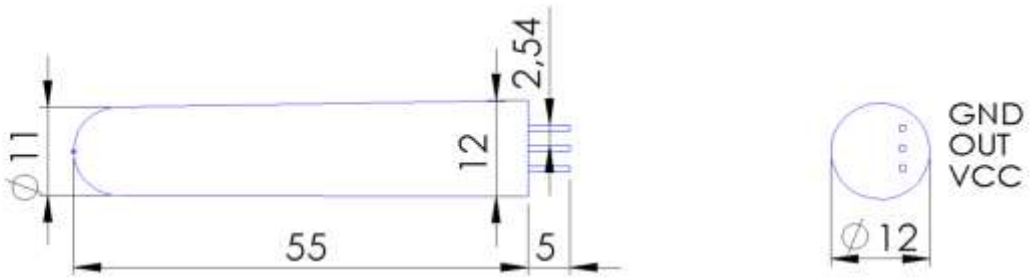
FG-3 Flux-Gate
Magnetic Fileld Sensor

FEATURES:

- **Single supply**
- **Low Current**
- **Low temperature sensitivity**
- **Internal RC supply filter**
- **DC to 20KHz Bandwidth**
- **Digital output**

APPLICATIONS:

- **Metal detector**
- **Weapon detector**
- **Gradiometer**
- **Vehicle and ship detector**
- **Aurora monitor**
- **3-axis orientation system**



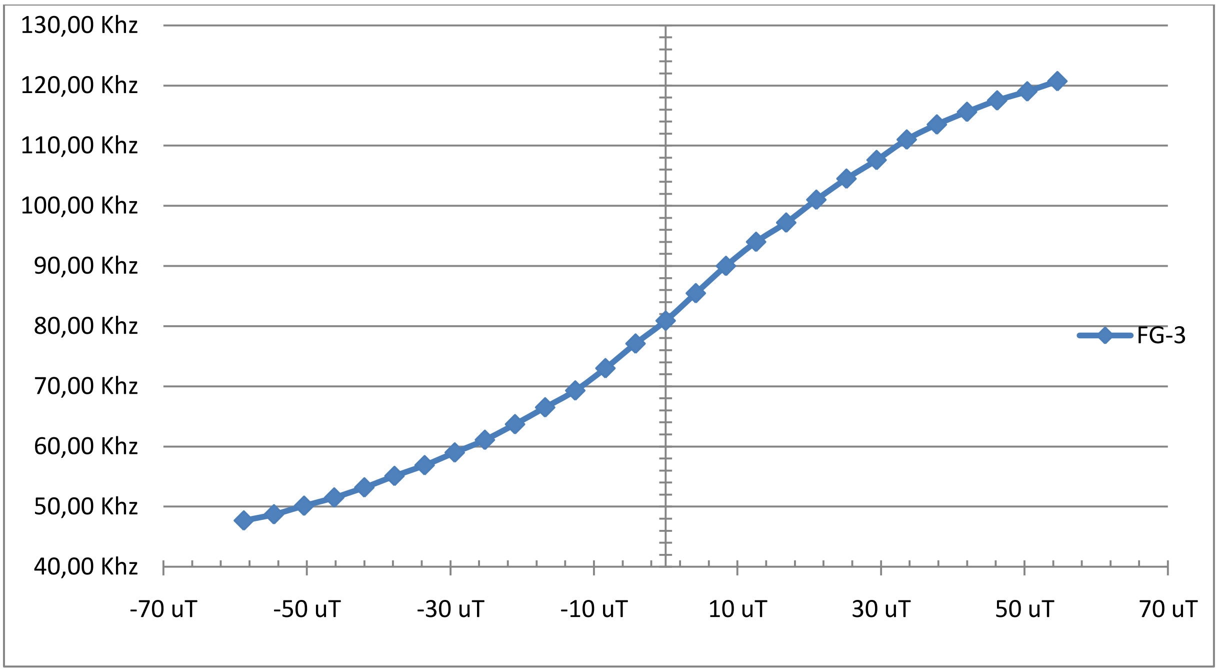
PARAMETER	VALUE	UNIT
Recommended supply voltage	5	VDC
Typical Supply Current	10	mA
Maximum supply Voltage	7	VDC
Temperature range	0 - 50	°C

GENERAL DESCRIPTION

The FG-3 devices is very high sensitivity magnetic field sensors operating in the ±50 microtesla range (±0.5 oersted). It's simple, essentially three terminal devices, operating from a single +5 volt supply, the connections being ground, +5v and output. The output is a robust 5 volt rectangular pulse whose period is directly proportional to the field strength, (giving a frequency which varies inversely with the field), making it very easy to interface to a computer or micro controller. The typical period swing for the full range of an FG-3 is from ~50 KHz to ~120KHz, a clear indication of its high sensitivity.

Unlike Hall Effect field sensors, which are virtually unusable in this range because of their large temperature sensitivity, the FG-3 has a very low temperature coefficient (even better then FGM-3)

The chart below shows the typical response of the larger size sensor of the range, the FGM-3



Between $\pm 50\ \mu T$esla the non-linearity is about 6%

This non-linearity varies somewhat between individual sensors, but may normally be expected to be in the region of 6%

A simple strategy will improve this considerably.
It was stated earlier that the field strength was inversely proportional to the frequency. In practice it will be found that the field strength is more closely inversely proportional to the frequency plus a small constant. If the frequency is measured and a fixed number of kilohertz is added before it is divided into one, to obtain the period, the response curve of period against field will be seen to become much more linear.

Supply Voltage Variation

The period (and frequency) of the FG-series of devices varies with supply voltage, having a coefficient of about 3.5% per volt at the nominal 5 volt supply level. For precise applications good supply regulation is required, but since the transducer's current (10mA) requirement is low, this is fairly easy to achieve using, for example, single or double regulation with devices from the LM78LXX series.

Use with Computers and Microcontrollers

The large pulse output gives considerable noise immunity permitting the use of transducers sited at long distances from the main system.

Interfacing is simple in that it requires only one bit of a digital input port per channel of measurement, the technique being to count input pulses for a fixed period to determine the frequency of the incoming signal, from which the field can be calculated.

Alternatively, where a faster response is required, the time between successive like edges permits the direct determination of period, from which again the field can be calculated. With microcontrollers this usually presents no problem, but with systems using many interrupts or extensive multi-tasking it may be necessary to buffer the input signals to deal with the high data rate. However this usually means no more than the addition of a single triple-counter I/O chip even for threedimensional orientation systems.

For applications such as earth field magnetometry, where readings may only be required at relatively long intervals simple binary division with a single chip 12 or 14 stage divider will reduce the input period to a level where data rate ceases to be a problem to the computer. Alternatively, in such applications where the field variation is extremely small, digital heterodyning with a stable oscillator will also reduce the period but simultaneously maintain the high sensitivity, (in hertz/oersted) to field variations.

For applications which need absolute field magnitude without any orientation sensitivity, it is necessary to use three orthogonal sensors and exploit the fact that the sum of the squares of the three signals is constant regardless of orientation. Provided that the zero offsets, channel sensitivities and linearisation are appropriate to the required absolute sensitivity, this will permit free movement of the sensor head while measuring small changes in absolute field. If the sensor is in constant angular motion, advantage can be taken of this to provide some level of auto-calibration of zero offset and channel sensitivity.

Where the sensor can be permanently fixed, only one sensor is necessary, the zero offset being adjusted to suit the local ambient field strength. This technique is appropriate to fixed ferrous metal detection systems such as conveyor belt counters, vehicle and ship passage detectors and materials magnetometry. A limit to the range of such systems results from the fact that the earth's field itself fluctuates at a low level continuously. The effective range will be a function of the size or likely magnetic moment of the objects being detected, ships generally giving a larger range than vehicles or hand guns. Appropriate filtering of the input frequency variations will enhance range.

Where extremely high sensitivity is required it may be possible to use two sensors in a gradiometer configuration to cancel out the micro-fluctuations of the earth's field. However, this will not always increase range, since the gradiometer sensitivity falls off faster with range than the simple field sensor. In this context, it should be remembered that the field produced at range by a magnetic moment falls off as the inverse **cube** of the range, so the gradiometer configuration will fall off as the inverse **fourth** power. However such systems may be useful as short range high sensitivity detectors and materials measurement systems. An example might be extremely small magnetic moment inert particles introduced into fluid flow systems for movement detection, such as chemical processing plants or animal internal fluid flow systems in medical research applications.

Sources:

- Speake and Co FGM datasheet