SAFRAN

ELECTRONICS & DEFENSE

Wheeled Gyrometer Sensor

DATASHEET 20BM00-60 SERIES

High Performance dual axis dynamically tuned gyroscope & gyrometer

Spinning gyro delivered without housing. Each gyro is factory calibrated and compensated for temperature effects to provide high accuracy differential analogue output voltage,

Key features

20BM00-60								Units
Measurement Range[1]	**± 30**	**± 60**	**± 100**	**± 120**	**± 180**	**± 250**	**± 300**	**°/sec**
Scale factor:								
Analogue output (differential):	± 0,33	± 0,16	± 0,100	± 0,083	± 0,055	± 0,040	± 0,033	V/°/sec
Scale factor sensitivity (-45°C to +85°C)				±100				ppm
Bias stability				0,5				°/h, 2σ
Noise:								
Angular Random Walk ARW [2]:				0,004				°/√h 2σ
Within 0,1 to 100Hz:				0,015				°/sec rms
Bandwidth				>100				Hz
Power supply				+/-15				Vdc
Temperature (operating)				-45, +85				°C

(1) Any other value available on request from 30 to 300°/sec.
(2) Analogue output, 2σ.

The 20BM00-60-SERIES gyro unit is an innovative, robust and solid-state dual spinning gyro unit used in numerous applications such as line of sight stabilization (sights and electro optical systems) turrets and line of fire stabilization, gravitometers, antenna and sonar's stabilization, ship anti-roll systems, artificial horizons, high-speed tilted trains and IMUs. A standard and unique rotating wheel is coupled to an electronics which can be adapted to meet customer's specifications in terms of measurement range, bandwidth, noise, etc.

The SAFRAN Electronics & Defense 20BM00-60 Gyro units, described in this present document is designed to deliver DC Voltage proportional to the angular rate seen by the sensitive axes of the gyro sensor.

Applications

Aircraft Flight Control
Fire control Systems
Tactical Training Simulators
Sights, optical and infrared line of sight
Gyro-stabilized gimbals

Naval and Land remote weapon systel
Antenna stabilization
Sonars stabilization
Ship anti-roll systems
Naval and Land weapon platforms

Unmanned Aerial vehicles (UAV's) control
Autonomous underwater vehicles (AUV's)
Automotive testing
Tilting trains
Robotics

PARAMETERS

All values are specified at ambient temperature (20°C) and +28V supply voltage.

Parameter	Comments	Min	Typ.	Max	Unit
Sensitivity					
Dynamic range	20BM00-60 Series	30		400	°/s
Scale factor	Analogue output (differential):	0,333		0,025	V/°/sec
Accuracy	Compensated -40°C to +80°C		0.05	0.1	%
Sensitivity over T	-45°C to +85°C, 1σ		50	100	ppm/°C
Axis misalignment			3	5	Arc min
Non linearity	% of measurement range		0.02	0.1	%
Angular Range	Gyroscope mode			20	Arc min
Angular scale factor	Gyroscope mode			0.5	Vdc/arc min (+/- 5%)
Precession scale factor	Gyroscope mode (+/- 0.1%)	1		20	°/s/Vdc
Linearity error	Gyroscope mode (% of range)		0.1	0.2	%
SF accuracy	Gyroscope mode -45°C to +85°C			100	ppm/°C
Bias					
In run bias	20°C		5	10	°/h
Accuracy over Temperature	-45°C to +85°C		5	15	°/h rms
Linear acceleration effect	Negligible, within noise. Acceleration should be <30g			< 1	°/h/g
Random drift Bias instability	20°C, during 1h		0.5	1	°/h
Run to run	For OFF time < 2 hours *See note below	-5		+5	°/h
In Phase G-sensitive drift			10	30	°/h/g
Quadrature G sensitive drift			10	30	°/h/g
Spin G sensitive drift			6	10	°/h/g
Noise					
Angular Random Walk ARW	Slope of the linear part of the Allan Variance at 22°C		0.004	0.01	°/√h
Noise	Gyrometer in band 0-100Hz Gyroscope in band 0-100Hz		0.006 0.5	0.015 1	°/s rms Arcsec rms
Bandwidth					
Frequency response	Gyrometer : -3dB / -90° Gyroscope : -3dB / -90°	> 100 >200			Hz
Temperature					
Operating		-45		+85	°C
Non-operating		-50		+90	°C
Power supply (V_{DD})					
Input voltage		14	15	16	V
consumption			10	15	W
Startup time				5	s
Warm up time	Time before reaching the performances			10	min
Environment					
Vibration / Shocks	See vibration & shocks note				
Angular accelerations				5000	°/s²
Altitude				40000	feet
EMC/EMI	See Handling precaution note				
MTBF	**MTBF reaches 50 000 hours.**				

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Specifications

Absolute maximum ratings

Absolute maximum ratings are stress ratings. Stresses in excess of these ratings can cause permanent damage to the device. Exposure of the device to the absolute maximum ratings for an extended period may degrade the device and affect its reliability.

Parameter	Comments	Min	Typ	Max	Unit
Supply voltage V_{cc}		18		36	V
Operational temperature		-45		+85	°C
Altitude				40 000	feet
Maximum angular acceleration				5 000	°/s²
Maximum linear acceleration				40	g

Absolute maximum ratings

Vibration & Shocks

Vibration (unit operational and non-operational) qualified according to Mil standard 810 issue G, Method 514-6, procedure 2. (0.3 g²/Hz)
Vibration frequency applied is 5 to 2000Hz.

Shock (unit operational and non-operational) qualified according to Mil standard 810 issue G, Method 516-6, procedure 1. Three Shocks applied on each axis. Shock form is ½ sinus.

Amplitude (g)	Duration (ms)
350	2
50	11

Definition

Mode Gyrometer / Gyroscope

The SAFRAN Two Axis Gyro Unit ref. 20BM00-60 described in this present document is designed to measure angle displacements (the unit is used in a so-called “reference mode”) or angular rates (the unit is used in a so-called “rate mode”) around two perpendicular axes.
According to the user requirement, the unit can be supplied in “rate mode”, or both in “rate” and “reference” mode. In this last case, the user will switch the unit from “reference” to “rate” mode by use of TTL logic input.

Measurement Range and outputs

The measurement range is the highest angular rate for which the user needs a very high accuracy (scale factor and linearity) without saturation.
When the applied rate on the gyro is equal to the measurement range, the differential analogue output of the unit is equal to 10 Volts.
The common measurement ranges are: 30, 60, 80, 90, 100,120, 180 and 300°/s.*
Other values are possible upon specific customer request within 5°/s up to 400°/s.

Servo-loop Range

It is the highest angular rate for which the servo-loop is still working and is equal to 400°/s whatever the measurement range is. (The servo-loop range is always greater than the measurement range).

G insensitive drift / bias drift

It is the output voltage delivered by the unit, when no angular rate is applied on the gyro’s sensitive axes.
The gyro typical drift value within the temperature range is 0.08°/h /°C from -45 to +85°C.

Caution: the reported value of the bias measurement is corrected from the projection of the earth rotation value.

Random drift/ Random walk

The Random drift values give the stability of the drift, during one hour, at constant temperature.
Typical value is 0.5°/h
Typical value for an Angular Random Walk at 22°C for analog output: 0.004°/fflh

G sensitive drift

Less than 30 °/h/g

G^2 sensitive drift

Less than 0.7°/h/g^2

Magnetic field sensibility

Drift variation is less than 1°/h/GAUSS

Input axes misalignment

The input axis misalignment is the angle between the mechanical references of the gyro measurement axis and the real sensitive axis of the gyroscope. Typical values for axis misalignment is 3 arc minute (5 arc minute max).

Start-up time

It is the time necessary for the Gyro unit to work correctly. Its typical value is 5 seconds.

Warm-up time

It is the time necessary for the Gyro unit to work into its performances. It is less than 10.

Run to run

The run to run value is defined as the difference of the bias measured following a restart without warm-up phases. In stabilized temperature:

- For OFF time < 2 hours, run to run value is < 5°/h

Scale factor accuracy

The associated servo-loop electronics performs a thermal compensation of the scale factor.
The scale factor is given with a tolerance of 0.1% from -45 to +85°C (0.05% at 1σ).

Linearity error

For different rate applied at 20°C, the linearity error is given by the formula:

$$Linearity\ error\ (\%) = \frac{Rm - Ra}{100\ x\ Mm}$$

Where Rm = rate measured (°/s) (1axis)
Ra = rate applied (°/s)
Mm = Measurement Range (°/s)

20BM60-44 linearity error is less than 0.2% of the measurement range (typ. Value 0.1%).

Bandwidth

The standard bandwidth is >100 Hz (amplitude -3db and phase lag at 90 degrees) and the overshoot is less than 2 dB.
See graphic in chapter “Bandwidth and phase”.

Noise (Analog)

The noise value is <0,015°/s rms, in the 0.1-100 Hz frequency range (typically: 0.006°/s rms).
See graphic in chapter “Noise”.

Temperatures

Operating range: - 45°C, + 85°C
Maximum non-operating range: -50°C to +90°C

Angular accelerations

The 20BM60-44 sensor can accept up to 5000°/s².

Altitude

The gyro unit is operating up to 40 000 feet.

Rain

The product is hermetic.

Weight

The weight is inferior to 200 grams

Sensitive axe

The angular rotation velocity is measured according to these axes:

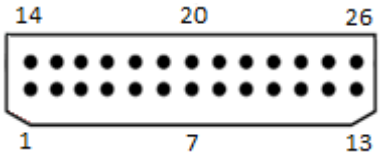
The rotation senses presented on this picture are the positive one (X&Y):

Electrical interface

Pin description

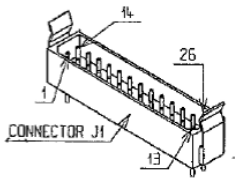
CONNECTOR: ATI 212M26R04LC (User connector: ATI 212F26C01U) or equivalent

Pin Out description



USER CONNECTOR (J1)		
PIN	DESIGNATION Rate + Zoom option board configuration	DESIGNATION Rate + Reference mode board configuration
1	X (-) RATE OUTPUT	X (-) RATE OR ANGULAR OUTPUT
2	X (+) RATE OUTPUT	X (+) RATE OR ANGULAR OUTPUT
3	Y (-) RATE OUTPUT	Y (-) RATE OR ANGULAR OUTPUT
4	Y (+) RATE OUTPUT	Y (+) RATE OR ANGULAR OUTPUT
5	BITE G GENERAL BUILT IN TEST OUTPUT	BITE G GENERAL BUILT IN TEST OUTPUT
6	ON/OFF INPUT (OPTION)	ON/OFF INPUT (OPTION)
7	MECHANICAL GROUND	MECHANICAL GROUND
8	NOT TO BE USED (REF MODE)	X (+) PRECESSION INPUT (REF MODE)
9	NOT TO BE USED (REF MODE)	X (-) PRECESSION INPUT (REF MODE)
10	NOT TO BE USED (SAGEM TEST)	NOT TO BE USED (SAGEM TEST)
11	BUILT IN TEST OUTPUT X AXIS	BUILT IN TEST OUTPUT X AXIS
12	NOT TO BE USED (REF MODE)	X MODE INPUT (RATE/REF)
13	ELECTRICAL GROUND	ELECTRICAL GROUND)
14	+ 15V DC SUPPLY	+ 15V DC SUPPLY
15	0/15V DC SUPPLY	0/15V DC SUPPLY
16	- 15V DC SUPPLY	- 15V DC SUPPLY
17	COMMON MODE LINE (GND for pin 1 2 3 4)	COMMON MODE LINE (GND for pin 1 2 3 4)
18	NOT TO BE USED (SAGEM TEST)	NOT TO BE USED (SAGEM TEST)
19	RATE ZOOM X MODE	RATE ZOOM X MODE (OPTION)
20	RATE ZOOM Y MODE	RATE ZOOM Y MODE (OPTION)
21	NOT TO BE USED (REF MODE)	Y (+) PRECESSION INPUT (REF MODE)
22	NOT TO BE USED (REF MODE)	Y (-) PRECESSION INPUT (REF MODE)
23	NOT TO BE USED (SAGEM TEST)	NOT TO BE USED (SAGEM TEST)
24	BUILT IN TEST OUTPUT Y AXIS	BUILT IN TEST OUTPUT Y AXIS
25	NOT TO BE USED (REF MODE)	Y MODE INPUT (RATE/REF)
26	ELECTRICAL GROUND	ELECTRICAL GROUND

FOR INFORMATION MATING CONNECTOR
ref fab : 212F26C01U ATI FICH.210* 26CONT.FEMELLE A SERT.SS.VERROU or equivalent

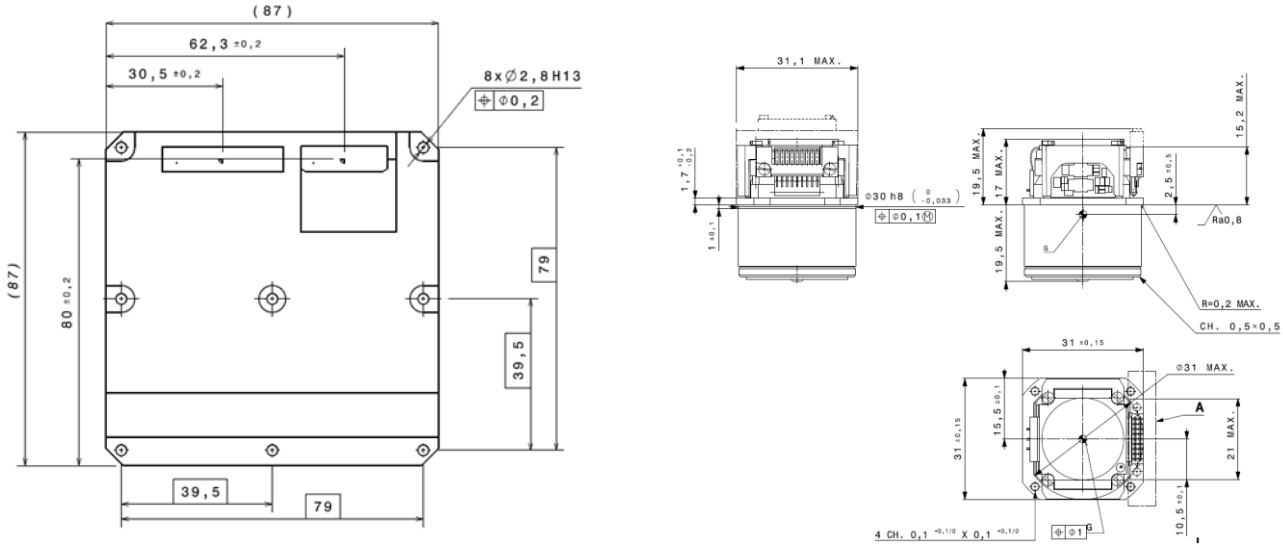


Depending of the length of the user cable, it is advised to twist and shield the power supply wires as well as the measurement output wires. The shielding has to be connected to the mechanical ground (pin 7).

Built-in self-Test function

A "Built In Test" TTL logic voltage output is also provided.
This self-test is a permanent monitoring of the gyroscope status. It tests the power supply and the sensor loops.
The built-in Self-Test generates a logic TTL signal on the device output BITE pin 14 and can be used for device failure detection. It can be used as a power on ready signal.
When the sensor is ready and functional, the signal level is 5V.

Mechanical Outlines (mm)



Electrical characteristics

Electrical consumption

Electrical consumption is under 15W, typical value is 7.5W.

Electrical isolation

Only applicable for packaged version (20BM60-44 series).
Electrical ground and mechanical ground are not connected inside our design. These grounds could be connected outside the gyroscope.

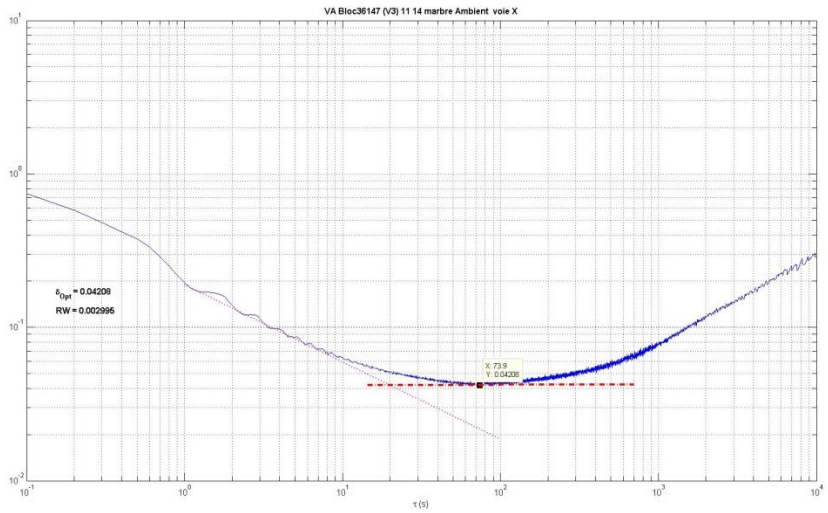
Typical characteristics

The 20BM00-60 series is a Dual Axis Rate gyro representing Safran Electronics & Defense's knowhow gyro technology enabling an ultra-low noise and exceptional Allan variance curve that has performance commensurable with other technologies.

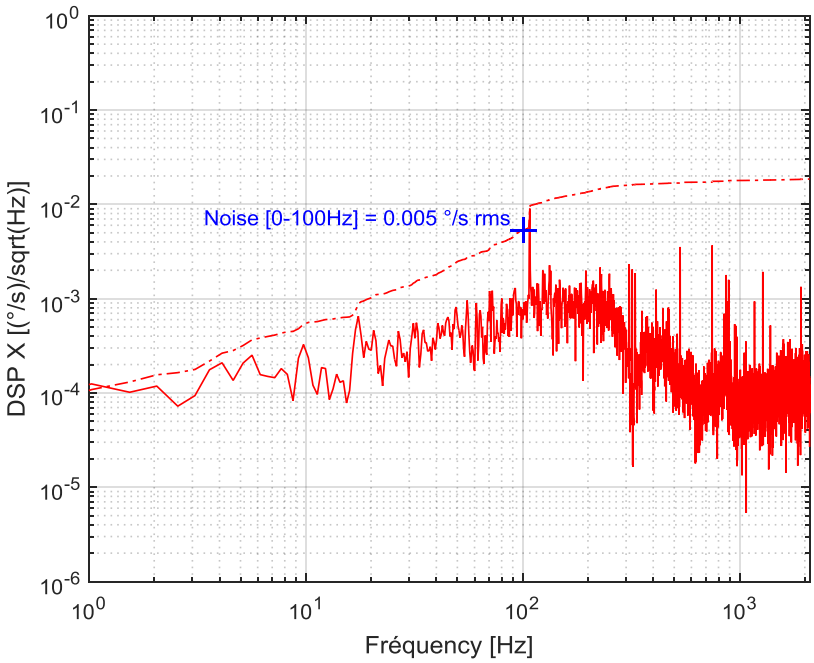
The 20BM00-60 is ideal when very low noise, excellent bias over shocks and temperature performance, very compact unit for two axis, light weight and rugged durability are desired

ALLAN VARIANCE CURVE ON ANANOG OUTPUT

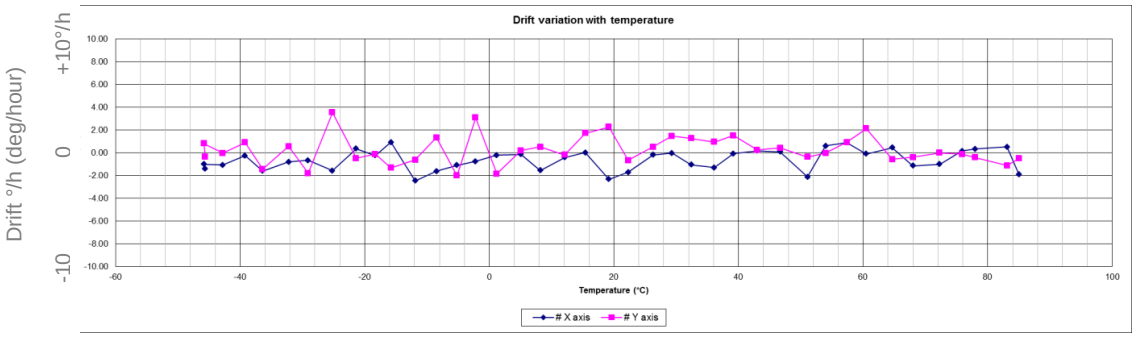
(min at 0.04°/h @ 74sec)



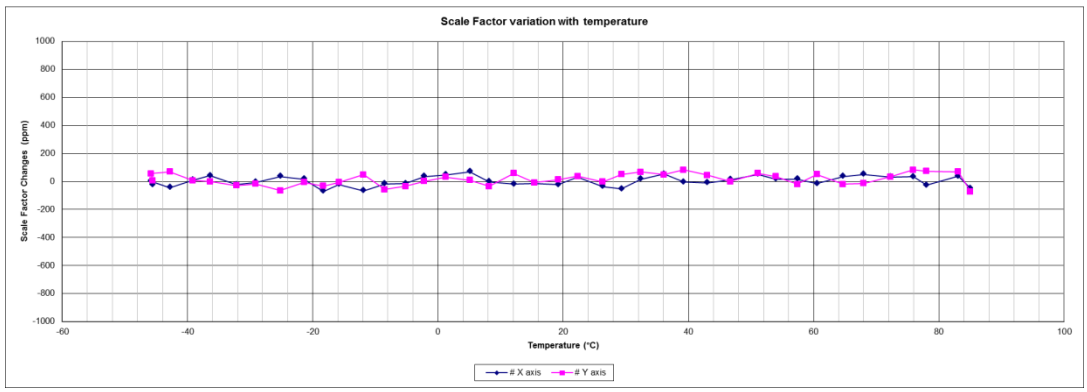
NOISE CURVE [0-100Hz] ON ANALOG OUTPUT :



BIAS IN TEMPERATURE



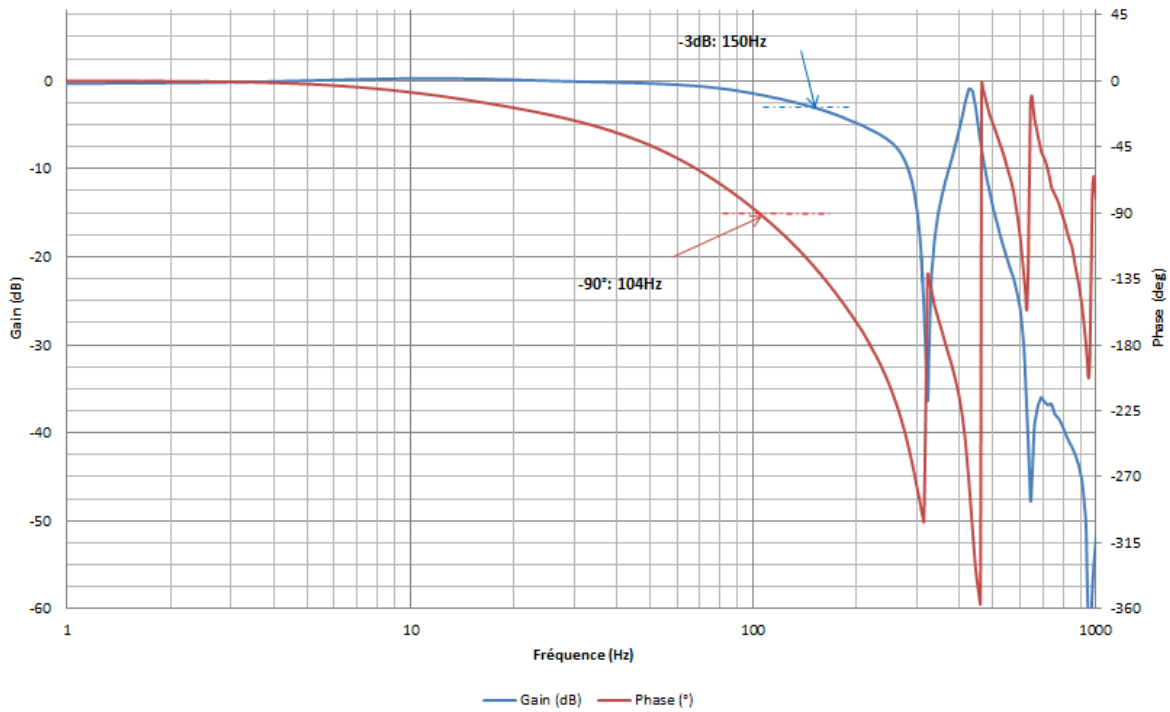
SCALE FACTOR IN TEMPERATURE



Bandwidth and phase:

The bandwidth is specified > 100Hz (-3dB) with a phase shift (-90°)
Typical value is bandwidth 150 Hz @ -3dB
Typical phase shift is 105 Hz @ -90°

Typical gain & phase:



20BM00-60 SERIES Datasheet

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