Designed with State-of-the-art Analog Technology

ISOLATION AMPLIFIER

We welcome your requests for special specifications.

We are capable of accepting even a single piece order because of our unique high-mix-low-volume production system!

20 SERIES
Indispensable in highly noisy environments!

The 20 Series is able to be delivered quickly!

Product introduction and application examples

M-SYSTEM CO., LTD.
www.m-system.com
What is an Isolation Amplifier?

An isolation amplifier is an electronic circuit that electrically isolates analog input signals from output signals. Accurate signal measurement is possible by integrating an isolation amplifier into the input circuit or output circuit on a printed circuit board, such as a microcomputer control board, and galvanically isolating signals coming from the field side. An isolation amplifier provides significant benefits, including the suppression of noise, countermeasures against high ground potential, and signal splitting (responsibility demarcation) as well as the prevention of electric shocks.

Benefits of Adopting M-System’s Isolation Amplifier

The designing of an analog isolation circuit for a product under development needs advanced technology and extensive experience. M-System’s Isolation Amplifier saves efforts to design the isolation circuit, thus making it possible to shorten the total design period of your product.

Operating Principle of Isolation Amplifier

(The numbers in the following explanations refer to those in the diagram on the right-hand side)

When the input signal (voltage signal) to be measured is provided to buffer circuit 1, which has a sufficiently high input impedance not to affect the signal source, the same voltage as that of the input signal will appear on the output side. The output of buffer circuit 1 is connected to the primary side of the signal transformer, and the impedance of the output is sufficiently low so that the output voltage will not fluctuate even if the impedance of the signal transformer changes.

If the primary side and the secondary side of the signal transformer are repeatedly turned on and off simultaneously by switching element 1 and switching element 2, the voltage equal to that of the input signal on the primary side will appear on the capacitor connected to the secondary side according to the principle of synchronous rectification.

This voltage will be output via buffer circuit 2 that has a sufficiently high input impedance so that the voltage will not drop as a result of the discharge of electricity from the capacitor. The output impedance of buffer circuit 2 is set to a sufficiently low value so that the output voltage will not be affected by the input impedance on the equipment (load) side where the output signal is connected.

The oscillation frequency of the oscillator is set according to the frequency characteristics of the Isolation Amplifier. The design and quality of the signal transformer significantly affect the performance of the Isolation Amplifier.

High withstand voltage

The Isolation Amplifier achieves high withstand voltage performance by keeping a wide gap between the primary- and secondary-side coils of the signal transformer and that of the power transformer in the isolation section and molding on the circuit board.

Fast response

The Isolation Amplifier achieves fast response performance by increasing the oscillation frequency of the built-in oscillator up to 200 kHz making high-speed signal transfer possible in the isolation section.

Isolated circuit

Transformer isolation is one of the main features of M-System’s Isolation Amplifier. Transformer coupling provides a complete galvanic isolation and prevents electrical overstress. The square waves appearing on the primary-side coils of the signal transformer on and off repeatedly will bring electricity from the capacitor. The output impedance of buffer circuit 2 is set to a sufficiently low value so that the output voltage will not be affected by the input impedance on the equipment (load) side where the output signal is connected.

Buffer circuit 1

The buffer circuit 1 converts input signals having a sufficiently high input impedance into output signals having a sufficiently low output impedance.

Actual size

Example of 20VS2-01

PCB before mold processing

- 30 mm (1.18 in)
- 17 mm (0.67 in)

Surface

Back side
The Isolation Amplifier achieves fast response by repeatedly turning on and off simultaneously by switching elements. M-System's Isolation Amplifier is used for signal measurement by integrating an isolation amplifier into the input circuit or output circuit on a printed circuit board. Accurate isolation amplifiers are indispensable in highly noisy environments. The isolation amplifier saves efforts to design the isolation circuit, thus making it possible to shorten the total design period of your product.

**Oscillator**
The oscillator is a component that will start self-excited oscillation and generates square waves when DC power is supplied.

**Signal transformer**
The signal transformer is a component that transfers signals from the primary side to the secondary side on the principle of synchronous rectification by transformer coupling, which provides a complete galvanic isolation between the primary side and the secondary side.

**Capacitor**
The capacitor is a component that holds the voltage on the secondary side of the signal transformer during synchronous rectification.

**Buffer circuit 2**
Buffer circuit 2 is an I/O signal conversion circuit that converts input signals having a sufficiently high input impedance into output signals having a sufficiently low output impedance.

**Switching element**
The switching element is a device that turns the primary- and secondary-side coils of the signal transformer on and off according to square waves output from the oscillator.

**Power transformer**
The power transformer is a component that transfers square waves applied to the primary side to the secondary side by transformer coupling. The square waves appearing on the secondary side will be rectified at the moment they are applied to switching element 2 and serve as the power source of buffer circuit 2. Transformer coupling provides a complete galvanic isolation between the primary side and the secondary side.

**Example of 20VS2-01**
Actual size
PCB before mold processing

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4x Expanded

- Oscillator
- Signal transformer
- Capacitor
- Buffer circuit 2
- Switching element
- Power transformer

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Main Uses of 20 Series

① Anti-noise measures
Example: Automobile performance measurement

Shuts out the influence of noise

The installation environment of automobile performance measurement equipment has many sources of noise generation. The Isolation Amplifier is used to prevent the influence of noise on measured values.

② Measures against high ground potential
Example: Distributed Control System (DCS) of Thermal Power Plant

Shuts out the influence of stray currents

The Isolation Amplifier eliminates the effect of stray currents resulting from high ground potential and protects DCS I/O.

③ Signal splitting (Responsibility demarcation)
Example: Semiconductor (pre-process) manufacturing equipment

Prevents mutual interference

In the case of branching and supplying signals to more than one system, there will be no need to consider the mutual interference of the systems if the signals are split by a number of Isolation Amplifiers.

④ Electric shock prevention
Example: Power supply circuit in operation panel of medical equipment

Prevents electric shocks from medical equipment that handles high electric potential

Isolation Amplifiers are inserted into the key points of the circuit as safety measures to protect the operators of the medical equipment from electric shocks that may result from equipment malfunctioning.
### Application Examples of 20 Series

The Isolation Amplifier is used in many applications in various industries. Examples are shown below.

<table>
<thead>
<tr>
<th>Heavy duty and industrial equipment (in-plant equipment)</th>
<th>Distribution boards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Switches</td>
</tr>
<tr>
<td></td>
<td>Rolling equipment (Shape controllers)</td>
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<tr>
<td></td>
<td>High-frequency induction heating equipment (High-frequency inverter controllers)</td>
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<tr>
<td></td>
<td>Papermaking equipment (Pulp disintegrators)</td>
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<tr>
<td></td>
<td>Industrial robots (Isolation of control systems)</td>
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<td></td>
<td>Elevators (Abnormal speed governors for elevator cages)</td>
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<td></td>
<td>FA equipment</td>
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<td></td>
<td>Battery charge/discharge test equipment (High-speed charge/discharge monitoring equipment)</td>
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<tr>
<td></td>
<td>Electric welders (Laser waveform controllers)</td>
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<td></td>
<td>Ultrasonic cleaners</td>
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<tr>
<td></td>
<td>Automobile-related equipment (Automobile engine/motor test benches and electrical equipment testers)</td>
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<tr>
<td></td>
<td>Various types of high-pressure equipment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Power supplies and power generators</th>
<th>Large UPS units (Instantaneous blackout detectors)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Power generators (Rotation speed detectors)</td>
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<tr>
<td></td>
<td>Power transmission and transformation installations (Power supply controllers)</td>
</tr>
<tr>
<td></td>
<td>Switching power supplies</td>
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<tr>
<td></td>
<td>Solar power generation (Power conditioner controllers)</td>
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<tr>
<td></td>
<td>Wind power generation (Rotation speed detectors)</td>
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<tr>
<td></td>
<td>Biogas power generation (Turbine speed detectors)</td>
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<tr>
<td></td>
<td>Various types of power supply devices</td>
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<tr>
<td></td>
<td>(DC power supplies, CVCFs, high-voltage power supplies, and inverters for motor drives)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductor manufacturing equipment</th>
<th>Dry etching equipment (High-frequency power supplies)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sputtering equipment (Ion beam injectors)</td>
</tr>
<tr>
<td></td>
<td>Leak detector power supplies</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transport machines (vehicles)</th>
<th>Electric vehicles</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Fuel cell vehicles</td>
</tr>
<tr>
<td></td>
<td>Bullet trains</td>
</tr>
<tr>
<td></td>
<td>Rolling stocks (Current detector for VVVF inverters)</td>
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<tr>
<td></td>
<td>Aircraft</td>
</tr>
<tr>
<td></td>
<td>Ship</td>
</tr>
</tbody>
</table>

| Others | Communication equipment, measuring instruments, and some consumer equipment |

**Precautions for Product Usage**

- M-System’s products are designed and manufactured as general industrial equipment. Therefore, never use them for applications that need extremely high product reliability and safety for nuclear power control equipment, radiation-related equipment, railroad, aviation, and vehicle installations, aviation and aerospace equipment, underwater equipment, or medical equipment for life support.
- Every customer is requested to take safety measures when using M-System’s products with consideration of enough margins for their ratings and performance and the use of alarms and safety equipment for the customer’s entire system that incorporates the product.
### Application Examples of 20 Series

#### 20 Series  Withstand Voltage and Frequency Characteristics Chart

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Frequency</th>
<th>Accuracy (linearity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 V AC</td>
<td>1 kV</td>
<td>±0.005 % G = 1</td>
</tr>
<tr>
<td>2000 V AC</td>
<td>1 kV</td>
<td>±0.005 % G = 1</td>
</tr>
<tr>
<td>3000 V AC</td>
<td>1 kV</td>
<td>±0.005 % G = 1</td>
</tr>
<tr>
<td>4000 V AC</td>
<td>1 kV</td>
<td>±0.005 % G = 1</td>
</tr>
<tr>
<td>5000 V AC</td>
<td>1 kV</td>
<td>±0.005 % G = 1</td>
</tr>
</tbody>
</table>

#### Dielectric strength: 2000 V AC

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>20VS2-3</td>
<td>For narrow span, input isolation</td>
<td>Approx. 2 Hz (narrow span input), approx. 1 kHz (not narrow span input)</td>
</tr>
<tr>
<td>20VS2-4</td>
<td>Current output, output isolation</td>
<td>Approx. 200 Hz, ±0.05 %, 0 – 5 V DC, 0 – 20 mA DC, 0 – 10 V DC</td>
</tr>
<tr>
<td>20VS1D</td>
<td>Top adjustment, for current output, output isolation</td>
<td>Approx. 200 Hz, ±0.05 %, 0 – 5 V DC, 1 – 5 V DC, 10 V DC, 4 – 20 mA DC</td>
</tr>
</tbody>
</table>

#### Dielectric strength: 1500 V AC

<table>
<thead>
<tr>
<th>Device</th>
<th>Description</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>20VS3-U</td>
<td>3-port isolation</td>
<td>Approx. 1 kHz, ±0.0001 % TYP. G = 1 (±0.05 % max.), ±5 V DC/±5 V DC, 0 – 5 V DC, 0 – 5 V DC</td>
</tr>
<tr>
<td>20VS3-SW4W-U</td>
<td>3-port isolation</td>
<td>Approx. 1 kHz, ±0.0001 % TYP. G = 2 (±0.05 % max.), ±5 V DC/±5 V DC, 0 – 20 mA DC</td>
</tr>
<tr>
<td>20VS3-4W4W-U</td>
<td>3-port isolation</td>
<td>Approx. 1 kHz, ±0.0001 % TYP. G = 1 (±0.05 % max.), ±5 V DC/±5 V DC, 0 – 20 mA DC, 0 – 20 mA DC</td>
</tr>
</tbody>
</table>

#### Example: Power supply circuit in operation

- Example: Distributed Control System (DCS) of Thermal Power Plant
- Anti-noise measures (Responsibility demarcation)
- Example: Power supply circuit in operation

### Additional Notes

- Communication equipment, measuring instruments, and some consumer equipment
- Aircraft
- Rolling stocks (Current detector for VVVF inverters)
- Leak detector power supplies
- Power generators (Rotation speed detectors)
- High-frequency induction heating equipment (High-frequency inverter controllers)
Main Uses of 20 Series

Application Examples of 20 Series

The Isolation Amplifier is used in many applications, including:

- Communication equipment, measuring instruments, and some consumer equipment
- Fuel cell vehicles
- Biogas power generation (Turbine speed detectors)
- Wind power generation (Rotation speed detectors)
- Electric welders (Laser waveform controllers)
- Elevators (Abnormal speed governors for elevator cages)
- Industrial robots (Isolation of control systems)
- Switches
- Semiconductor
- etc.

Characteristics Chart

Dielectric strength: 5000 V AC

- **20VS4-384**: 5 kV input isolation
  - Input: 1 kHz
  - ±0.05 %
  - ±5 V DC/±5 V DC
  - Input to output or power

Dielectric strength: 3000 V AC

- **20VS8-202Yx**: Input isolation, SIP type
  - Input: 2 kHz
  - ±0.05 ~ ±0.012 %
  - ±5 V DC/±5 V DC
  - Input or reference voltage source to output or power supply

Dielectric strength: 2500 V AC

- **20VS5-210**: High-accuracy, input isolation, external synchronous
  - Input: 6 kHz
  - ±0.005 % TYP.
  - G = 1 (±0.01 % max.)
  - ±5 V DC/±5 V DC
  - Input or reference voltage source to output or power supply

Dielectric strength: 2300 V AC

- **20VS1B**: Input isolation
  - Input: 1 kHz
  - ±0.05 %
  - ±7.5 V DC
  - ±0.05 % max.
  - ±10 V DC
  - ±0.05 % max.
  - ±10 V DC/±10 V DC
  - Input to output or power

Dielectric strength: 1000 V AC

- **20VS6-251**: High-accuracy, input isolation
  - Input: 3 kHz
  - ±0.005 % TYP. G = 1
  - ±5 V DC/±5 V DC
  - Input to output or power

Clock Generator 20VS5-2

- Power Input: 15 V DC
- Clock Output
- Output voltage: 0 ~ 15 V DC ±5 % @ rated power
- Frequency: 210 kHz ±5 %
- Duty cycle: 50 % ±5 %
- Waveform: Square wave
- Fan-out: 8 of 20VS5-210, 20VS5-213

- **20VS5-210**: Ultra-high-speed response, input isolation
  - Input: 50 kHz
  - ±0.5 % TYP. G = 1
  - ±5 V DC/±5 V DC
  - Input or reference voltage source to output or power supply

- **20VS100**: Bi-directional amplifier
  - Input: 5 kHz
  - ±0.2 %
  - ±7 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±7 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±10 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±10 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - Input to output or power

- **20VS140**: Output isolation
  - Input: 5 kHz
  - ±0.05 %
  - ±7 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±7 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±10 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±10 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - Output to input or power

- **20VS150**: Input isolation
  - Input: 5 kHz
  - ±0.05 %
  - ±7 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±7 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±10 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - ±10 V DC @ 15 V power, ±5 V DC @ 11.5 V power
  - Input to output or power

- **20VS251**: High-accuracy, input isolation
  - Input: 3 kHz
  - ±0.005 % G = 1
  - ±5 V DC/±5 V DC
  - Input or reference voltage source to output or power supply
Operating Principle of Isolation Amplifier

When the input signal (voltage signal) to be measured is provided to buffer circuit 1, the voltage equal to that of the input signal on the secondary side will appear on the capacitor. The output of buffer circuit 1 is connected to the primary side of the signal transformer. Transformer coupling provides a complete galvanic isolation between the primary side and the secondary side.

Power transformer

The power transformer is a component that transfers square waves output from the oscillator. Synchronization signal is supplied. The oscillator is a component that will start self-excited oscillation and repeatedly turn on and off simultaneously by switching element 1. Power supply (15 V DC)

Capacitor

The capacitor is a component that holds the voltage on the secondary side will be rectified at the moment they are applied. Power transformer signifi cantly affect the performance of the Isolation Amplifier.

Signal transformer

The signal transformer is a component that transfers signals from the primary side to the secondary side on the principle of electromagnetic coupling. It consists of primary-side and secondary-side coils of the signal transformer and secondary-side coils of the signal transformer and circuit 1. When the input signal (voltage signal) to be measured is provided to buffer circuit 1, the voltage equal to that of the input signal on the secondary side will appear on the capacitor. The output of buffer circuit 1 is connected to the primary side of the signal transformer.

Synchronization signal

A span drift is a phenomenon in which the output signal deviates from 100 % at the time of 100 % input, and the less it is, the higher the performance of the Isolation Amplifier is.

Span Drift

The design and quality of the signal source, the same voltage as that of the input signal will appear on the secondary side. The output impedance of buffer circuit 2 is set to a sufficiently low value so that the output voltage will not be affected by the input impedance. The output impedance of buffer circuit 2 is set to a sufficiently low value so that the output voltage will not drop as a result of the discharge of the capacitor. This voltage will be output via buffer circuit 2.

Buffer circuit 2

Buffer circuit 2 is an I/O signal conversion circuit that converts input signals having a sufficiently high input impedance not to affect the characteristics of the Isolation Amplifier. The design and quality of the signal source, the same voltage as that of the input signal will appear on the secondary side.

Characteristics of the Isolation Amplifier

The oscillation frequency of the oscillator is sufficiently low value so that the output voltage will not be affected by the input impedance. Oscillator

The linearity of the 20 Series Isolation Amplifier is expressed by the extent of the deviation. The linearity of the 20 Series Isolation Amplifier is expressed by end-point detection linearity based on the deviation at 0 % I/O signals and that at 100 % I/O signals.

Linearity

The relationship of linearity between the input signal and output signal may slightly deviate from the ideal straight line in the case of measuring the output signal with the level of the input signal changed. Linearity refers to the extent of the deviation. The linearity of the 20 Series Isolation Amplifier is expressed by end-point detection linearity based on the deviation at 0 % I/O signals and that at 100 % I/O signals.

Temperature Coefficient ppm/°C

A temperature coefficient is usually obtained from the maximum change of the output signal divided by the full span of the output signal when the ambient temperature is increased or decreased from the reference temperature within the operating temperature range and expressed in percentage per Celsius degree. In the case of the 20 Series Isolation Amplifier, which has high accuracy, the temperature coefficient is expressed in parts per million (ppm).

Temperature Coefficient ppm/°C

A span drift is a phenomenon in which the output signal deviates from 100 % at the time of 100 % input, and the less it is, the higher the performance of the Isolation Amplifier is.

Span Drift

A drift is a phenomenon in which the operating point of the Isolation Amplifier in DC amplifying operation is shifted to cause erroneous output. A zero drift refers to an error output voltage appearing when the input voltage is zero, and the smaller it is, the higher the performance of the Isolation Amplifier is.

Zero Drift

A gain is a ratio of the input to the output. For example, if the gain is expressed as x1±1 %, it means that output at 10 V will appear against input at 10 V with a dispersion of 1 % (±200 mV as 1 % of the span of 20 V) when the input and output range is ±10 V.

Conversion Gain

The input offset is the output signal voltage deviated from 0 V when the input is short-circuited.

Input Offset

An input bias current flows into or flows out of the input terminals under the control of the first-stage operational amplifier.

Input Bias Current

Output impedance refers to the internal impedance of the output circuit viewed from the load side.

Output Impedance

For example, 1 kHz - 3 dB represents the attenuation of input from the initial value (DC input) when the input is a 1 kHz sinusoidal wave signal, and -3 dB means that the level of the signal will be 70.7 % of the original signal.

Frequency Characteristics

Specifications are subject to change without notice. When ordering, use the latest data sheets available at M-System web site: www.m-system.com