Grad-01-1000L

Very High Stability
Single Axis Fluxgate Magnetic Gradiometer

The *Grad*-01-1000L is a vertical component magnetic gradiometer for archaeological and geophysical surveys and UXO detection. It is designed for use alone or as one element in a gradiometer array for rapid data collection over large areas. An open interface is provided to allow settings to be adjusted by the user. Resolution which is mostly limited by thermal drift, is around 50pT/m.

The Gradiometer contains two directionally sensitive fluxgate elements spaced 1m apart on a very stable beam together with the necessary electronics to provide an analog output representing the magnetic gradient along the main axis. It is housed in a rugged, lightweight 38mm diameter protective tube which is fully sealed for operation under wet conditions.

The unit operates from a 12V unregulated power supply, has a bandwidth of d.c. to 10Hz and a range which can be switched between ±100nT/m (±1mGauss/m) and ±1000nT/m (±10mGauss/m). The analog output is ±4V full scale. Beyond four volts, a logarithmic compensation extends the range to 3 and 30µT/m. The interface allows directional and offset errors of the sensing elements to be nulled electronically. The influence of the background field can thereby be eliminated and only anomalies in the field will be recorded. This compensation also applies where the gradiometer is rigidly mounted near a magnetic structure. The enclosure is clearly labelled with a direction arrow to facilitate orientation during set-up, see figure 3.

Specification – Grad-01-1000L	
Sensor element spacing	1m
Gradient range	±100nT/m or ±1000nT/m full scale (3µT or 30µT compressed)
Output	±4V full scale, output impedance 1kΩ (±5V compressed)
Accuracy	±1%
Maximum ambient field	±100µT
Noise	100pT pk-pk max.
Differential Drift	<0.02nT/°C (warm up time 2-3 minutes)
Bandwidth *	d.c. to 10Hz min. with -12dB/octave roll off
Power supply	12V nominal (9.5 -18.5V) unregulated, polarity protected
Power supply current	58mA
Pull-up current (pins 5-11)	0.5mA when held low
Connector	12 pole Tajimi R04-R12M
Environmental	IP65
Operating temperature	-20°C to +70°C
Size	38mm diameter x 1052mm in length
Weight	0.82kg (1.8lb)

* Optional 200Hz bandwidth

Operation

The unit requires a power supply of 12V unregulated. The input is protected against reversed polarity. The analog output of ±4V full scale is referenced to power ground within the gradiometer. A separate signal ground connection permits the use of a differential input data logger for good noise immunity. The normal scale factor is ±100nT full scale but a high scale of ±1000nT can be selected by pulling input /HR to ground at any time. The analog output is active irrespective of the status of the other digital control lines. Enquiries are welcomed for suitable data loggers and power supplies.

Resolution limit

The gradiometer output represents the difference between the outputs of the two sensors. The resolution of any fluxgate gradiometer is limited by small errors in offset, gain and angular alignment between these sensors. These errors appear in response to changes in the sensor orientation. The *Grad*-01-1000L has a digital interface to allow the user to minimise these errors. The errors are classified as follows:

Offset Error - O
This is the departure from zero output regardless of the orientation of the gradiometer.

Vertical Error – V
This error alternates in magnitude when the long axis of the gradiometer is alternately inverted and non-inverted. This error increases in significance as the inclination of the terrestrial field increases, that is, towards the poles.

North/South Error – N
This error is due to misalignment of the sensors in the direction of the arrow and therefore is discovered by pointing the arrow alternately north and south.

East/West Error – E
This error is due to misalignment of the sensors at right angles to the direction of the arrow and is discovered by pointing the arrow east and west.

Digital adjustment

Compensation for the above errors is set using six CMOS/TTL inputs. The most recent settings are stored internally even with the power disconnected. They may be revised at any time whilst in use. The digital lines are active in the low state and are fitted with internal pull-up resistors. All lines are heavily protected against electrical damage and false operation. The lines are inhibited for a time of 2 seconds following power up. The lines operate as follows:

Device Select /DS
This line must be held low to select the gradiometer which is to be adjusted and held low during adjustment. Settings are stored when this line returns high but only if the /INC line is stable and high. A delay of 20mS must be allowed for the /DS line to stabilise after each level change.

Parameter Address Lines A, B, C
Three lines are used to address the relevant control within the gradiometer, as shown below.

Polarity POL
This line determines the polarity of the desired correction (increase or decrease).

Increment - /INC
Each time this line goes low the selected compensation setting is incremented one step to remove the error under investigation. A delay of 1mS must be allowed for the /INC line to stabilise after each level change.

Specification – Error Parameter Address Lines			
A	**B**	**C**	**Function**
H	H	H	Zero Offset fine Of
L	H	H	Zero Offset coarse Oc
H	L	H	Vertical fine Vf
L	L	H	Vertical coarse Vc
H	H	L	North/South fine Nf
L	H	L	North/South coarse Nc
H	L	L	East/West fine Ef
L	L	L	East/West coarse Ec

Specification – Parameter adjustment			
/DS	/INC	POL	Mode
L		H	Step adjustment +ve direction
L		L	Step adjustment -ve direction
	H	X	Store current value

Specification – Digital Interface Timing		
Symbol	Parameter	Minimum ms
t_{AC}	Address stable to DS	0.5
t_{CL}	/DS to /INC setup	0.5
t_{ID}	/INC HIGH to POL Change	0.5
t_{DI}	POL to /INC Setup	0.5
t_{IL}	/INC LOW Period	0.5
t_{IH}	/INC HIGH Period	0.5
t_{IC}	/INC Inactive to /DS Inactive	0.5
t_{CPH}	/DS Deselect time	22
t_{IW}	/INC to output change	1
t_{CYC}	/INC Cycle time	0.5
t_R, t_F	/INC Input rise and fall time	1

Connector Cabling

See Figure. Electrical connection to the gradiometer is via a waterproof connector mounted on the side of the tube. The cable should be screened and the power conductors (pins A and B) should be a tightly twisted pair to minimise the production of stray magnetic fields. As a precaution the cable should be immobilised relative to the gradiometer when in use.
A mating connector can be supplied upon request.

Specification – Pin Connections		
***Grad*-01-1000L / Cable**	**Symbol**	**Function**
A	Vs	V supply
B	Vso	Power ground (0V)
C	Va	Analog output (±4V)
D	Vao	Analog output reference (0V)
E	/HR	Lo = High Range Select
F	/DS	Lo = Device Selected
G	Add A	Address A (LSB) Input
H	Add B	Address B Input
J	Add C	Address C (MSB) Input
K	POL	Direction of Setting Hi = positive
L	/INC	Incremental Setting
M		Shield

Mounting

The Gradiometer may be mounted using a suitable clamp at any point or points along the tube.

Figure 1 Electronic Interface

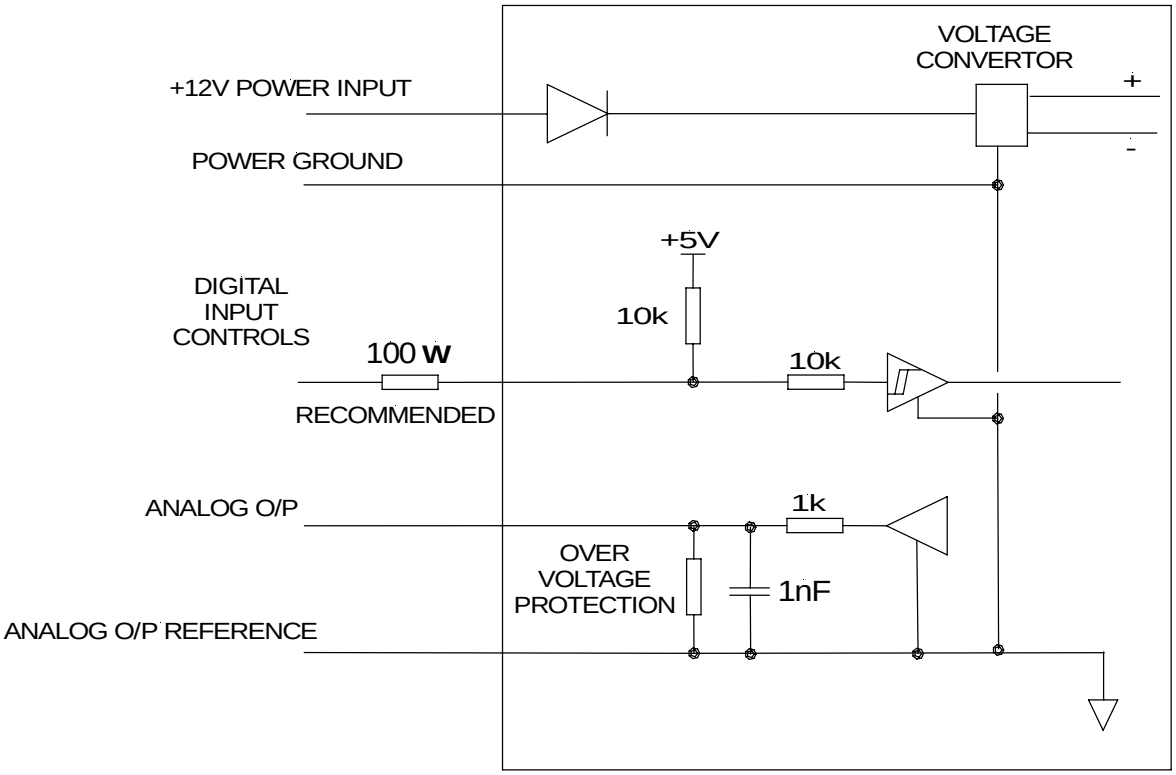


Figure 2 DIGITAL INTERFACE TIMING

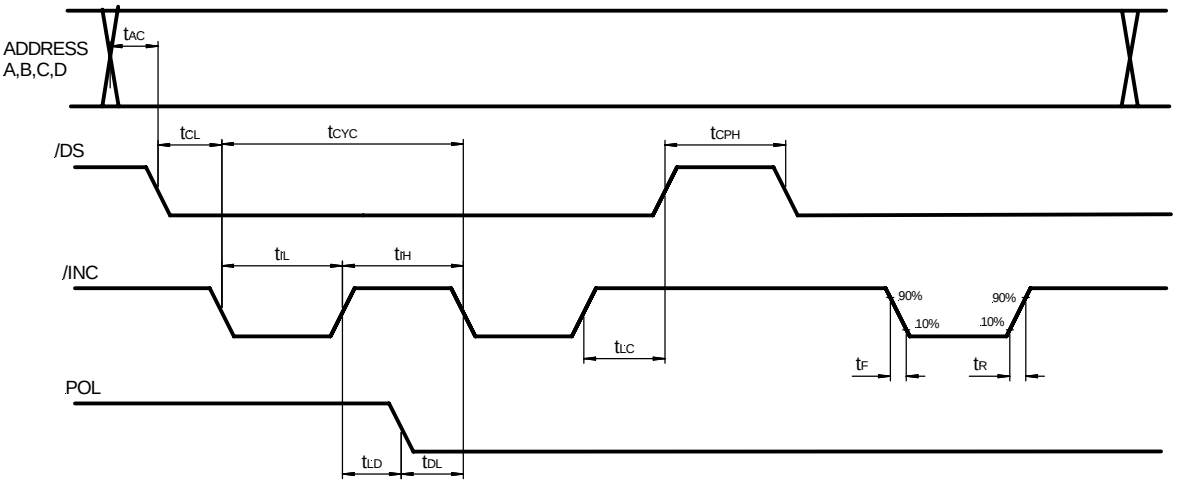
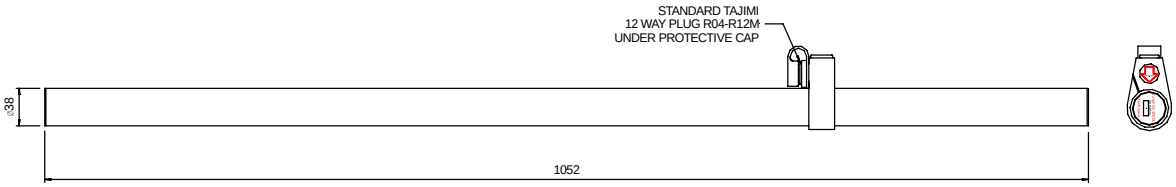
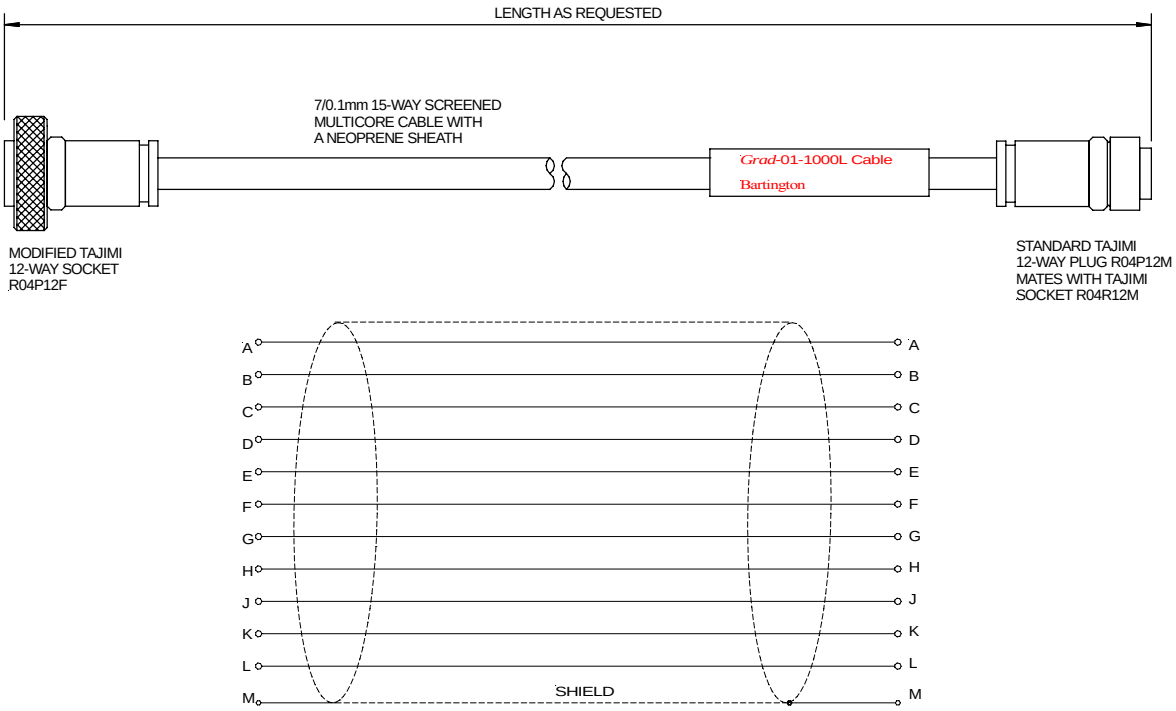


Figure 3 Outline Drawing



Grad-01-1000L
Gradiometer Assembly

Figure 4 Cable Drawing



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