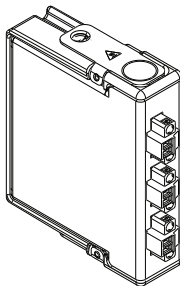OPERATING INSTRUCTIONS AND SPECIFICATIONS

NI 9225

3-Channel, 300 V$_{rms}$, 24-Bit Simultaneous,
Channel-to-Channel Isolated Analog Input Module

Français	Deutsch	日本語	한국어	简体中文

ni.com/manuals

This document describes how to use the NI 9225 and includes specifications and pin assignments for the NI 9225.

✎ **Note** The safety guidelines and specifications in this document are specific to the NI 9225. 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.

Related Information

**NI CompactDAQ &
NI CompactRIO Documentation**
ni.com/info ⇨ cseriesdoc

Chassis Compatibility
ni.com/info ⇨ compatibility

Software Support
ni.com/info ⇨ softwareversion

Services
ni.com/services

Safety Guidelines

Operate the NI 9225 only as described in these operating instructions.

⚡ **Hazardous Voltage** This icon denotes a warning advising you to take precautions to avoid electrical shock.

⚠ **Caution** Do not operate the NI 9225 in a manner not specified in this manual. 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 NI for repair.

Safety Guidelines for Hazardous Voltages

If hazardous voltages are connected to the module, take the following precautions. A hazardous voltage is a voltage greater than 42.4 V_{pk} or 60 VDC to earth ground.

⚠ **Caution** Ensure that hazardous voltage wiring is performed only by qualified personnel adhering to local electrical standards.

⚠ **Caution** Do *not* mix hazardous voltage circuits and human-accessible circuits on the same module.

⚠ **Caution** Make sure that devices and circuits connected to the module are properly insulated from human contact.

⚠ **Caution** When module terminals are hazardous voltage LIVE (>42.4 V_{pk}/60 VDC), you must ensure that devices and circuits connected to the module are properly insulated from human contact. You must use the NI 9971 connector backshell kit for the screw terminal and the NI 9990 connector backshell kit for the snap in terminal to ensure that the terminals are *not* accessible.

Figure 1 shows the NI 9971 connector backshell.

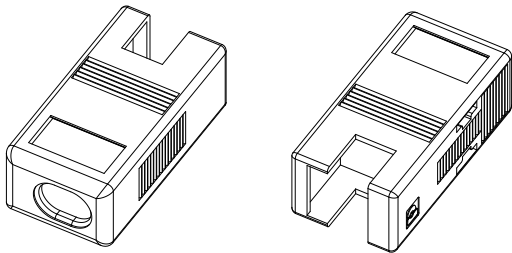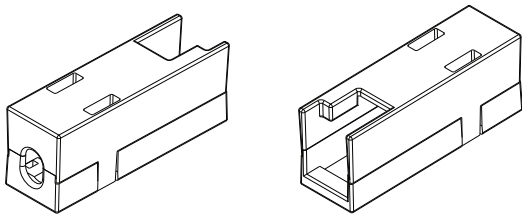**Figure 1.** NI 9971 Connector Backshell for Screw Terminal

Figure 2 shows the NI 9990 connector backshell.

Figure 2. NI 9990 Connector Backshell for Snap in Terminal

Safety Guidelines for Hazardous Locations

The NI 9225 is suitable for use in Class I, Div 2, Gr A, B, C, D, T4 and Class I, Zn 2, Gr IIC, T4 hazardous locations, and nonhazardous locations only. Follow these guidelines if you are installing the NI 9225 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 Zone 2 applications, install the system in an enclosure rated to at least IP 54 as defined by IEC 60529 and EN 60529.

Special Conditions for Marine Applications

To verify marine approval certification for a product, refer to the product label or visit ni.com/certification and search for the certificate.

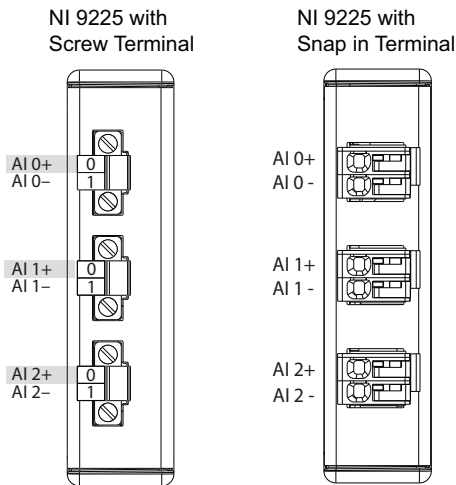⚠ **Caution** To meet radio frequency emission requirements for marine applications, use shielded cables and install the system in a metal enclosure. Suppression ferrites must be installed on power supply inputs near power entries to modules and controllers. Power supply and module cables must be separated on opposite sides of the enclosure and must enter and exit through opposing enclosure walls.

Connecting the NI 9225

The NI 9225 has three 2-terminal detachable screw terminal or snap in connectors that provide connections for three simultaneously sampled, isolated analog input channels.

Figure 3. NI 9225 Terminal Assignments

NI 9225 with
Screw Terminal

NI 9225 with
Snap in Terminal

AI 0+
AI 0−

AI 1+
AI 1−

AI 2+
AI 2−

AI 0+
AI 0 -

AI 1+
AI 1 -

AI 2+
AI 2 -

You can connect ground-referenced or floating signal sources to the NI 9225. Connect the positive signal of the signal source to the AI+ terminal, and connect the negative signal of the signal source

to the AI- terminal. If you make a ground-referenced connection between the signal source and the NI 9225, make sure the voltage on the AI+ and AI- connections are in the channel-to-earth safety voltage range to ensure proper operation of the NI 9225. Refer to the *Specifications* section for more information about operating voltages and overvoltage protection.

> **Note** You must use 2-wire ferrules to create a secure connection when connecting more than one wire to a single terminal on the NI 9225.

Refer to Figures 4 and 5 for illustrations of how to connect grounded and floating signal sources to the NI 9225.

Figure 4. Connecting a Grounded Signal Source to the NI 9225
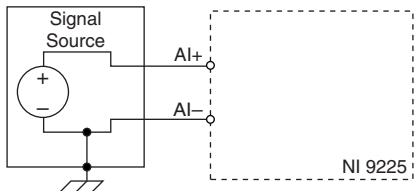
Figure 5. Connecting a Floating Signal Source to the NI 9225
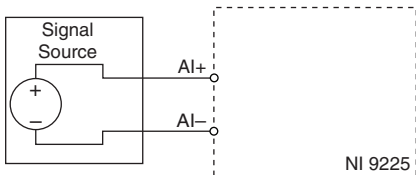
The NI 9225 analog input channels are floating with respect to earth ground and each other. The incoming analog signal on each channel is conditioned, buffered, and then sampled by a 24-bit Delta-Sigma ADC.

Each channel provides an independent signal path and ADC, enabling you to sample all three channels simultaneously. Refer to Figure 6 for an illustration of the circuitry for one channel of the NI 9225.

Figure 6. Input Circuitry for One Channel of the NI 9225
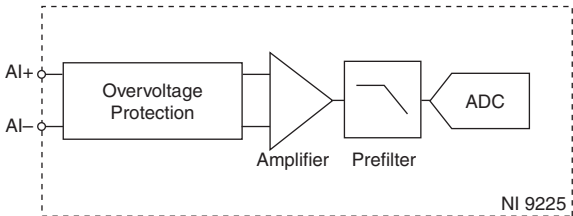
Wiring for High-Vibration Applications

If an application is subject to high vibration, NI recommends that you either use ferrules to terminate wires to the detachable screw terminal or snap in connector or use the NI 9971 backshell kit for screw terminal connectors or NI 9990 backshell kit for snap in connectors to protect the connections. Refer to Figures 7 and 8 for illustrations of using ferrules. Refer to Figures 1 and 2 for illustrations of the NI 9971 and NI 9990 connector backshells.

Figure 7. 2-Terminal Detachable Screw Terminal Connector with Ferrule
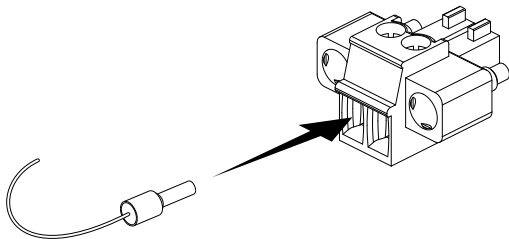
Figure 8. Snap in Terminal Connector with Ferrule
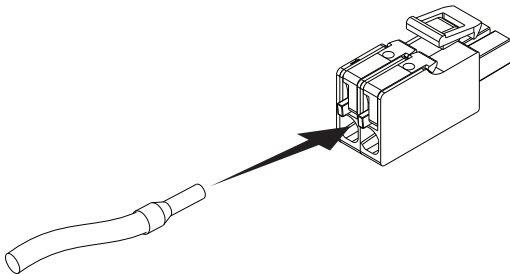
Manually Activating the Clamping Feature for 26 to 22 AWG Wire Size Applications

📝 **Note** The terminal will work with 0.25 mm² to 0.34 mm² (26 to 22 AWG) copper when manually activated.

Complete the following steps to activate the clamping feature manually.

1. Insert the wire inside the terminal, as shown in Figure A.

2. Using a tool with a small bit size, gently apply force as shown in Figure B and at the contact area as shown in Figure C until you hear a click sound.

3. Ensure the wire is inserted up to the end by gently pulling the wire to make sure the clamping feature securely engaged with the wire.

Figure 9. Manually Activating the Clamping Feature

Figure A

Figure B

Figure C
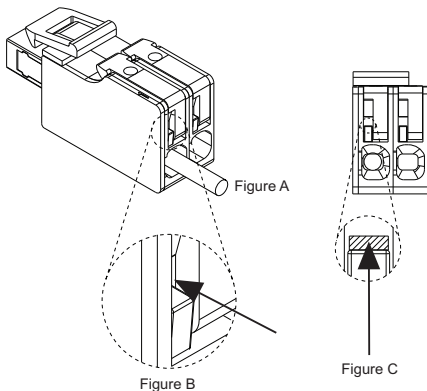
Understanding NI 9225 Filtering

The NI 9225 uses a combination of analog and digital filtering to provide an accurate representation of in-band signals while rejecting out-of-band signals. The filters discriminate between signals based on the frequency range, or bandwidth, of the signal. The three important bandwidths to consider are the passband, the stopband, and the alias-free bandwidth.

The NI 9225 represents signals within the passband, as quantified primarily by passband flatness and phase nonlinearity. All signals that appear in the alias-free bandwidth are either unaliased signals or signals that have been filtered by at least the amount of the stopband rejection.

Passband

The signals within the passband have frequency-dependent gain or attenuation. The small amount of variation in gain with respect to frequency is called the passband flatness. The digital filters of the NI 9225 adjust the frequency range of the passband to match the data rate. Therefore, the amount of gain or attenuation at a given frequency depends on the data rate. Figure 10 shows typical passband flatness for the NI 9225.

Figure 10. Typical Passband Response of the NI 9225
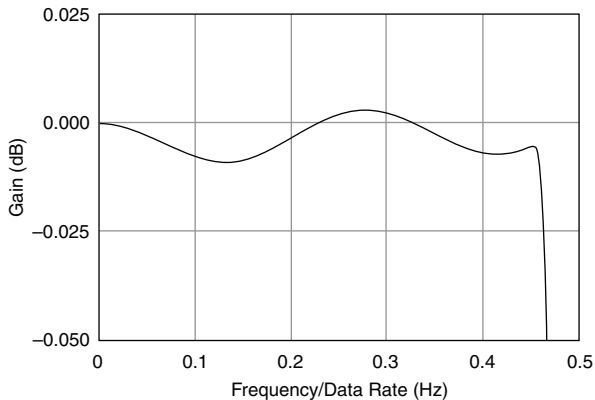
Stopband

The filter significantly attenuates all signals above the stopband frequency. The primary goal of the filter is to prevent aliasing. Therefore, the stopband frequency scales precisely with the data rate. The stopband rejection is the minimum amount of attenuation applied by the filter to all signals with frequencies within the stopband.

Alias-Free Bandwidth

Any signal that appears in the alias-free bandwidth of the NI 9225 is not an aliased artifact of signals at a higher frequency. The alias-free bandwidth is defined by the ability of the filter to reject frequencies above the stopband frequency and equals the data rate minus the stopband frequency.

Understanding NI 9225 Data Rates

The frequency of a master timebase (f_M) controls the data rate (f_s) of the NI 9225. The NI 9225 includes an internal master timebase with a frequency of 12.8 MHz, but the module also can accept an external master timebase or export its own master timebase. To synchronize the data rate of an NI 9225 with other modules that use master timebases to control sampling, all of the modules must

share a single master timebase source. Refer to the software help for information about configuring the master timebase source for the NI 9225. Visit ni.com/info and enter cseriesdoc for information about C Series documentation.

The following equation provides the available data rates of the NI 9225:

$$f_s = \frac{f_M \div 256}{n}$$

where *n* is any integer from 1 to 31.

However, the data rate must remain within the appropriate data rate range. Refer to the *Specifications* section for more information about the data rate range. When using the internal master timebase of 12.8 MHz, the result is data rates of 50 kS/s, 25 kS/s, 16.667 kS/s, and so on down to 1.613 kS/s, depending on the value of *n*. When using an external timebase with a frequency other than 12.8 MHz, the NI 9225 has a different set of data rates.

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 to 70 °C unless otherwise noted. All voltages are relative to the AI- signal on each channel unless otherwise noted.

Input Characteristics

Number of channels .... 3 analog input channels

ADC resolution .... 24 bits

Type of ADC .... Delta-Sigma (with analog prefiltering)

Sampling mode .... Simultaneous

Internal master timebase (f_M)

    Frequency .... 12.8 MHz

    Accuracy .... ±100 ppm max

Data rate range (f_s) using internal master timebase

    Minimum .... 1.613 kS/s

    Maximum .... 50 kS/s

Data rate range (f_s) using external master timebase

    Minimum .... 390.625 S/s

    Maximum .... 51.36 kS/s

Data rates[1] (f_s) .... $\dfrac{f_M \div 256}{n}$, $n = 1, 2, ..., 31$

Operating voltage ranges[2]

    Minimum .... 294 V_{rms}

    Typical .... 300 V_{rms}

Typical scaling coefficient .... 50.66 µV/LSB

Overvoltage protection .... ±450 VDC

Input coupling .... DC

Input impedance (AI+ to AI-) .... 1 MΩ

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[1] The data rate must remain within the appropriate data rate range. Refer to the *Understanding NI 9225 Data Rates* section for more information.

[2] Refer to the *Safety Guidelines* section for more information about safe operating voltages.

Accuracy

Measurement Conditions	Percent of Reading (Gain Error)	Percent of Range[*] (Offset Error)
Calibrated max (-40 to 70 °C)	±0.23%	±0.05%
Calibrated typ (25 °C, ±5 °C)	±0.05%	±0.008%
Calibrated max (25 °C, ±15 °C)	±0.084%	±0.016%
Uncalibrated max (-40 to 70 °C)	±1.6%	±0.66%
Uncalibrated typ (25 °C, ±5 °C)	±0.4%	±0.09%
[*] Range equals 425 V.		

Input noise .... 2 mV$_{rms}$

Stability

    Gain drift .... ±10 ppm/°C

    Offset drift .... ±970 µV/°C

Post calibration gain match
(ch-to-ch, 20 kHz) .... ±0.25 dB max

Crosstalk (60 Hz) .... –130 dB

Phase match

    Ch-to-ch, max .... 0.035°/kHz

    Module-to-module, max .... $0.035°/kHz + 360° \cdot f_{in}/f_M$

Phase linearity (f_s = 50 kS/s) .... 0.22° max

Input delay .... $40\dfrac{5}{512}/f_s + 3.6$ μs

Passband

    Frequency .... $0.453 \cdot f_s$

    Flatness (f_s = 50 kS/s) .... ±100 mdB max

Stopband

    Frequency .... $0.547 \cdot f_s$

    Rejection .... -100 dB

Alias-free bandwidth .... $0.453 \cdot f_s$

-3 dB bandwidth (f_s = 50 kS/s) .... 24.56 kHz

CMRR (f_{in} = 60 Hz) .... 104 dB

SFDR (1 kHz, -60 dBFS) .... 128 dBFS

Total Harmonic Distortion (THD)
(1 kHz, -20 dB)...................................-95 dB

MTBF ....301,606 hours at 25 °C;
Bellcore Issue 2, Method 1,
Case 3, Limited Part Stress
Method

Note Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Power consumption from chassis

Active mode ....495 mW max

Sleep mode ....25 µW max

Thermal dissipation (at 70 °C)

Active mode ....760 mW max

Sleep mode ....265 mW max

Physical Characteristics

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

Weight

NI 9225 with screw terminal......141 g (5.0 oz)

NI 9225 with snap in terminal....149.5 g (5.3 oz)

Screw Terminal Wiring

Gauge ....0.05 mm^2 to 1.5 mm^2
(30 AWG to 16 AWG)
copper conductor wire

Wire strip length.........................6 mm (0.24 in.) of
insulation stripped from the
end

Temperature rating...........................90° C, minimum

Torque for screw terminals ....0.22 N · m to 0.25 N · m
(1.95 lb · in to 2.21 lb · in.)

Wires per screw terminal ....One wire per screw terminal;
two wires screw terminal
using a 2-wire ferrule

Ferrules   0.25 mm^2 to 1.5 mm^2

Connector securement

    Securement type ....Screw flanges provided

Snap in Terminal Wiring

    Gauge ....0.5 mm^2 to 2.5 mm^2
                                     (20 AWG to 14 AWG)
                                     copper conductor wire

    Wire strip length.........................9 mm ± 1 mm (0.35 in. ±
                                     0.04 in.) wire strip length of
                                     insulation stripped from the
                                     end

    Temperature rating...........................90° C, minimum

Wires per snap in terminal ....One wire per snap in
                                     terminal; two wires per snap
                                     in terminal using a 2-wire
                                     ferrule

Ferrules ....0.5 mm^2 to 2.5 mm^2

Connector securement

    Securement type ....Snap in securement provided

Safety

Maximum Voltage

Connect only voltages that are within the following limits.

AI+ to AI- .... 300 V_{rms} max

Isolation Voltages

Channel-to-channel

    Continuous .... 600 V_{rms}, Measurement
        Category II

    Withstand.................................... 2,300 V_{rms}, verified by a 5 s
        dielectric withstand test

Channel-to-earth ground

    Continuous .... 300 V_{rms}, Measurement
        Category II

    Withstand.................................... 2,300 V_{rms}, verified by a 5 s
        dielectric withstand test

Measurement Category II is for measurements performed on
circuits directly connected to the electrical distribution system.
This category refers to local-level electrical distribution, such as

that provided by a standard wall outlet, for example, 115 V for U.S. or 230 V for Europe.

⚠️ **Caution** Do *not* connect the NI 9225 to signals or use for measurements within Measurement Categories III or IV.

Safety Standards

This product is designed to meet 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 visit ni.com/certification, search for the module number or product line, and click the appropriate link in the Certification column.

Hazardous Locations

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

Class I, Zone 2,
                                    IIC T4

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

Environmental

NI C Series modules are intended for indoor use only but may be used outdoors if installed in a suitable enclosure. 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 to 70 °C

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

Ingress protection..............................IP 40

Operating humidity
(IEC 60068-2-78)..............................10 to 90% RH,
                                    noncondensing

Storage humidity
(IEC 60068-2-78)..............................5 to 95% RH,
noncondensing

Maximum altitude.............................2,000 m

Pollution Degree (IEC 60664)..........2

Shock and Vibration

To meet these specifications, you must panel mount the system and either affix ferrules to the ends of the terminal wires or use the NI 9971 or NI 9990 backshell kit to protect the connections.

Operating vibration

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

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

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
- ICES-001: Class A emissions

Note For EMC compliance, operate this device with shielded cabling.

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 *Minimize Our Environmental Impact* 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, NI 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 9225 at ni.com/calibration.

Calibration interval .... 1 year

NI Services

The NI website 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.

Visit ni.com/services for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit ni.com/register to register your NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

A Declaration of Conformity (DoC) is our claim of compliance with the Council of the European Communities using the manufacturer's declaration of conformity. This system affords the user protection for electromagnetic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting ni.com/certification. If your product supports calibration, you can obtain the calibration certificate for your product at ni.com/calibration.

NI corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. NI also has offices

located around the world. For telephone support in the United States, create your service request at ni.com/support or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the Worldwide Offices section of ni.com/niglobal to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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