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TRC-8543

2022-06-30

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Overview

This document explains how to connect the TRC-8543.

Note Before you begin, complete the software and hardware installation procedures in your chassis documentation.

Note The guidelines in this document are specific to the TRC-8543. The other components in the system might not meet the same safety ratings. Refer to the documentation for each component in the system to determine the safety and EMC ratings for the entire system.

Safety Guidelines

Caution Observe all instructions and cautions in the user documentation. Using the product in a manner not specified can damage the product and compromise the built-in safety protection.

Attention Suivez toutes les instructions et respectez toutes les mises en garde de la documentation d'utilisation. L'utilisation du produit de toute autre façon que celle spécifiée risque de l'endommager et de compromettre la protection de sécurité intégrée.

Safety Guidelines for Hazardous Locations

The TRC-8543 is suitable for use in hazardous locations; , and hazardous locations; and nonhazardous locations only. Follow these guidelines if you are installing the TRC-8543 in a potentially explosive environment. Not following these guidelines may result in serious injury or death.

Caution Do not disconnect bus-side connector unless power has been switched off or the area is known to be nonhazardous.

Caution Do not unplug the TRC-8543 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, or Zone 2.

Caution The system must be installed in an enclosure certified for the intended hazardous (classified) location, having a tool secured cover/door, where a minimum protection of at least IP54 is provided.

Caution For Zone 2 applications, install a protection device between the CAN bus and the TRC-8543CAN pins. The device must prevent the CAN Port-to-COM voltage from exceeding 55 V if there is a transient overvoltage condition.

Special Conditions for Hazardous Locations Use in Europe and Internationally

The TRC-8543 has been evaluated as equipment under DEMKO ATEX and is IECEx certified. Each TRC-8543 is marked and is suitable for use in Zone 2 hazardous locations, in ambient temperatures of -40 °C ≤ Ta ≤ 70 °C.

Caution Transient protection shall be provided that is set at a level not exceeding 140% of the peak rated voltage value of 85 V at the supply terminals to the equipment.

Caution The system shall only be used in an area of not more than Pollution Degree 2, as defined in IEC/EN 60664-1.

Caution The system shall be mounted in an ATEX/IECEx-certified enclosure with a minimum ingress protection rating of at least IP54 as defined in IEC/EN 60079-15.

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) stated in the product specifications. These requirements and limits provide reasonable protection against harmful interference when the product is operated in the intended operational electromagnetic environment.

This product is intended for use in industrial locations. However, harmful interference may occur in some installations, when the product is connected to a peripheral device or test object, or if the product is used in residential or commercial areas. To minimize interference with radio and television reception and prevent 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.

Notice To ensure the specified EMC performance, operate this product only with shielded cables and accessories. Do not use unshielded cables or accessories unless they are installed in a shielded enclosure with properly designed and shielded input/output ports and connected to the product using a shielded cable. If unshielded cables or accessories are not properly installed and shielded, the EMC specifications for the product are no longer guaranteed.

Mounting the TRC-8543

Caution The TRC-8543 is a thermally active device that dissipates heat. Refer to the user manual of the host this device directly connects to for specific information regarding thermal management. Not following mounting requirements may affect the system ambient temperature and/or the measurement accuracy of modules in the system.

Caution To meet thermal management requirements, do not zip tie more than six cables in a bundle, and allow for air flow around the bundle. If used with a cRIO or cDAQ chassis, mount all cables at least 152 mm (6.0 in.) from the chassis and do not mount more than six cables directly beneath the chassis.

You can route and strain relieve the TRC-8543 similarly to ordinary cables. You also can panel mount it using its removable jackscrews, zip tie, or screw mount it. The screw mounting holes support #6 and M3 screws spaced 35.56 mm (1.400 in.) center-to-center, with minimum length of 23 mm (7/8 in.). The TRC-8543 supports zip ties up to 5.33 mm (0.210 in.) wide.

The following figure shows jackscrews, zip tie mounting slots, and screw mounting holes on the TRC-8543.

Figure 1. TRC-8543 Mounting Features



Panel Mounting the TRC-8543

The recommended panel mounting cutout dimensions are shown below.

Figure 2. Recommended Cutout Dimensions



The jackscrews included with the TRC-8543 work with panel thicknesses up to 2.21 mm (0.087 in.).

> **Caution** Tighten the jackscrews to a maximum torque of 0.56 N · m (5.0 lb · in.).

If your panel is thicker than 2.21 mm (0.087 in.), you can mill out a recessed pocket for the TRC-8543. The following figure shows the recommended pocket dimensions and cutout position.

Figure 3. Recommended Pocket Dimensions



Wiring to the TRC-8543

The TRC-8543 is used with an NI-XNET interface host port.

Figure 4. TRC-8543 Connections



The TRC-8543 has one 9-pin male D-Sub connector that provides connections to a CAN bus. The TRC-8543 has pins for CAN_H and CAN_L, to which you connect the CAN bus signals. Connect these signals using twisted-pair cable.

The port has two common pins (COM) that are internally connected to the TRC-8543 isolated reference and serve as the reference ground for CAN_H and CAN_L. You can

connect the CAN bus reference ground (sometimes referred to as CAN_V-) to one or both COM pins.

The D-Sub connector shell connects through the TRC-8543 shielding to the connector on the host port end. The shielding does not electrically connect to the COM signals.

Caution When tightening the D-Sub connector jackscrews, do not exceed the maximum jackscrew torque of 0.56 N · m (5.0 lb · in.).

The TRC-8543 receives power from the NI-XNET host port, but also requires an external power supply of +9 V to +30 V to operate in Low-Speed/Fault-Tolerant mode. Supply power from the CAN bus to the V_{SUP} pin.

Note Power on V_{SUP} is required for Low-Speed/Fault-Tolerant CAN operation, but is not required for High-Speed CAN operation.

The TRC-8543 features software-selectable bus termination for both CAN High-Speed/Flexible Data-Rate and Low-Speed/Fault-Tolerant transceivers. For High-Speed/Flexible Data-Rate mode, you can enable 115 Ω of termination resistance between CAN_H and CAN_L through an API call. For Low-Speed/Fault-Tolerant mode, you can select either 1.11 kΩ or 4.99 kΩ of termination resistance for RTH and RTL through an API call (refer to the **Termination Resistors** section for more information). If you choose to use external termination, Table 4 lists recommended termination resistor values.

The following table lists the TRC-8543 pinout.

Table 5. Pin Assignments for the TRC-8543

Connector	Pin	Signal Name
Object Missing TRISOFT This object is not available in the repository.	1	No Connection (NC)
	2	CAN_L
	3	COM
	4	NC
	5	NC
	6	COM
	7	CAN_H

Connector	Pin	Signal Name
	8	NC
	9	V_{SUP}

CAN Bus Topology and Termination

A CAN bus consists of two or more CAN nodes cabled together. The CAN_H and CAN_L pins of each node are connected to the main CAN bus cable through a short connection known as a “stub.” The pair of signal wires, CAN_H and CAN_L, constitutes a transmission line. If the transmission line is not terminated, each signal change on the bus causes reflections that may cause communication errors.

High-Speed/Flexible Data-Rate CAN

Because the CAN bus is bidirectional, both ends of the cable must be terminated. However, this requirement does not mean that every node on the bus should have a termination resistor; only the two nodes at the far end of the cable should have termination resistors.

The following figure shows a simplified diagram of a CAN bus with multiple CAN nodes and proper termination resistor (R_t) locations.

Figure 5. CAN HS/FD Bus Topology and Termination Resistor Locations



Low-Speed/Fault-Tolerant CAN

Every device on a low-speed/fault-tolerant CAN network requires a termination resistor for each CAN data line: R_{RTH} for CAN_H and R_{RTL} for CAN_L.

The following figure shows a simplified diagram of a low-speed/fault-tolerant CAN bus with termination resistor placements.

Figure 6. CAN LS/FT Bus Topology and Termination Resistor Locations



High-Speed/Flexible Data-Rate CAN

You can connect the TRC-8543 port to any location on a CAN bus. The following figure shows one example of connecting the TRC-8543 directly to one CAN node.

Figure 7. Connecting the TRC-8543 to a CAN Device



Low-Speed/Fault-Tolerant CAN

You can connect the TRC-8543 to any location on a Low-Speed/Fault-Tolerant CAN bus. The following figure shows one example of connecting the TRC-8543 directly to one CAN node.

Figure 8. Connecting the TRC-8543 to a CAN Device



Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11898, shown in the following tables. Belden cable (3084A) meets all these requirements and should be suitable for most applications.

High-Speed/Flexible Data-Rate CAN

Table 5. ISO 11898 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

Characteristic	Value
Impedance	95 Ω min, 120 Ω nominal, 140 Ω max
Length-related resistance	70 mΩ/m nominal
Specific line delay	5 ns/m nominal

Low-Speed/Fault-Tolerant CAN

Table 3. ISO 11898 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

Characteristic	Value
Length-related resistance	90 mΩ/m nominal
Length-related capacitance: CAN_L and ground, CAN_H and ground, CAN_L and CAN_H	30 pF/m nominal

High-Speed/Flexible Data-Rate CAN

The termination resistors (R_t) should match the nominal impedance of the CAN cable and therefore comply with the values in the following table. The onboard, software-selectable termination has a nominal value of 115 Ω. If you are not using the onboard termination, use the values listed in the following table.

Table 5. Termination Resistor Specification

Characteristic	Value	Condition
Termination resistor, R_t	100 Ω min, 120 Ω nominal, 130 Ω max	Minimum power dissipation: 220 mW

Low-Speed/Fault-Tolerant CAN

Unlike High-Speed/Flexible Data-Rate CAN, Low-Speed/Fault-Tolerant CAN requires termination at the Low-Speed/Fault-Tolerant CAN transceiver instead of on the cable itself. Termination requires two resistors, RTH for CAN_H and RTL for CAN_L.

This configuration allows the NXP fault-tolerant CAN transceiver to detect and recover from bus faults. It is important to determine the overall termination of the existing network, or the termination of the individual device, before connecting it to a low-speed/fault-tolerant port. NXP recommends an overall RTH and RTL termination of 100 Ω to 500 Ω (each) for a properly terminated low-speed network. You can determine the overall network termination as follows:

$$\frac{1}{R_{RTHoverall}} = \frac{1}{R_{RTHnode1}} + \frac{1}{R_{RTHnode2}} + \frac{1}{R_{RTHnode3}} + \frac{1}{R_{RTHnoden}}$$

NXP also recommends an individual device RTH and RTL termination of 500 Ω to 16 kΩ. After determining the existing network or device termination, you can use the following formula to indicate which nearest value the termination property needs to be set to produce the proper overall RTH and RTL termination of 100 Ω to 500 Ω upon connection of the card:



where $\mathbf{R_{RTH\ overall}}$ should be 100 Ω to 500 Ω

NI-XNET Low-Speed/Fault-Tolerant CAN hardware features software selectable bus termination resistors, allowing you to adjust the overall network termination through an API call. In general, if the existing network has an overall network termination of 125 Ω or less, you should select the 5 kΩ option for your NI-XNET device. For existing overall network termination above 125 Ω, you should select the 1 kΩ termination option for your NI-XNET device.

Onboard termination on the low-speed/fault-tolerant ports of the TRC-8543 is set through the NI-XNET software to either 1.11 kΩ or 4.99 kΩ.

Cable Lengths

The cabling characteristics and desired bit transmission rates affect the allowable cable length. You can find detailed cable length recommendations in the ISO 11898, CiA DS 102, and DeviceNet specifications.

ISO 11898 specifies 40 m total cable length with a maximum stub length of 0.3 m for a bit rate of 1 Mb/s. The ISO 11898 specification says that significantly longer cable

lengths may be allowed at lower bit rates, but you should analyze each node for signal integrity problems.

High-Speed/Flexible Data-Rate CAN

The maximum number of nodes depends on the electrical characteristics of the nodes on the network. If all nodes meet the ISO 11898 requirements, you can connect at least 30 nodes to the bus. You can connect higher numbers of nodes if the nodes' electrical characteristics do not degrade signal quality below ISO 11898 signal level specifications.

The TRC-8543 electrical characteristics allow at least 110 CAN ports on a network.

Low-Speed/Fault-Tolerant CAN

The maximum number of nodes depends on the electrical characteristics of the nodes on the network. If all of the nodes meet the requirements of Low-Speed/ Fault-Tolerant CAN, up to 32 nodes may be connected to the bus.

TRC-8543 Hardware Overview

The TRC-8543 has one full-featured CAN port that is isolated from the host it is plugged into. Software can select between either an NXP TJA1043T High-Speed CAN transceiver or NXP TJA1055T Low-Speed/Fault-Tolerant CAN transceiver by controlling on-board relays. The TJA1043T is fully compatible with the ISO 11898 standard and supports baud rates up to 2 Mbps. The NI-XNET driver enables baud rates up to 8 Mbps. The TJA1055T is fully compatible with the ISO 11898 standard and supports baud rates up to 125 Kbps.

Figure 9. TRC-8543 Hardware Overview



Inserting and Removing the TRC-8543

The TRC-8543 connects to a host device with an active latching connector. To connect the TRC-8543 to a host device, push the connector assembly into the host receptacle until the internal latch snaps into position. The latch emits an audible click when engaged. To remove the TRC-8543, push the lock ejector forward to disengage the latch and simultaneously pull the TRC-8543, as shown in the following figure.

Figure 10. Inserting and Removing the TRC-8543



TRC-8543 LEDs

The TRC-8543 includes two LEDs to help you monitor hardware and bus status. LED 1 primarily indicates whether the hardware is currently in use. LED 2 primarily indicates the activity information of the connected bus. Each LED can display two colors (red or green), which display in the following four patterns:

Table 5. LED Pattern Definitions

Pattern	Meaning
Off	No LED illumination
Solid	LED fully illuminated
Blink	Blinks at a constant rate of several times per second
Activity	Blinks in a pseudo-random pattern

Table 6. LED Pattern Indications

Condition/State	LED 1	LED 2
Port identification	Blinks green	Blinks green
NI-XNET catastrophic error	Blinks red	Blinks red
No open session on hardware	Off	Off
Open session on hardware, port is properly powered, and hardware is not communicating	Solid green	Off

Condition/State	LED 1	LED 2
Hardware is communicating, and controller is in Error Active state	Solid green	Activity green (returns to idle/off one second after last TX or RX)
Hardware is communicating, and controller is in Error Passive state	Solid green	Activity red (returns to idle/off one second after last TX or RX)
Hardware is running, and controller transitioned to bus off	Solid green	Solid red

TRC-8543 Specifications

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

High-Speed/Flexible Data-Rate CAN Characteristics

Transceiver	NXP TJA1043T
Max certified baud rate	5 Mbps [1]
Input voltage limits CAN_H, CAN_L bus lines	-27 VDC to +40 VDC
Output voltage limit CAN_H, CAN_L bus lines	5 VDC
MTBF	Contact NI for Bellcore MTBF specifications at other temperatures or MIL-HDBK-217F specifications.

Low-Speed/Fault-Tolerant CAN Characteristics

Transceiver	NXP TJA1055T
Max baud rate	125 Kbps
CAN_H, CAN_L bus lines voltage	-27 VDC to +40 VDC
CAN Supply voltage range (V_{SUP})	+9 VDC to +30 VDC
MTBF	Contact NI for Bellcore MTBF specifications at other temperatures or for MIL-HDBK-217F specifications.

Power Requirements

Thermal dissipation (at 70 °C)	700 mW maximum (Low-Speed/Fault-Tolerant fault condition) 550 mW maximum (High-Speed active mode) 440 mW typical (High-Speed active mode) 333 mW typical (Low-Speed/Fault-Tolerant active mode)
Power consumption from TRC-8543 host	550 mW maximum (High-Speed active mode) 440 mW typical (High-Speed active mode) 310 mW maximum (Low-Speed/Fault-Tolerant active mode) 245 mW typical (Low-Speed/Fault-Tolerant active mode)
Power consumption from V_{SUP}	320 mW maximum (Low-Speed/Fault-Tolerant fault condition) 90 mW typical (Low-Speed/Fault-Tolerant active mode)

Note Power on V_{SUP} is required for Low-Speed/Fault-Tolerant CAN operation.

Physical Characteristics

Weight	70 g (2.5 oz)
Length	447 mm to 462 mm (17.6 in. to 18.2 in.)
D-Sub connector jackscrew maximum torque	0.56 N · m (5.0 lb · in.)

Safety

Maximum Voltage[2]

Connect only the voltages that are within these limits.

Port-to-COM	-27 V DC to +40 V DC maximum, Measurement Category I

Isolation Voltage

Port-to-earth ground	
Continuous	60 V DC, Measurement Category I

Note The TRC-8543 COM signals are not connected to the host port ground.

Caution Do not connect the product to signals or use for measurements within Measurement Categories II, III, or IV.

Attention Ne pas connecter le produit à des signaux dans les catégories de mesure II, III ou IV et ne pas l'utiliser pour effectuer des mesures dans ces catégories.

Warning Do not connect the product to signals or use for measurements within Measurement Categories II, III, or IV, or for measurements on MAINs circuits or on circuits derived from Overvoltage Category II, III, or IV which may have transient overvoltages above what the product can withstand. The product must not be connected to circuits that have a maximum voltage above the continuous working voltage, relative to earth or to other channels, or this could damage and defeat the insulation. The product can only withstand transients up to the transient overvoltage rating without breakdown or damage to the insulation. An analysis of the working voltages, loop impedances, temporary overvoltages, and transient overvoltages in the system must be conducted prior to making measurements.

Mise en garde Ne pas connecter le produit à des signaux dans les catégories de mesure II, III ou IV et ne pas l'utiliser pour des mesures dans ces catégories, ou des mesures sur secteur ou sur des circuits dérivés de

surtensions de catégorie II, III ou IV pouvant présenter des surtensions transitoires supérieures à ce que le produit peut supporter. Le produit ne doit pas être raccordé à des circuits ayant une tension maximale supérieure à la tension de fonctionnement continu, par rapport à la terre ou à d'autres voies, sous peine d'endommager et de compromettre l'isolation. Le produit peut tomber en panne et son isolation risque d'être endommagée si les tensions transitoires dépassent la surtension transitoire nominale. Une analyse des tensions de fonctionnement, des impédances de boucle, des surtensions temporaires et des surtensions transitoires dans le système doit être effectuée avant de procéder à des mesures.

Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as **MAINS** voltage. MAINS is a hazardous live electrical supply system that powers equipment. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.

Note Measurement Categories CAT I and CAT O are equivalent. These test and measurement circuits are for other circuits not intended for direct connection to the MAINS building installations of Measurement Categories CAT II, CAT III, or CAT IV.

Safety and Hazardous Locations Standards

This product is designed to meet the requirements of the following electrical equipment safety standards for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1
- EN 60079-0:2012, EN 60079-15:2010
- IEC 60079-0: Ed 6, IEC 60079-15; Ed 4
- UL 60079-0; Ed 6, UL 60079-15; Ed 4

- CSA 60079-0:2011, CSA 60079-15:2012

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

Hazardous Locations

U.S. (UL)	; ,
Canada (C-UL)	; ,
Europe (DEMKO)	

Environmental Characteristics

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

Temperature[3]	
Operating	-40 °C to 70 °C
Storage temperature	-40 °C to 85 °C
Humidity	
Operating	10% RH to 90% RH, noncondensing
Storage	5% RH to 95% RH, noncondensing
Ingress protection	IP40
Pollution Degree	2
Maximum altitude	5,000 m

Shock and Vibration

To meet these specifications, you must securely mount the product and ensure all cables and connectors have proper strain relief.

Operating vibration	
Random	5 g RMS, 10 Hz to 500 Hz
Sinusoidal	5 g, 10 Hz to 500 Hz
Operating shock	30 g, 11 ms half sine; 50 g, 3 ms half sine; 18 shocks at 6 orientations

Shock and Vibration

To meet these specifications, you must securely mount your TRC-8543 and ensure all cables and connectors have proper strain relief.

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

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
- EN 55022 (CISPR 22): Class A emissions
- EN 55024 (CISPR 24): Immunity
- AS/NZS CISPR 11: Group 1, Class A emissions
- AS/NZS CISPR 22: 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 generate radio frequency energy for the treatment of material or inspection/analysis purposes.

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

CE Compliance CE

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

- 2014/35/EU; Low-Voltage Directive (safety)
- 2014/30/EU; Electromagnetic Compatibility Directive (EMC)
- 2014/34/EU; Potentially Explosive Atmospheres (ATEX)

Product Certifications and Declarations

Refer to the product Declaration of Conformity (DoC) for additional regulatory compliance information. To obtain product certifications and the DoC for NI products, visit ni.com/product-certifications, search by model number, and click the appropriate link.

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 **Engineering a Healthy Planet** 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.

EU and UK Customers

- Waste Electrical and Electronic Equipment (WEEE)—At the end of the product life cycle, all NI products must be disposed of according to local laws and regulations. For more information about how to recycle NI products in your region, visit ni.com/environment/weee.

电子信息产品污染控制管理办法（中国 RoHS）

- 中国 RoHS— NI 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 NI 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.)

[1] The NXP TJA1043 transceiver is CiA certified for baud rates up to 5 Mb/s in the CAN FD fast phase, while speeds up to 8 Mb/s are possible experimentally. NI-XNET provides a warning when a transceiver is used at higher baud rates than it is certified for. As new CiA-certified transceivers with higher baud rates are released, NI will continue to update the hardware with newer revisions.

[2] The maximum voltage that can be applied or output without creating a safety hazard.

[3] Similar to other standard PVC cables, this product's cable becomes less ductile at low temperatures. Preroute and secure the cable while flexible to avoid premature failure.

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