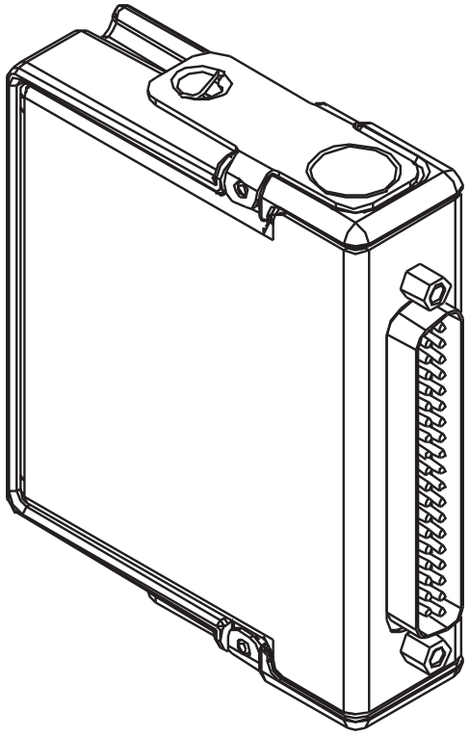
OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI 9381

0 V to 5 V, 12-Bit, Multifunction Input/Output Module

Français Deutsch 日本語 한국어 简体中文

ni.com/manuals



NATIONAL INSTRUMENTS™

This document describes how to use the National Instruments 9381 and includes specifications and pin assignments for the NI 9381. For information about installing, configuring, and programming the system, refer to the system documentation. Visit `ni.com/info` and enter the following Info Codes:

- `cseriesdoc`—for information about C Series and system documentation.
- `compatibility`—for information about chassis and carrier compatibility for the modules you are using.
- `rdsoftwareversion`—for information about which software you need for the modules you are using.

Note The safety guidelines and specifications in this document are specific to the NI 9381. The other components in the system might not meet the same safety ratings and specifications. Refer to the documentation for each component in the system to determine the safety ratings and specifications for the entire system. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Safety Guidelines

Operate the NI 9381 only as described in these operating instructions.

Hot Surface This icon denotes that the component may be hot. Touching this component may result in bodily injury.

Caution Do not operate the NI 9381 in a manner not specified in these operating instructions. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to National Instruments for repair

Safety Guidelines for Hazardous Locations

The NI 9381 is suitable for use in Class I, Division 2, Groups A, B, C, D, T4 hazardous locations; Class I, Zone 2, AEx nA IIC T4, and Ex nA IIC T4 hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the NI 9381 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.

Caution Do *not* disconnect I/O-side wires or connectors unless power has been switched off or the area is known to be nonhazardous.

Caution Do *not* remove modules unless power has been switched off or the area is known to be nonhazardous.

Caution Substitution of components may impair suitability for Class I, Division 2.

Caution For Division 2 and Zone 2 applications, install the system in an enclosure rated to at least IP 54 as defined by IEC/EN 60529.

Caution For Division 2 and Zone 2 applications, connected low impedance sources must include a protection device installed between the source and the AI and DIO terminals. The protection device must prevent the AI to ground voltage and DIO to ground voltage from exceeding 42 V if there is a transient overvoltage condition.

Special Conditions for Hazardous Locations Use in Europe

This equipment has been evaluated as Ex nA IIC T4 Gc equipment under DEMKO 12 ATEX 1202658X. Each module is marked ⟨Ex⟩ II 3G and is suitable for use in Zone 2 hazardous locations, in ambient temperatures of –40 °C ≤ Ta ≤ 70 °C. If you are using the NI 9381 in Gas Group IIC hazardous locations, you must use the device in an NI chassis that has been evaluated as Ex nC IIC T4, EEx nC IIC T4, Ex nA IIC T4, or Ex nL IIC T4 equipment.

Caution You *must* make sure that transient disturbances do not exceed 140% of the rated voltage.

Caution The system shall be mounted in an ATEX certified enclosure with a minimum ingress protection rating of at least IP54 as defined in IEC/EN 60529 and used in an environment of not more than Pollution Degree 2.

Caution The enclosure must have a door or cover accessible only by the use of a tool.

Electromagnetic Compatibility Guidelines

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) as stated in the product specifications. These requirements and limits are designed to provide reasonable protection against harmful interference when the product is operated in its intended operational electromagnetic environment.

This product is intended for use in industrial locations. There is no guarantee that harmful interference will not occur in a particular installation, when the product is connected to a test object, or if the product is used in residential areas. To minimize the potential for the product to cause interference to radio and television reception or to experience unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any changes or modifications to the product not expressly approved by National Instruments could void your authority to operate it under your local regulatory rules.

Caution To ensure the specified EMC performance, operate this product only with shielded cables and accessories.

Special Guidelines for Marine Applications

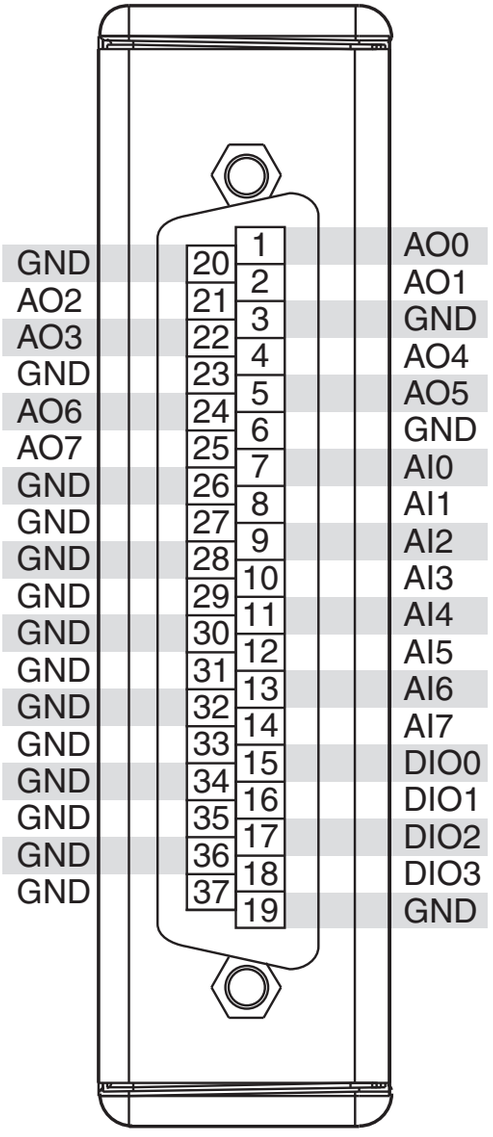
Some products are Lloyd's Register (LR) Type Approved for marine (shipboard) applications. To verify Lloyd's Register certification for a product, visit `ni.com/certification` and search for the LR certificate, or look for the Lloyd's Register mark on the product label.

Caution In order to meet the EMC requirements for marine applications, install the product in a shielded enclosure with shielded and/or filtered power and input/output ports. In addition, take precautions when designing, selecting, and installing measurement probes and cables to ensure that the desired EMC performance is attained.

Connecting the NI 9381

The NI 9381 provides connections for 8 analog input channels, 8 analog output channels, and 4 DIO channels.

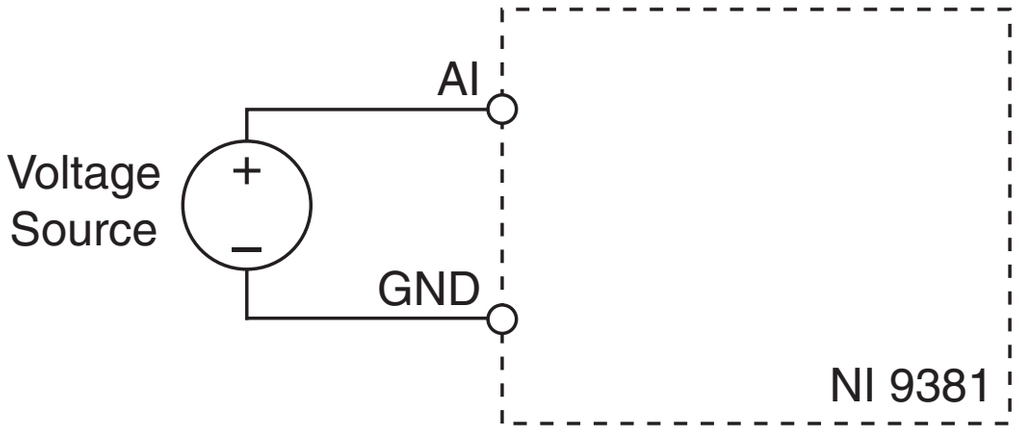
Figure 1. NI 9381 Pin Assignments



Connecting Single-Ended Voltage Signals

Refer to Figure 2 for an illustration of connecting single-ended voltage signals to the module.

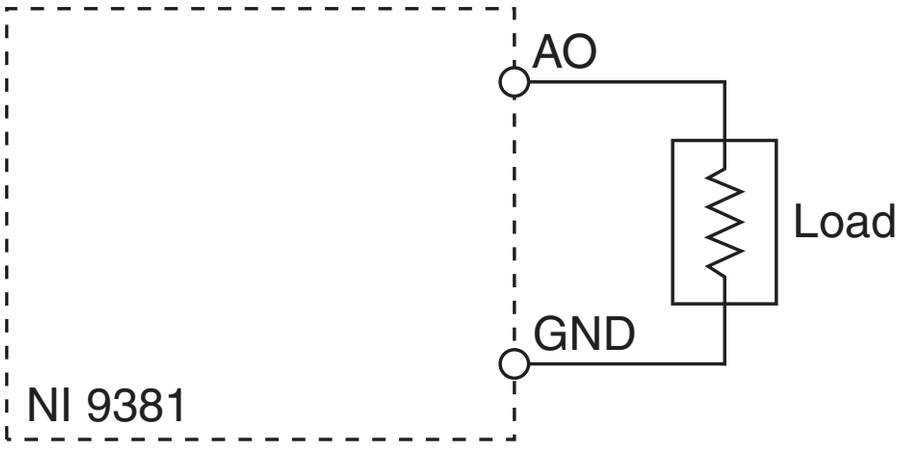
Figure 2. Connecting a Single-Ended Voltage Signal to the Module



Connecting a Load

Refer to Figure 3 for an illustration of connecting a load to the module.

Figure 3. Connecting a Load to the Module



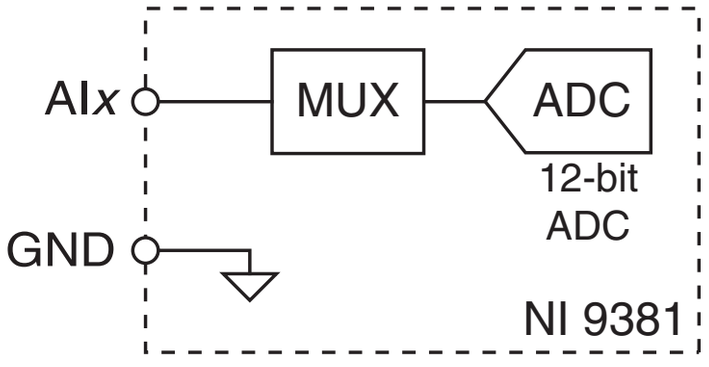
NI 9381 Circuitry

The module provides an analog-to-digital converter (ADC), eight digital-to-analog converters (DAC), and four digital lines.

Analog Input

The analog input channels are conditioned and sampled by a 12-bit ADC.

Figure 4. NI 9381 Analog Input Circuitry for One Channel



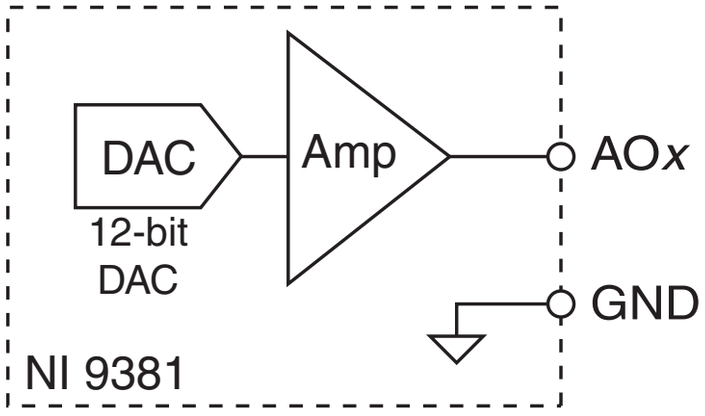
Analog Input Accuracy

To ensure fast settling times, use signal sources that have an impedance smaller than 1 kΩ. Large source impedances increase the settling time of the ADC, which decreases the accuracy at fast scanning rates.

Analog Output

The analog output channels have a DAC that produces a voltage signal.

Figure 5. NI 9381 Analog Output Circuitry for One Channel

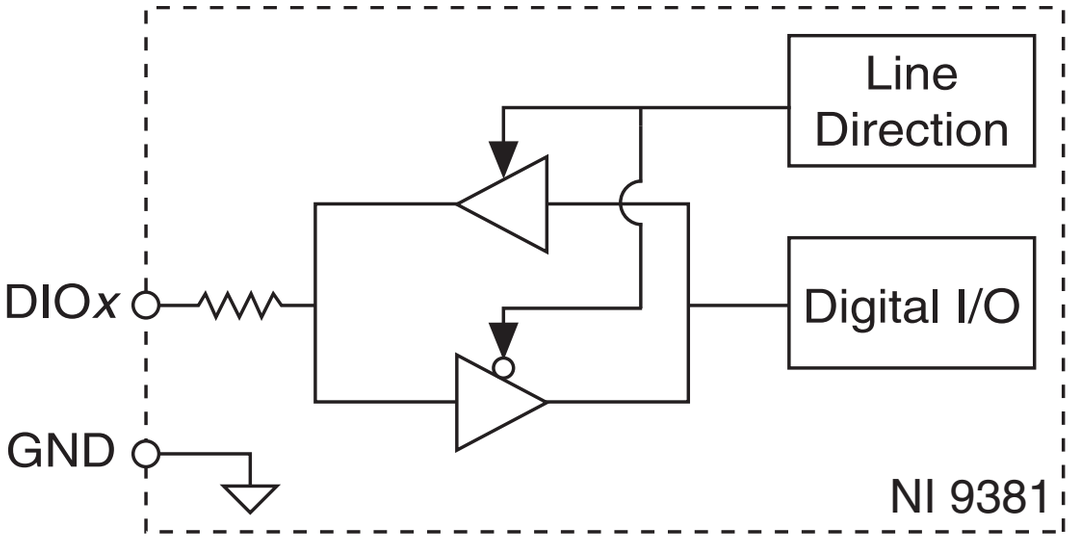


Digital Input/Output

You can configure each DIO channel of the NI 9381 in software for input or output. Changing the direction on any channel will not affect the direction on the other channels. Refer to the software help for information about configuring channel direction.

Line direction logic enables/disables the line input and output transceiver.

Figure 6. NI 9381 Digital Input/Output for One Channel



Timing Considerations

You can use the AI, AO, and DIO channels on the NI 9381 concurrently. However, you should consider the following guidelines when designing your application to ensure high accuracy.

- Use a single I/O Node to access AI and AO operations to ensure proper sequencing.
- Configure the line direction of the DIO channels before performing operations on other channels or stop all operations to change the line direction of a DIO channel.

Refer to the *NI-RIO Software Help* for more information about NI 9381 timing.

Sleep Mode

This module supports a low-power sleep mode. Support for sleep mode at the system level depends on the chassis that the module is plugged into. Refer to the chassis manual for information about support for sleep mode. If the chassis supports sleep mode, refer to the software help for information about enabling sleep mode. Visit `ni.com/info` and enter `cseriesdoc` for information about C Series documentation.

Typically, when a system is in sleep mode, you cannot communicate with the modules. In sleep mode, the system consumes minimal power and may dissipate less heat than it does in normal mode. Refer to the *Specifications* section for more information about power consumption and thermal dissipation.

Specifications

The following specifications are typical for the range –40 °C to 70 °C unless otherwise noted.

Input/Output Characteristics

MTBF ..... Contact NI for Bellcore MTBF or MIL-HDBK-217F specifications.

Analog Input

Number of channels ..... 8 single-ended analog input channels

ADC resolution ..... 12 bits

Type of ADC ..... Successive approximation register (SAR)

Input range ..... 0 V to 5 V ±1%

DNL ..... ±1.25 LSB

Conversion time ..... 50 µs (20 kS/s)

Input coupling ..... DC

Input impedance ..... 1 MΩ in parallel with 50 pF

Bandwidth..... 1 kHz

Accuracy[1]

Measurement Conditions	Percent of Reading (Gain Error)	Offset Error
Calibrated max (–40 °C to 70 °C)	±0.70%	±13 mV
Calibrated typ (23 °C ±5 °C)	±0.15%	±6.5 mV
Uncalibrated max (–40 °C to 70 °C)	±1.00%	±16 mV
Uncalibrated typ (23 °C ±5 °C)	±0.50%	±7.5 mV

Stability

Gain drift ..... 80 ppm/°C

Offset drift ..... 85 µV/°C

Analog Output

Number of channels..... 8 analog output channels

DAC resolution..... 12 bits

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[1] Accuracy is impacted for AC signals by an amount equal to 4.0*f* µV, where *f* is the signal frequency in hertz.

Type of DAC..... String

Startup voltage..... 0 V

Output range..... 0 V to 5 V ±1%

Current drive..... ±1 mA

Output impedance..... 5 Ω

Accuracy[1]

Measurement Conditions	Percent of Reading (Gain Error)	Offset Error
Calibrated max (–40 °C to 70 °C)	±1.02%	±23.5 mV
Calibrated typ (23 °C ±5 °C)	±0.19%	±5 mV
Uncalibrated max (–40 °C to 70 °C)	±1.9%	±50 mV
Uncalibrated typ (23 °C ±5 °C)	±0.6%	±10 mV

[1] Accuracy is impacted for AC signals by an amount equal to $4.0f$ µV, where f is the signal frequency in hertz.

Stability

- Gain drift ..... 85 ppm/°C
- Offset drift ..... 180 µV/°C

Update time ..... 50 µs (20 kS/s)

Short-circuit protection ..... Indefinitely

Slew rate ..... 30 V/ms

Settling time ..... 900 µs

DNL ..... ±1 LSB

Capacitive drive ..... 1,500 pF

Digital Input/Output

Number of channels ..... 4 digital input/output channels

Default power-on line direction ..... Input

Input/output type ..... LVTTL, single-ended

Digital logic levels

- Maximum input voltage ..... 5.2 V
  - Input high, V_{IH} ..... 2 V
  - Input low, V_{IL} ..... 0.8 V
- Output high, V_{OH}
  - Sourcing 100 µA ..... 2.7 V
- Output low, V_{OL}
  - Sinking 100 µA ..... 0.2 V

Maximum I/O switching frequency ..... 1 MHz

Capacitive drive ..... 100 pF

Power Requirements

Power consumption from chassis

- Active mode ..... 600 mW max
- Sleep mode ..... 1 mW max

Thermal dissipation (at 70 °C)

- Active mode ..... 600 mW max
- Sleep mode ..... 1 mW max

Physical Characteristics

If you need to clean the module, wipe it with a dry towel.

Note For two-dimensional drawings and three-dimensional models of the C Series module and connectors, visit `ni.com/dimensions` and search by module number.

Weight ..... 145 g (5.1 oz)

Safety

Isolation Voltages

Channel-to-channel ..... None

Channel-to-earth ground ..... None

Hazardous Locations

U.S. (UL) ..... Class I, Division 2,
Groups A, B, C, D, T4;
Class I, Zone 2,
AEx nA IIC T4

Canada (C-UL) ..... Class I, Division 2,
Groups A, B, C, D, T4;
Class I, Zone 2,
Ex nA IIC T4

Europe (DEMKO) ..... Ex nA IIC T4 Gc

Safety Standards

This product meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326-1 (IEC 61326-1): Class A emissions; Industrial immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note In the United States (per FCC 47 CFR), Class A equipment is intended for use in commercial, light-industrial, and heavy-industrial locations. In Europe, Canada, Australia and New Zealand (per CISPR 11) Class A equipment is intended for use only in heavy-industrial locations.

Note Group 1 equipment (per CISPR 11) is any industrial, scientific, or medical equipment that does not intentionally generates radio frequency energy for the treatment of material or inspection/analysis purposes.

Note For EMC declarations and certifications, refer to the *Online Product Certification* section.

CE Compliance CE

This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

To obtain product certifications and the Declaration of Conformity (DoC) for this product, visit `ni.com/certification`, search by module number or product line, and click the appropriate link in the Certification column.

Shock and Vibration

To meet these specifications, you must panel mount the system.

Operating vibration

Random (IEC 60068-2-64)..... 5 g_{rms}, 10 Hz to 500 Hz

Sinusoidal (IEC 60068-2-6) ..... 5 g, 10 Hz to 500 Hz

Operating shock
(IEC 60068-2-27)..... 30 g, 11 ms half sine,
50 g, 3 ms half sine,
18 shocks at 6 orientations

Environmental

Refer to the manual for the chassis you are using for more information about meeting these specifications.

Operating temperature
(IEC 60068-2-1, IEC 60068-2-2) ..... –40 °C to 70 °C

Storage temperature
(IEC 60068-2-1, IEC 60068-2-2) ..... –40 °C to 85 °C

Ingress protection..... IP 40

Operating humidity
(IEC 60068-2-56)..... 10% to 90% RH,
noncondensing

Storage humidity
(IEC 60068-2-56)..... 5% to 95% RH, noncondensing

Pollution Degree 2

Maximum altitude..... 2,000 m

Indoor use only.

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at `ni.com/environment`. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of the product life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers,

National Instruments WEEE initiatives, and compliance with WEEE Directive 2002/96/EC on Waste and Electronic Equipment, visit ni.com/environment/weee.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。关于 National Instruments 中国 RoHS 合规性信息，请登录 ni.com/environment/rohs_china。 (For information about China RoHS compliance, go to ni.com/environment/rohs_china.)

Calibration

You can obtain the calibration certificate and information about calibration services for the NI 9381 at ni.com/calibration.

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development

self-help resources to email and phone assistance from NI Application Engineers.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world to help address your support needs. For telephone support in the United States, create your service request at `ni.com/support` and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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