Genesis HIGH SPEED

# User Guide

English

# BE560 User Guide
# 8/16 CHANNEL MODULAR ISOLATION AMPLIFIER

HBM

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**INSPECTION**
Inspect the exterior of the instrument for any visible signs of damage that may have occurred during transit.

If damaged, contact -
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FAX: 608/826-6690
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## Contents

## Contents

# 1 Safety Messages

## 1.1 Symbols Used in This Manual

The following symbols are used throughout this manual to indicate hazards.

**WARNING**
**Indicates a potentially hazardous situation, which if not avoided, could result in death or serious injury.**

**CAUTION**
**Indicates a potentially hazardous situation, which if not avoided, could result in minor or moderate injury, or alerts against unsafe practices, or alerts against actions which could damage the product.**

## 1.2 Operation Safety

**WARNING**
**Do not use amplifiers in housings which are only partially populated. All systems are shipped with full racks of instruments or with blanking modules added. If a module is to be returned for repair etc., FROM A RACK WHICH IS TO REMAIN IN USE, fit the appropriate blank module as required.**

**IF IN DOUBT, CONTACT THE FACTORY**

**CAUTION**
**HIGH VOLTAGES MAY EXIST ON THE INPUT CONNECTORS**

**Internal parts of the amplifiers may be at high voltage and for this reason, all housings are fitted with front retaining rails for the modules.**

**DO NOT remove the retaining rail or modules unless the system is disconnected from the power supply AND DISCONNECTED FROM ALL INPUT CONNECTIONS.**

**CAUTION**
**INSPECT CABLES REGULARLY FOR CUTS AND BREAKS**

**Where high voltage measurements are being made, it is advisable to include fuse links in circuit between the power equipment and the instrumentation equipment.**

**CAUTION**
**BE SURE to select the correct power supply voltage for your amplifiers. The BE560 Isolation Amplifier has selectable 115/230V mains supply capability, please be certain to select the correct setting for the available supply voltage.**

**WARNING**
**Always ensure that a mains earth connection exists on the output common return.**

# 2 Introduction and Initial Operation

## 2.1 Overview


The BE560 is a general purpose isolation amplifier for front end use when hazardous or off ground voltages must be measured. The amplifier comprises a low noise, low drift input stage with differential characteristics, a high performance isolation stage and a filter with buffered voltage output.

Voltage isolation is up to 1500 VDC or pk.

Signal range is up to 1000 VDC or pk.

Maximum bandwidth is 50 kHz.

The amplifier is fully protected using advanced depletion mode FET devices and has a gain range of ÷100 up to x100, enabling the conditioning of signals in the range from 100 mV to 1 kV full scale.

Applications include power line monitoring including high side current shunts, ground loop elimination and as a protected front end for data acquisition systems, transient recorders and oscilloscopes.

Three different housings are available:

- FE-PE8 for up to 8 amplifier modules
- FE-PE17 for up to 16 amplifier modules
- FE-PE17-RK for up to 16 amplifier modules, rack mountable.

The isolation amplifiers are single channel modules to be inserted in these housings.

Open slots are covered with blank panels.

All I/O connections are made on the rear panel.

Power source is either 115 V or 230 V RMS at 50/60 Hz, rear panel switch selectable.

## 2.2 HBM and FYLDE

The BE560 is an isolation amplifier sold by HBM and engineered and manufactured by FYLDE (UK).

The BE560 is a special, pre configured system (out of the broader FYLDE offering) matching the needs of isolated measurements as performed using HBM instruments.

The BE560 as sold by HBM is a system build of components called the FE-560 “blue panel” from FYLDE.

HBM is also the partner for customers for pre and post sales support and service. However, BE560 instruments sent to HBM may be forwarded to FYLDE for calibration or repair.

## 2.3 BE560 Isolation Amplifier Initial Operation & Verification

The BE560 is a general purpose Isolation Amplifier. Users familiar with Isolation Amplifier operation may take advantage of the following initial operating procedure.

### 2.3.1 Selecting the Power Source

The BE560 Isolation Amplifier Housing is delivered with a switchable 115/230 V mains power supply.

The power supply type and rating are clearly marked on the rear panel.

**CAUTION**
**As your housing has selectable 115/230 V capability, please be certain to select the correct setting for the available supply voltage.**

### 2.3.2 Connecting the Input

**WARNING**
**The application of isolation amplifiers may result in connection being necessary to high voltage conductors with a consequent SERIOUS RISK OF INJURY. It is ESSENTIAL to ensure that power to high voltage input circuits is removed prior to any connections being made. IF IN ANY DOUBT, consult a qualified electrician or contact the factory for advice.**

The BE560 has a single ended isolated (also knows as differential unbalanced) input configuration, that is to say the input is two wire, having a signal and common connection. In practice, since the amplifier is isolated, these may be regarded as “high” and “low” and should be connected across the voltage to be measured with the low side of the signal to common, chassis or the expected lower potential of the signal source.

The input connectors fitted to the cases are two 4 mm safety banana plugs per channel.

### 2.3.3 Connecting the Output

The output connectors fitted to the cases are BNC. Connect the output to the following instrumentation using a standard BNC coaxial lead.

### 2.3.4 Initial Control Setting

No pre-setting of controls is required before switch on, other than power supply voltage selection (see 1.1 above).

### 2.3.5 Switching On

On power on the amplifier will always assume the last used gain condition and this LED indicator will illuminate as soon as power is applied. In the event that the input is too high for the selected range, the amplifier input protection will ensure that no damage to the amplifier or danger to the operator ensues.

**Note:** In any event, the amplifier has full input overload protection in the case of incorrect gain setting.

### 2.3.6 Gain Control

The required gain can be set using the up and down front panel buttons.

**Note:** The buttons auto-repeat if held down. The last used gain position will be stored through power down.

Detailed operating instructions are given in sections 4 and 5.

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# 3 BE560 Amplifier Description

## 3.1 Introduction

The BE560 is a general purpose isolation amplifier for use when hazardous voltages must be measured. Voltage isolation is up to 1500V DC or peak, with input signals up to 1000V DC or peak.

**The system rear panel is clearly marked with maximum ratings.**

The amplifier utilizes a proprietary isolation amplifier device and a specially wound transformer which is polyurethane impregnated and proof tested to 5 kV pk.

The module may be most easily appreciated by consideration of its constituent parts:

1. Mains power supply
2. Switched input attenuator
3. Input preamplifier
4. Isolation Amplifier
5. Isolation power supply
6. Low Pass Filter
7. Output Stage

## 3.2 Mains Power Supply

The amplifier has a built in power supply which is mains operated. This is suitable for operation from 102-123 V and 207-253 VAC at 50/60 Hz, rear panel selectable. The power supply rating is marked on the back panel of each housing.

## 3.3 Switched Input Attenuator

In order to be able to accept high voltage inputs, an input attenuator is switched into circuit ahead of the preamplifier for ÷10 and ÷100 settings.

**Note:** The amplifier input impedance is always 1 MΩ whether direct or attenuated.

## 3.4 Input Preamplifier

The input preamplifier has selectable gains which are utilized for x10 and x100 gain settings. The amplifier is protected (up to the specified limits) against overvoltage arising from incorrect gain or attenuator setting using advanced depletion mode FET devices.

## 3.5 Isolation Amplifier

The isolation amplifier integrated circuit operates by capacitance coupling using a digital technique, and enables the input preamplifier to be isolated to as high as 1500 V pk or DC.

### 3.6 Isolation Power Supply

An isolation power supply which operates at high frequency supplies the preamplifier and input stages of the isolation amplifier. The power supply utilizes a specially wound transformer with polyurethane impregnation which is proof tested to 5kV pk.

### 3.7 Low Pass Filter

A 50 kHz low pass filter receives the isolated signal from the isolation amplifier integrated circuit and filters out any sample frequencies remaining in the signal.

### 3.8 Output Stage

The output stage is designed to buffer the filtered signal in order to enable high cable loads to be driven.

# 4 Installation and Configuration

## 4.1 Case or Rack Housings and Amplifier Removal

Three different housings are available for the BE560 as follows:

- FE - PE8 8 amplifier slots, portable case with handle
- FE - PE17 16 amplifier slots, portable case with handle
- FE - PE17 - RK 16 amplifier slots, rack mountable

In general, amplifiers purchased will be supplied ready assembled in prewired mounting crates with rear panel connections completed.

All housings are always pre configured to receive the maximum number of modules, meaning the input and output connectors are already mounted, even if the housing is not completely filled with isolation amplifier modules. This allows an easy upgrade with more isolation amplifier modules later.

Removal of the amplifier from the case or rack may be necessary during configuration. To do this, proceed as follows:

1. Isolate power and input connections from the rack or case.
2. Remove the locking rail at the front panel lower edge by unscrewing the retaining screws.
3. Use an extractor tool screwed into the front panel threaded bush in the centre of the lower edge of the front panel and withdraw the module by pulling firmly.
4. The module may be carefully reinserted without use of a tool.
5. Reinstall the locking rail.

## 4.2 Input Connection

The inputs are wired with isolated 4 mm Safety Banana connectors.

The input HIGH is connected to the RED socket, input LOW to the BLUE socket.

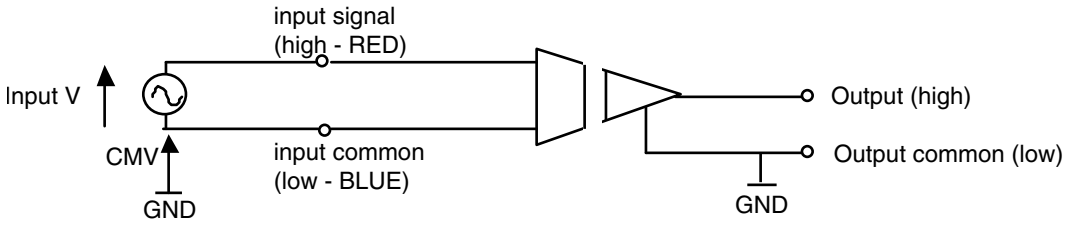


**Figure 4.1:** Input Connections

**Note:** The CMV (Common Mode Voltage) is specified as the maximum voltage of the LOW input with respect to ground (GND).

These maximum voltage limits for both the Input voltage (Input V) as well as the Common Mode Voltage (CMV) are clearly marked on the rear panel of the equipment case or rack adjacent to the input connectors.

The input impedance of the amplifier is 1 MΩ under all conditions.

This may result in a loading (attenuation of the signal) for higher source impedances. For example, a 1% attenuation will occur when connected to source impedances of 10 kΩ but only 0.1% for sources of 1 kΩ.

### 4.3 Output Connection

The portable or rack cases are all fitted with the now almost universal BNC output connector. The cable may be any good quality coaxial type and impedance is not critical. The length of the cable should, if possible, be kept below 10 m in length as this maintains amplifier maximum bandwidth and reduces the possibility of capacity load instability.

#### 4.3.1 EMC Filter

The BNC output connector is fitted with an EMC filter for compliance with regulations governing the performance of electrical equipment. The output impedance of the amplifier due to the filter is 100 Ω. In nearly all cases this will be insignificant when compared to the input impedance of following equipment (often 1MΩ), but should be kept in mind if low impedance equipment is to be connected. Following equipment with an input source impedance of 10 kΩ would result in a drop in the amplifier output of 1% (<0.1 dB).

### 4.4 Power Connection

Before applying mains power to the amplifier, ensure that the mains selector switch on the back is set to the proper position: either 240 V or 120 V.

The amplifier will operate over the nominal mains voltage ranges of 102-123 V and 207-253 V AC at 50/60 Hz.

### 4.5 Earthing the Output

A mains earth connection to the amplifier output common (shell of the BNC connector) is made in the amplifier.

### 4.6 Frequency Response

The BE560 incorporates a low pass filter. This filter has a 3 pole (-18 dB/octave) Butterworth response which means that it will pass frequencies below its cut off frequency with minimal effect on amplitude, but above the cut off frequency the amplitude is attenuated by a factor of eight for each doubling of the frequency.

The bandwidth of the low pass filter is 50 kHz @ -3 dB.

# 5 Operation

Before operating the equipment, it is advisable to study the previous pages referring to setting up the module and making the input and output connections.

## 5.1 Switching On

The system power switch is located on the rear panel.

All housings are delivered with dual voltage capability; be sure to check that the most suitable setting for your available supply is selected:

**120 V:** 103 - 127 VAC 50/60 Hz VA rating is indicated on the rear panel

**240 V:** 207 - 253 VAC 50/60 Hz VA rating is indicated on the rear panel

All housings are fitted with rear panel fuses.

(For extra safety, the amplifiers incorporate individual over current and over temperature fuses – these are not field or user serviceable).

**CAUTION**
**The rear panel fuse is rated at 0.63 A (T). Be certain to replace with the same type fuse.**

### 5.1.1 Output Voltage

With power on and inputs connected, check that the LEDs (the last used gain setting) are illuminated. If no LED is illuminated check that power has been correctly applied.

The output of the amplifier should be in the range ±10 V. If the output is greater than these limits it is likely that the gain setting selected is too high for the input signal. In this case select a lower gain setting using the front panel push buttons to bring the amplifier output into range.

## 5.2 Gain Setting

The table below shows the available gain settings for the BE560 and the input voltage required to generate full scale (10 V) at the output. Note that in general no damage will result for input overloads which are within the maximum for the amplifier. In most situations this means that up to 1000 VDC or peak signal may be input on any gain range without damage (see the following section for further information on input protection).

| Gain Setting | Input for 10 V Output |
|---|---|
| ÷100 | 1000 VDC or pk |
| ÷10 | 100 VDC or pk |
| ×1 | 10 VDC or pk |
| ×10 | 1 VDC or pk |
| ×100 | 100 mVDC or pk |

## 5.3 Input Protection

**WARNING**
**This isolation amplifier is designed to be applied to signal sources which may be at high potentials for both input terminals and thus protection is required to prevent damage through inadvertent application and operation. For this reason, the BE560 features an input protection circuit employing high voltage depletion mode FET transistors which automatically limit the input should an overload occur. However, it is important that the user establishes that the highest voltage which is likely to be applied to the input is within both the limits of the amplifier and the limits of the wiring employed. Failure to do this may result in a SAFETY HAZARD.**

# 6 Measurement Accuracy

**Note:** The output has both an amplitude and a phase relationship to the conditions measured at the input. Of course, the output signal's amplitude relationship to the transducer conditions depends upon the gain, but also depends on the gain accuracy (±0.25%) and the frequency response.

## 6.1 Low Pass Response

The low pass frequency response is nominally 3 dB down (Fc) at 50 kHz.

Low pass phase match between channels is ±1° at 0.75 Fc.

## 6.2 Input Impedance and Cable Capacitance

### 6.2.1 Loading of Input Source

The amplifier input impedance is 1 MΩ under all gain conditions. In most situations this will produce minimal attenuation of the signal source but should be borne in mind if source impedances are likely to exceed 10 kΩ when the attenuation will be approximately 1%.

### 6.2.2 Bandwidth Limiting Caused by Input Capacitance

Where input cables become long, and particularly when input source resistance may be high, attention should be given to the dynamic consequences for the signal caused by the input low pass filter so formed.

For example, consider the situation when a coaxial cable of 30 m length is used when the signal source exhibits an impedance of 5 kΩ.

The low pass filter pole occurs at:

$F = \frac{1}{2}\pi RC$

where : R = source impedance
C = cable capacity

For an example cable with 100 pF/m:

$F = \frac{1}{2}\pi \times 5x10^{3} \times 3000x10^{-12}$

F = 10.6 kHz

It can be seen that, in certain circumstances, the full amplifier bandwidth may not be realized unless the cable length or cable capacity can be reduced.

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# 7 Calibration

The BE560 will remain within its stated specification without routine adjustment as high stability components have been used in the construction of the amplifier. However, some ageing is inevitable, and the results should only be considered valid within the calibration interval.

## 7.1 Calibration Interval

A calibration interval of two years is recommended for the BE560.

HBM offers servicing for the BE560 and is able to test, repair and recalibrate the amplifiers quickly and cost effectively using instruments traceable to national standards and to ISO9000 quality standard.

## 7.2 User Calibration Procedure

User calibration may require specialist equipment (especially at higher gains). However, calibration may be checked by use of an external signal generator applied via the rear panel connector and a calibrated AC Digital Volt Meter (AC DVM).

A sinusoidal signal of frequency 70 Hz is recommended.

Input amplitude must be set so that the output amplitude does not exceed 10 V pk-pk.

Input and Output signal amplitudes can then be measured using a calibrated AC DVM and absolute gain accuracy derived.

### 7.2.1 Gain Adjustment

The fine gain corrections for this amplifier are stored in a non-volatile eeprom which is part of the PIC microcontroller.

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# 8 Appendix A: Specifications

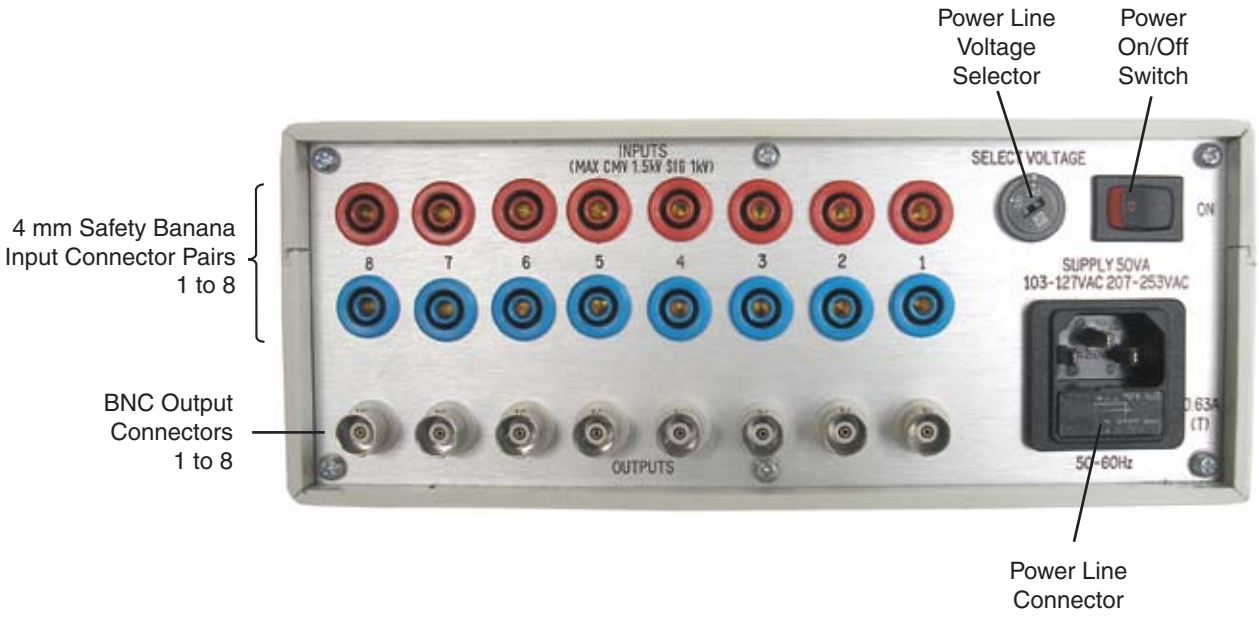
| | | |
|---|---|---|
| **8.1** | **Input** | |
| | **Voltage Ranges** | 5 ranges:<br>± 100 mV; ± 1 V; ± 10 V; ± 100 V; ± 1000 V<br>Maximum 1000 VDC or pk |
| | **Gain** | ÷ 100 to x100 |
| | **Protection** | Against incorrect gain setting up to maximum input |
| | **Impedance** | > 1 MΩ |
| | **CMRR** | > 150 dB (DC to 60 Hz)<br>@ Input range +/- 100 mV |
| | **Bandwidth** | DC - 50 kHz (-3 dB) |
| **8.1.1** | **Accuracy** | |
| | **Gain Accuracy** | ± 0.25% FS |
| | **Linearity** | ± 0.02% FS |
| | **Offset** | < 200 µV |
| | **Offset Drift** | < 10 µV/°C (Referred To Input) RTI |
| | **Gain Drift** | < 0,01 %/°C |
| | **Stability** | < 0.1% change over 12 months |
| | **Noise** | < 20 µV pk-pk (DC - 50 kHz) RTI |
| | **Isolation Voltage** | 1500 V DC or peak (tested 5 s @ 2500 V) |
| **8.2** | **Output** | |
| | **Voltage Range** | ± 10 V nominally |
| | **Signal Filter** | 3 pole Butterworth (60 dB/decade) |
| | **Noise** | < 2 mV RMS DC - 50 kHz |
| | **Offset** | < ± 15 mV |
| | **Offset Temp Coefficient** | < 1 mV/ °C |
| | **Load** | > 5 kΩ minimum |

| | | |
|---|---|---|
| **8.3** | **Physical Characteristics** | |
| | **Operating Temperature** | 0 - 50 °C |
| | **Power Supply Voltage** | 115/230 V, 50/60 Hz standard |
| | **Power Selection** | Through switch on the back panel |
| | **Power Consumption** | 8 slot mainframe fully loaded: 25 VA max. |
| | | 16 slot mainframe fully loaded: 50 VA max. |
| **8.3.1** | **Connectors** | |
| | **Input** | 2 x 4 mm Safety-Banana per channel |
| | **Output** | 1 BNC per channel |
| | All connectors are located on the back panel | |
| **8.3.2** | **Dimensions** | |
| | **8 slot Mainframe** | 220 x 350 x 90 mm (8.7" x 13.8" x 3.5") (W x D x H) |
| | **16 Slot Mainframe** | 450 x 350 x 90 mm (17.7" x 13.8" x 3.5") (W x D x H) |
| **8.3.3** | **Weight (fully loaded)** | |
| | 8 slot mainframe | 3.1 kg (6.8 lb) |
| | 16 slot mainframe | 6 kg (13.2 lb) |

# 9 Appendix B: Input and Output Connections

All input and output connections are located on the back panel. The power connection, Power On/Off switch, and power line voltage selector are also located on the back panel.

The figure below shows the portable eight channel housing.



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