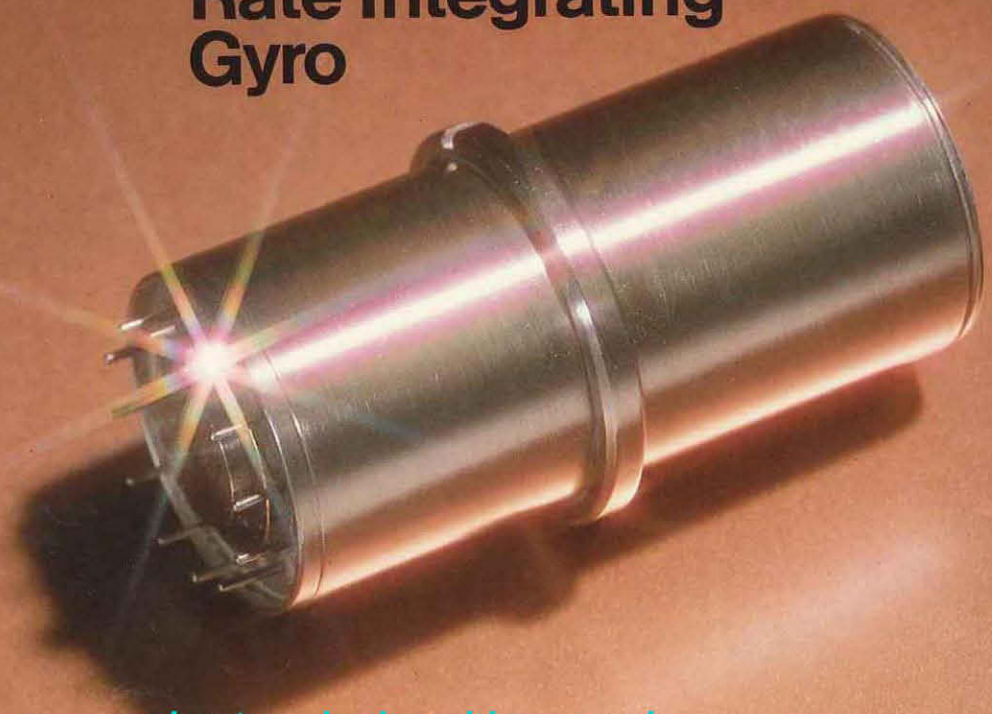
GEC AVIONICS

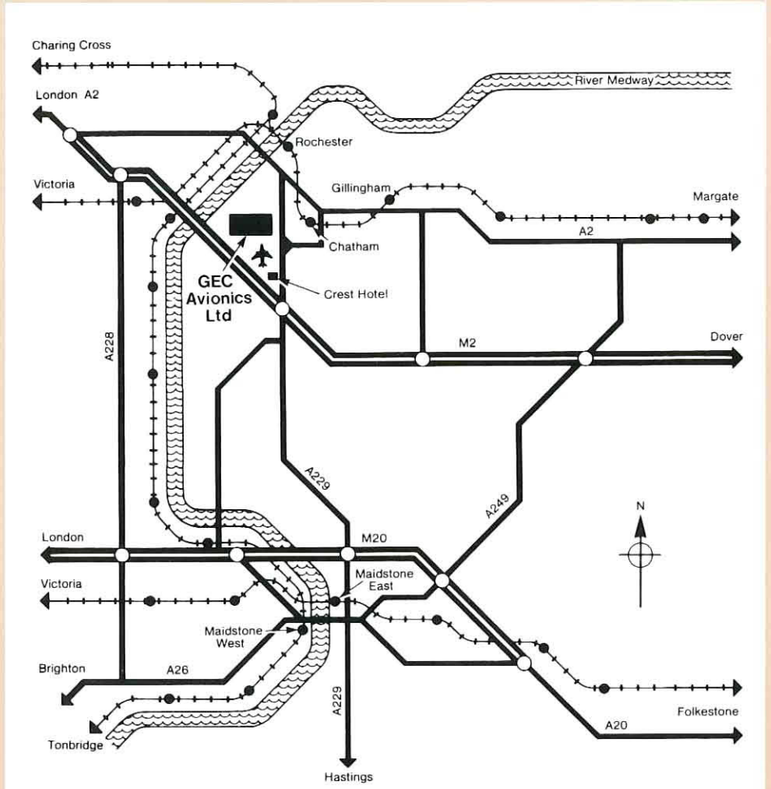
GI-G6

Rate Integrating Gyro



Guidance Systems Division

GEC Avionics Limited comprises a group of divisions situated at Rochester, Borehamwood, Basildon, Milton Keynes and Nailsea, specialising in all aspects of aviation instrumentation and control. The Guidance Systems Division situated at Rochester is responsible for the development and production of precision gyros, accelerometers, sensor assemblies, Strapdown Attitude Reference and Navigation Systems including Power Supplies, Output Processing Electronics and Computing.



GI-G6 Gyro

In line with GEC Avionics policy, developing technology has produced extremely successful Strapdown Inertial Reference Systems, and future design requirements for programmes of the 80's and 90's, dictate the need for the GI-G6 precision single axis torque Subminiature Rate Integrating Gyroscope.

Introduced in 1970, this gyroscope has become a designer's standard. Its high performance and reliability under adverse environments, and its ability to be produced at low cost have enabled it to be specified on many US and European programs. It is estimated that the GI-G6 supplies more than two thirds of the entire US market for subminiature rate integrating gyros.

European applications associated with the GI-G6 Gyro include the stabilisation of shipborne communication antennae, weapon aiming systems for aircraft, ships, tanks and missiles, advanced fly-by-wire flight controls, guidance systems for underwater weapons and navigation systems for land vehicles.

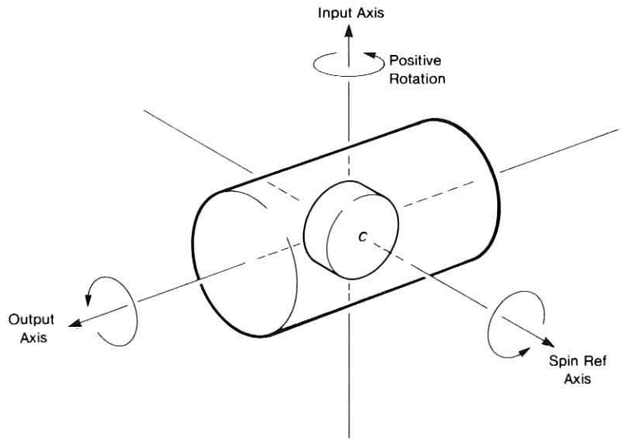
Many different models of the basic GI-G6 Gyro have been built to satisfy the varying application requirements of our customers. Some models feature very low drift rates – between 10° and 15°/hr over a temperature range of about 100°F (55°C). Some are capable of performing at around 1°/hr when kept at a constant temperature and under steady state conditions such as exist in a gimballed platform. Other models are designed to operate over temperature ranges of up to 300°F (149°C) with a drift rate of between 10° & 20°/hr.

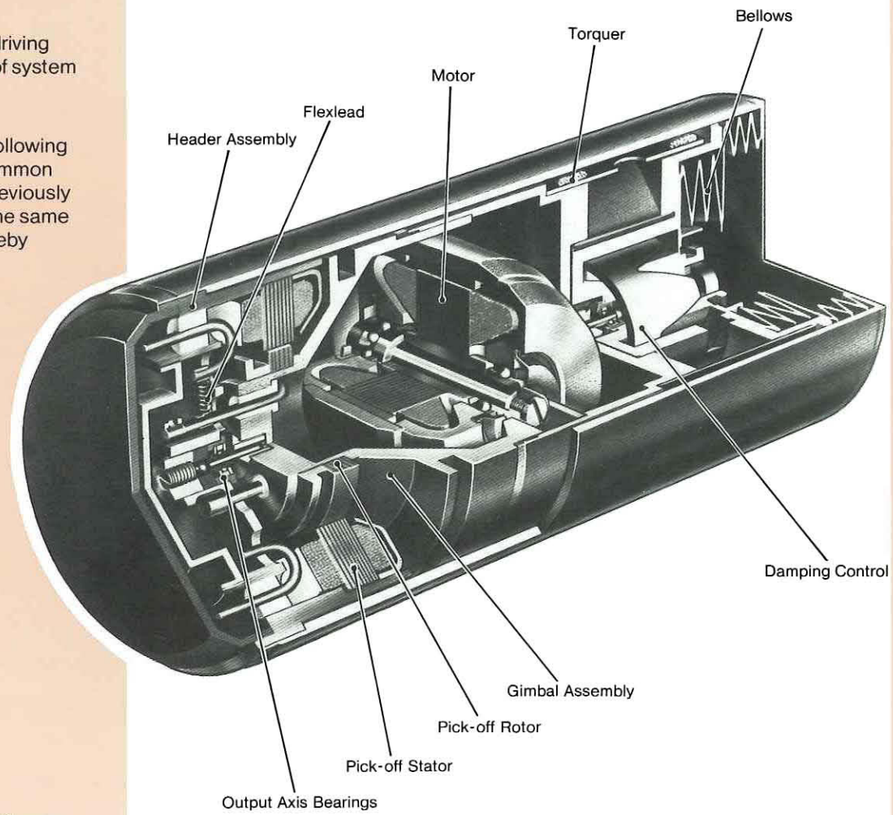
Gyro Selection

Gyro selection is usually a compromise between performance and cost. Obviously the best gyro will have optimum features in all of its sub-component elements, ie, spin motor, torquer, damping etc., but for a given application certain best features may, conflict with those of others. For instance, a larger angular momentum wheel clearly gives superior drift performance, but time taken to reach synchronisation, and/or cost to incorporate a new spin motor into the gyro assembly may be unacceptable.

An important aspect of this selection process is a thorough discussion with the gyro manufacturer during the establishment of the system error budget. Such discussion often reveals for instance, that the system will allow for the use of an existing gyro that is produced on the assembly line in large quantities, and can therefore be procured at substantially less cost than if it had to be tailored to a prespecified set of conditions. It is therefore most advantageous to consider cost driving factors during the early phases of system design.

Typical GI-G6 performance characteristics are given in the following pages. These models have in common many of the sub-components previously mentioned, and in general use the same assembly and test facilities, thereby keeping costs to a minimum.





Various specifications are available on request and we would be pleased to quote against your specific requirements. For further information please contact the Guidance Systems Division Sales Office.

Typical GI-G6 Characteristics

Parameter	*Units*	*310C*	*657 B/C/E*	*650C*	*650E*	*651 A/J*	*651B*	*651D*	*651E*	*653A*	*654A*	*340B*	*342A*
Spin Motor													
Voltage	*Volts RMS*	27.4	26	52/26	26	26	30	30	30	26	19.4	26	26 ± 3%
Frequency	*Hz*	400	400	400 + 3%	400	800	400	400	400	400	400	800	400 ± 5
Power													
Start	–	4.5 W	3.8 W	25 W	5 W	5 W	5 W	5 W	5 W	5 W	5 W	4.5 W	3.5 W
Run	–	3.5 W	3.5 W	3W	4 W	4 W	4 W	4 W	4 W	4 W	3.5 W	2.5 W	3 W
Angular Momentum	*gm-cm²/sec.*	32,000	18,500	18,500	18,500	25,500	32,000	32,000	32,000	32,000	11,000	32,000	32,000
Sync Time, Room Temp	*sec.*	60	10	6	30	20	30	20	20	30	12	60	10
Signal Generator													
Voltage	*Volts RMS*	10	8	10 ± 5%	8	8	8	8	8	8	10	2	4.5
Frequency	*Hz*	4800	4000	4800 ± 3%	5000	4800	4800	4800	4800	4000	3840	3280	400
Load	*Ohms*	10k	10k	10k	10k	10k	10k	10k	10k	10k	952	10k, 0.027 μF	10k
Phase Shift	*deg.*	± 7	± 5	+ 5 ± 7	± 10	± 10	± 10	± 10	± 10	± 12	0 + 5	±35	+72
Sensitivity	*Volts/rad.*	24	29.5	29	23	19	19	19	19	29.5	12.3	7.5	3.6
Null	*mV (max.)*	10	10	25	5	5	5	5	5	10	10	5	10
Torque Generator													
Maximum Torquing Rate													
Continuous	*°/sec.*	75	125	75	105	105	105	105	105	75	200	40	75
Intermittent	*°/sec.*	200	200	600	200	200	200	200	200	–	–	150	–
Resistance	*Ohms*	145	50	60	50	45	108	105	105	60	230	100	85
Scale Factor	*°/sec./mA*	1.0	0.6	0.6 ± 1%	0.6 ± 5%	0.4	1.25	1.2	1.2	0.35	2.0	1.0	0.63
Linearity	%	0.1	0.1	1	0.03°/sec. or 0.25%	0.25	0.25	0.25	0.25	0.25	1	0.5	1
Gyro Performance													
Transfer Function	*Volts/rad.*	11.5	17.9	23 ± 25%	18 ± 15%	14	19	19	19	18	2.5	7.5	3.4
Time Constant	*msec.*	1.0	1.0	1.1	1.0	1.25	1.25	1.25	1.0	1.1	0.5	1.0	1.25 ± 35%
IA Freedom	± *deg*	2 – 3	0.6 – 1.2	1	2	2 – 3	2 – 3	0.7	–	0.9 – 1.8	0.35 – 1.2	1.0 – 2.0	2
Drift Rates – Maximum													
G-Insensitive	*°/hr.*	27	40	72	40	40	40	40	40	30	60	54	25
G-Sensitive	*°/hr./g*	25	40	65	30	30	30	30	30	25	50	36	25
Anisoelastic	*°/hr./g²*	1.8	4	3.6	2	2	2	2	2	2	2	1.8	2
Noise	*μrad.(max.)*	6 (to 240 Hz)	6 (to 240 Hz)	15	15	6 (to 240 Hz)	6 (to 240 Hz)	15	15	6 (to 240 Hz)	15	6 (to 240 Hz)	15
Environments													
Operating Temperature	*°F*	–50 to +240	–50 to +212	–50 to +240	–25 to +165	–50 to +200	–50 to +200	–50 to +200	–50 to +200	–50 to +200	+32 to +122	+40 to +160	–40 to +160
Shock	*g, msec.*	100, 11	50, 11	50,11	50, 11	100, 11	100, 11	100, 11	100, 11	100, 11	50, 11	50, 11	50, 11
Vibration	*g RMS*	38	19.2	20	20	30	30	30	30	30	22	22	22
	Hz	20-2000	10-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000

Note 1

This specification data lists typical customer requirements for the GI-G6 gyro, and therefore some models are capable of achieving a higher performance than that stated here. Where the gyro is used in a microprocessor based system, considerable performance improvements can be made by the use of digital characterisation techniques. To date some 180 variants of this sensor have been produced covering a wide range of applications and specification requirements. Minimum costs and delivery time can therefore be achieved by selecting from those gyros currently in volume production. For further information please contact the Guidance Systems Division Sales Office.

Note 2

The GI-G6-031 variant refers to a long life, low noise gas bearing spin motor gyro.

Design Notes

- **Minimum noise performance is ensured by:-**
  (1) Sine wave drive to the spin motor
  (2) Driving the signal generator with a high RMS voltage which reduces subsequent capture loop gain requirements
- **Performance over temperature range**
  High angular momentum, high rate range and high performance GI-G6 gyros employ Samarium Cobalt magnets in the torque generator. To offset the variation of magnet performance with temperature, compensating networks are fitted into the gyro
- **Signal Generator**
  The signal generator is optimised for operation at 4.8kHz and provides minimum phase shift at this frequency. However operation over the range 400Hz to 12.8kHz is possible
- **Mounting Flange**
  Index notch aligned to input axis to within 3 milliradians as standard. Higher accuracy optional
- **Lead/Pin Functions**
  Two phase motor.

Pin No.	*Function*
1	Torquer Hi
2	Torquer Lo
3	Microsyn Pri Hi
4	Microsyn Pri Lo
5	Motor-lead φA
6	Motor-common
7	Microsyn Sec Hi
8	Microsyn Sec Lo
9	Motor-φB
10	Case-ground
11	—
12	—

Typical GI-G6 Characteristics

Parameter	*Units*	*343A*	*346A*	*321A*	*321C*	*321E*	*321F*	*321G*	*321H*	*337A*	*320B*	*320C*	*325B*
Spin Motor													
Voltage	*Volts RMS*	70	24/12	7.0	7.0	7.0	7.0	7.0	7.0 ± 0.5	12	28.5/13.0	28/13	42/35
Frequency	*Hz*	900	1600	900	800	900	900	787.5	900 ± 0.5%	800	1488	1488	3200
Power													
Start	–	600 mA	16.5 W	600 mA	5 W	7 W	5 W	–	7 W	2.7 W	1400 mA	1600 mA	8.5 W
Run	–	400 mA	0.9 W	400 mA	4 W	4 W	3 W	6 W max.	4 W	1.3 W	170 mA	170 mA	2.1 W
Angular Momentum	*gm-cm²/sec.*	36,000	50,850	57,200	51,000	57,200	57,200	50,050	57,200	12,750	20,500	20,500	24,600
Sync Time, Room Temp	*sec.*	10	6	60	30	30	30	30	30	15	1.75	1.75	8
Signal Generator													
Voltage	*Volts RMS*	20	8	20	8	8	8	8 ± 10%	8 ± 1.0%	4	5	5	3.75
Frequency	*Hz*	4000	4800	4000	9600	9000	9000	3937.5 ± 2%	9000	3200	5950	5950	4800
Load	*Ohms*	10k, 500 pF	10k	10k, 500pF	10k	10k	10k	10k	10k	10k	10k	10k	10k
Phase Shift	*deg.*	±5	0 ± 10	±3	–18	±5	± 7	0 ± 10	0 ± 5	0 ± 5	± 10	± 10	± 10
Sensitivity	*Volts/rad.*	46	19	24	19	8	8	10	8	9	10-15	12.5	9
Null	*mV (max.)*	20	5	10	10	6	6	–	6	10	2	2	20
Torque Generator													
Maximum Torquing Rate													
Continuous	*°/sec.*	60	60	60	75	60	60	60	60	400	60	60	30
Intermittent	*°/sec.*	100	–	90	100	75	75	–	75	800	260	150	N/A
Resistance	*Ohms*	50	45	108	108	108	130 max.	108	125 max.	346	35	35	4.2
Scale Factor	*°/sec./mA*	0.6	0.35 ± 1%	0.6	0.6	0.8	0.6	0.834 ± 10%	0.6 ± 1%	6.0	0.4	0.4	0.1
Linearity	*%*	0.1	0.2	1.0	0.2	0.1	0.1	1	0.1	0.05°/sec or 0.5%	0.05	0.05	0.1
Gyro Performance													
Transfer Function	*Volts/rad.*	17.2	19	10	12	8	8	15 ± 20%	8 ± 10%	3.5	4.0	4.0	40
Time Constant	*msec.*	1.05	0.75 ± 30%	0.6 Nom.	0.6	0.5	1.0	1.2 ± 20%	1.0 ± 10%	1.05 ± 35%	0.75	0.75	6
IA Freedom	*± deg*	0.5 – 3.0	1	2 – 3	2 – 3	2 – 3	2 – 3	2 – 3	2 – 3	2 – 3	3 – 6	3 – 6	0.5
Drift Rates – Maximum													
G-Insensitive	*°/hr.*	12	10	12	15	10	15	40	10	50	35	25	8
G-Sensitive	*°/hr./g*	18	10	18	15	10	15	12	15	60	25	15	8
Anisoelastic	*°/hr./g²*	0.3	2	0.3	1	1	0.5	0.5	1	2	0.4	0.4	0.2
Noise	*µrad.(max.)*	6 (to 500Hz)	15	6 (to 500 Hz)	10 (to 450 Hz)	10 (to 150 Hz)	10 (to 2000 Hz)	15	10 (to 1-2000 Hz)	15	6 (to 500 Hz)	6 (to 500 Hz)	6 (to 500 Hz)
Environments													
Operating Temperature	*°F*	–30 to +165	0 to +118	–50 to +220	–67 to +149	+41 to +167	+32 to +131	–20 to +136	–65 to +167	+ 40 to +160	+45 to +125	+40 to +140	+170
Shock	*g, msec.*	50, 11	100, 11	80, 11	80, 11	80, 11	80, 11	80, 11	80, 11	80, 11	100, 6	100, 6	50, 11
Vibration	*g RMS*	10	15	10	10	10	10	10	10	10	12.3	12.3	8
	Hz	5-500	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000	20-2000

Note 1

This specification data lists typical customer requirements for the GI-G6 gyro, and therefore some models are capable of achieving a higher performance than that stated here. Where the gyro is used in a microprocessor based system, considerable performance improvements can be made by the use of digital characterisation techniques. To date some 180 variants of this sensor have been produced covering a wide range of applications and specification requirements. Minimum costs and delivery time can therefore be achieved by selecting from those gyros currently in volume production. For further information please contact the Guidance Systems Division Sales Office.

Note 2

The GI-G6-031 variant refers to a long life, low noise gas bearing spin motor gyro.

Design Notes

- **Minimum noise performance is ensured by:-**
  (1) Sine wave drive to the spin motor
  (2) Driving the signal generator with a high RMS voltage which reduces subsequent capture loop gain requirements
- **Performance over temperature range**
  High angular momentum, high rate range and high performance GI-G6 gyros employ Samarium Cobalt magnets in the torque generator. To offset the variation of magnet performance with temperature, compensating networks are fitted into the gyro
- **Signal Generator**
  The signal generator is optimised for operation at 4.8kHz and provides minimum phase shift at this frequency. However operation over the range 400Hz to 12.8kHz is possible
- **Mounting Flange**
  Index notch aligned to input axis to within 3 milliradians as standard. Higher accuracy optional
- **Lead/Pin Functions**
  Two phase motor.

Pin No.	*Function*
1	Torquer Hi
2	Torquer Lo
3	Microsyn Pri Hi
4	Microsyn Pri Lo
5	Motor-lead φA
6	Motor-common
7	Microsyn Sec Hi
8	Microsyn Sec Lo
9	Motor-φB
10	Case-ground
11	—
12	—

Typical GI-G6 Characteristics

Parameter	*Units*	*326C*	*329B*	*344B*	*367A*	*353B*	*342C*	*355A*	*321M*	*351A*	*031* Gas bearing, low noise
Spin Motor											
Voltage	*Volts RMS*	30/15	28.5/13	30/20	28.1/13	16.8	26	17	7	6.5	28
Frequency	*Hz*	1250	1498	1563	400	400	400	800	875	893	5000
Power											
Start	–	6VA	3000 mA	6 W	50 W	5.1 W	3.5 W	4.4 W	6.5 W	600 mA	10 W
Run	–	4VA	300 mA	1 W	3.5 W	4 W	3 W	4 W	5 W	1.2 W/Leg.	2.75 W
Angular Momentum	*gm-cm²/sec.*	17,200	20,500	21,500	9250	24000	32,000	7127	55611	35720	32,000
Sync Time, Room Temp	*sec.*	2	1.75	6	0.8	60	20	50	30	60	20
Signal Generator											
Voltage	*Volts RMS*	9	5	4.2	30	12	4.5	5	7	7	7
Frequency	*Hz*	3125	4800	6250	4800	6567	400	12.8	4375	4465	5000
Load	*Ohms*	20k	10k	10k	10k	10k	10k	10k	10k	10k	10k
Phase Shift	*deg.*	± 14	± 7	± 10	± 7	10 ± 15	72	–	±5	10	5
Sensitivity	*Volts/rad.*	25	12	13	116	30	3.6	9	9.0	16	17
Null	*mV (max.)*	6	6	6	TBD	25	10	–	4	20	14.3
Torque Generator											
Maximum Torquing Rate											
Continuous	*°/sec.*	10	40	175	525	205	60	200	80	60	115
Intermittent	*°/sec.*	200	150	185	–	–	120	–	–	120	N/A
Resistance	*Ohms*	350	35	425	80.5	291	28.1	253	121	58	69
Scale Factor	*°/sec./mA*	1.75	0.33	2.7	3.14	2.38	0.69	7.14	0.75	0.62	0.729
Linearity	*%*	0.3	0.3	0.015 °/sec	0.2	0.3	4	1.5	–	0.1	0.34
Gyro Performance											
Transfer Function	*Volts/rad.*	15	5.5	4.0	27	9.9	3.4	3.7	10	10	17.94
Time Constant	*msec.*	2.0	0.7	1.3	0.68	0.48	1.25	2.0	0.86	1.0	1.2
IA Freedom	*± deg*	2.5 – 5.0	3 – 6	0.5 – 1.0	±4	±4.5	–				±14
Drift Rates – Maximum											
G-Insensitive	*°/hr.*	30	15	50	290	100	25	122	12	20	15
G-Sensitive	*°/hr./g*	15	10	15	176	100	25	104	12	30	14.2
Anisoelastic	*°/hr./g²*	0.8	0.2	1.0	1.8	1.8	–	–	0.5	2	–
Noise	*µrad.(max.)*	6 (to 240 Hz)	6 (to 500 Hz)	6 (to 500 Hz)	–	–	–	–	–	10	TS-2858
Environments											
Operating Temperature	*°F*	+140 to +185	+130 to +150	+40 to +185	+5 to +160	+40 to +225	–26 to +160	–65 to +203	–24 to +160	150 ± 2	+140
Shock	*g, msec.*	85, 5	40, 11	50, 11	35,30	30,30	30,11 See Customer Spec	MIL-STD-810B *Method 516*	MIL-STD-810B		15,11
Vibration	*g RMS*	11,4	5.4	35	15	10		MIL-STD-810B *Method 514*	MIL-STD-810B		2
	Hz	50-2500	20-2000	10-2000	20-2000	20-2000	100-2000				10-2000

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9	Motor-ϕB
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11	—
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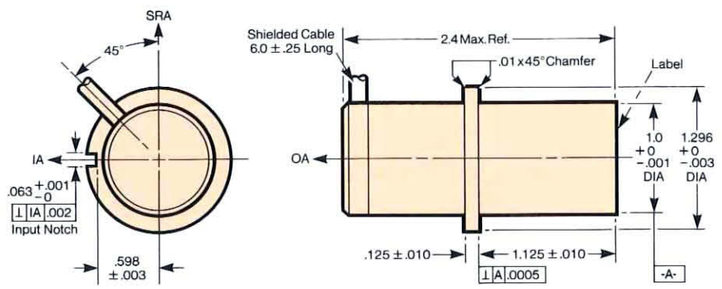
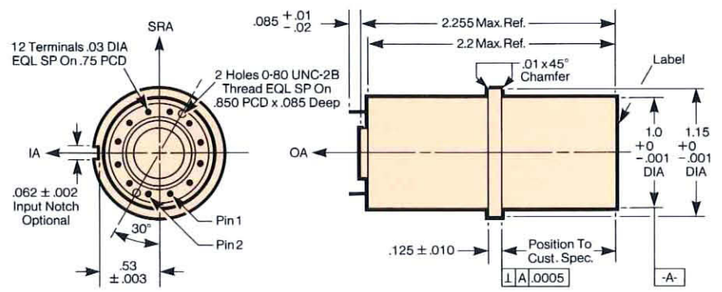
Typical GI-G6 Configurations

Mounting Flange and Flying Leads *(Standard)*



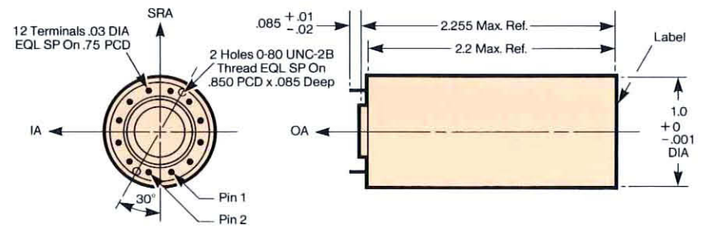
Dimensions in Inches

Mounting Flange and Header Pins *(Alternative)*



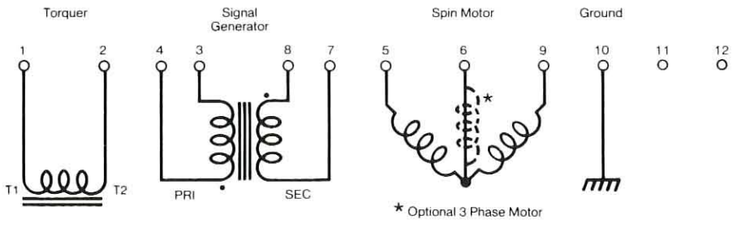
Dimensions in Inches

Basic Outline *(Alternative)*



Dimensions in Inches

Gyro Circuit Diagram



GEC AVIONICS

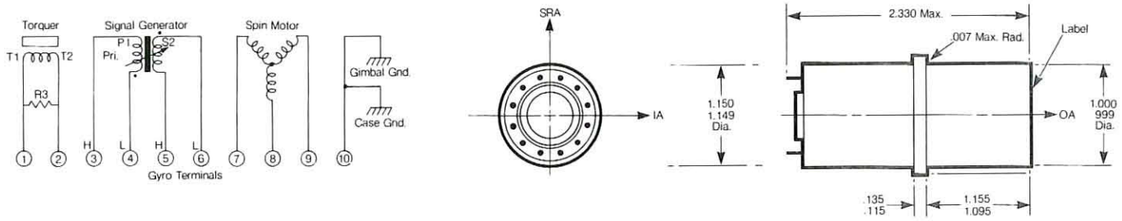
GI-G6-317Y RATE INTEGRATING GYRO

PERFORMANCE CHARACTERISTICS

DRIFT	
G-Insensitive	40°/hr
Stability (1 Sigma)	10°/hr
G-Sensitive, per axis	30°/hr/g
vector sum	40°/hr/g
Stability (1 Sigma)	8°/hr/g
G^2-Sensitive	2°/hr/g²
Random	2°/hr
PICK-OFF	
Excitation	8v RMS, 4800 Hz
Load	10K ohms
Phase Shift	0 ± 10 degrees
Current	12.5 ma, typical
TORQUER	
Torquing Rate, (2 sec ON, 20 sec OFF)	200°/sec
Torquing Rate, Continuous	105°/sec
Scale Factor	1.25°/sec/ma ± 20%
Scale Factor Temperature Coefficient	0.025%/°F
Linearity	0.03°/sec or 0.25% of reading
Resistance	108 ohms

SPIN MOTOR	
Excitation	30v RMS, 400 Hz
Waveform	Sine or Square
Power, Starting	5 watts, max
Running	4 watts, max
Phases	1, 2 or 3
Sync Time, Room Temperature	30 sec, max (2 or 3-Phase Operation)
Angular Momentum	32,000 gm-cm²/sec
GYRO TRANSFER FUNCTION	
At Room Temperature	19v RMS/rad ± 20%
Variation from Room Temperature	
0 to +200°	0 to + 15%
−50 to 0°F	Plus 20%, Minus 50%
DAMPING COEFFICIENT	32,000 dyna-cm/rad/sec
CHARACTERISTIC TIME	1.0 msec (nominal)
ENVIRONMENTS	
Temperature, Storage	−65 to +250°F
Operating	−50 to +200°F
Random Vibration	30g RMS, 20 - 2000 Hz
Shock	100g, 11 msec, Sawtooth
Linear Acceleration	50g
Slew Rate Capability	20 rad/sec

OUTLINE



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