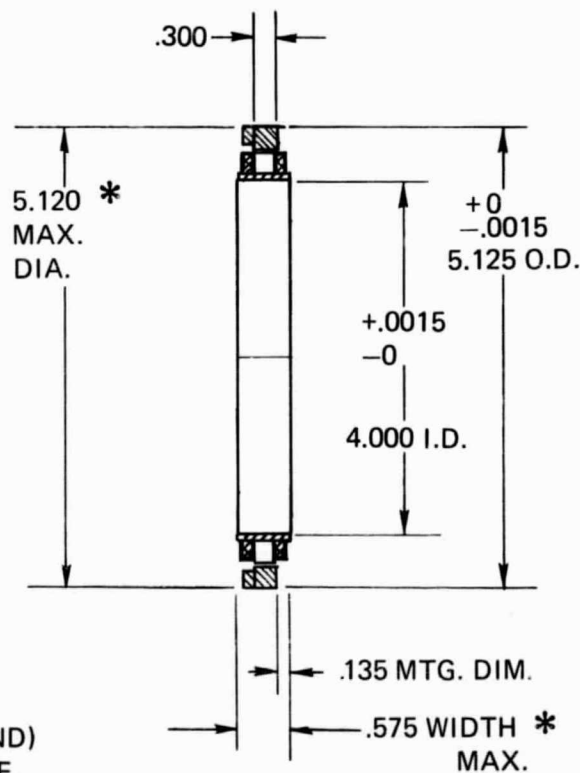
TACHOMETER, PITCH AXIS**Magnetic Technology
Model 5125B-058**

TACHOMETER GENERATOR SIZE CONSTANTS				
	UNITS		SYMBOL	VALUE
Tach generator friction torque	oz-in		T_F	2.0
Ripple voltage, average to peak	percent		E_R	6.0
Ripple cycles per revolution	cycles/rev		—	71
Rotor moment of inertia	oz-in-sec ²		I_p	0.08
Tach generator weight	oz		—	12
TACHOMETER GENERATOR WINDING CONSTANTS				
	UNITS	TOL	SYMBOL	VALUE
DC resistance (25°C)	ohms	± 12.5%	R_a	187
Voltage sensitivity	volts/rad/sec	± 10%	K_g	1.26
Inductance	henries	± 30%	L_a	0.056
Min load resistance	ohms	nom	$R_{L(min)}$	18,700
Max operating speed	rad/sec	nom	$\omega_p(max)$	60
Volts @ max operating speed	volts	nom	$V_a(max)$	75

TACHOMETER, PITCH AXIS



NO. 39 (.100) DIA. THRU
CSK 82° X .181 DIA. MIN
4 PLACES EQUALLY SPACED
ON 4.891 DIA.



ROTATION: CLOCKWISE
(VIEWED FROM BRUSH END)
WITH RED LEAD POSITIVE.

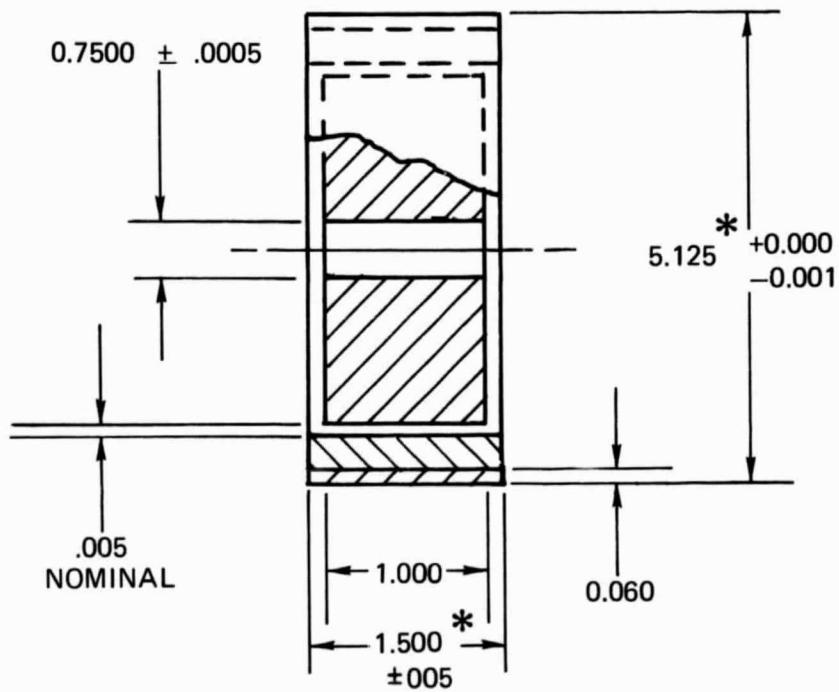
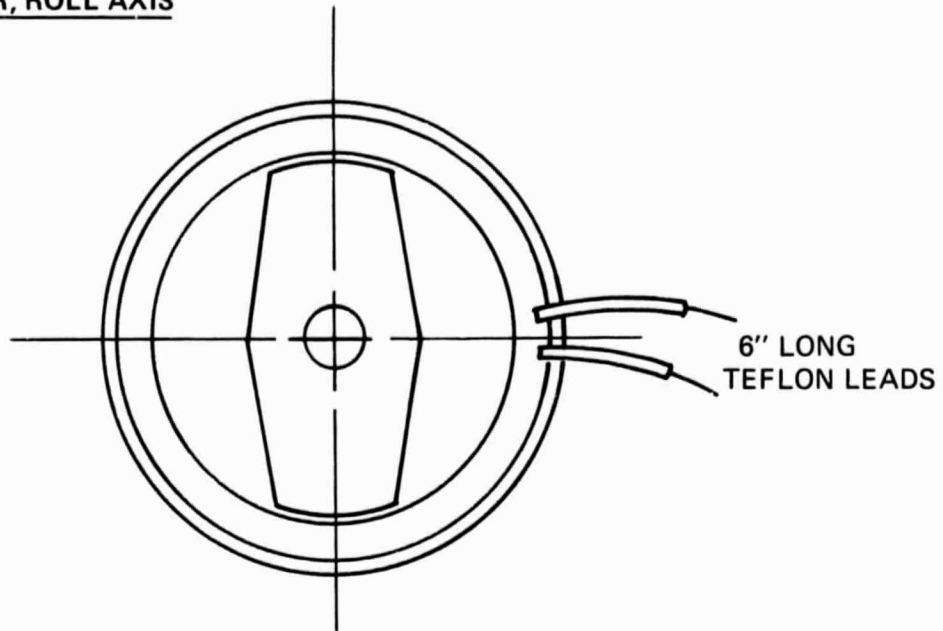
*Critical to application – if equivalent components are used, variations in these parameters can cause significant system changes.

TACHOMETER, ROLL AXIS**Aeroflex Laboratories****Model TG52W-5P**

TACHOMETER GENERATOR SIZE CONSTANTS				
	UNITS		SYMBOL	VALUE
Tach generator friction torque	oz-in		T_F	NA
Ripple voltage, average to peak	percent		E_R	NA
Ripple cycles per revolution	cycles/rev		—	NA
Rotor moment of inertia	oz-in-sec ²		I_P	0.107
Tach generator weight	oz		—	85
TACHOMETER GENERATOR WINDING CONSTANTS				
	UNITS	TOL	SYMBOL	VALUE
DC resistance (25°C)	ohms	±12.5%	R_a	1200
Voltage sensitivity	volts/rad/sec	±10%	K_g	4.5
Inductance	henries	±30%	L_a	7.8
Min load resistance	ohms	nom	$R_{L(min)}$	1200
Max operating speed	rad/sec	nom	$\omega_R(max)$	NA
Volts @ max operating speed	volts	nom	$V_a(max)$	NA

NA - Not applicable

TACHOMETER, ROLL AXIS



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