

## GENERAL SPECIFICATIONS

- Universal input: voltage, current, resistance, thermoresistances, thermocouples.
- Active output 4..20 mA or 0..20 mA for PID loop control.
- Integrated PID controller.
- Sampling time 300 ms.
- Input protection up to 60 V (excluding mA input).
- 1500 Vac input insulation with respect to remaining low voltage circuits.
- Possibility of power supply and serial bus facilitated wiring by means of a bus that can be housed in the DIN guide alternatively to the terminals.
- RS485 serial communication with MODBUS – RTU protocol, maximum 32 nodes.
- Insertion into and removal from bus without interruption of bus communication or power supply.
- Automatic setting of default values for regulator in the event of control system failure.
- Communication times below 20 ms (@ 38400 baud).
- Connection distance up to 1200 m.

## TECHNICAL SPECIFICATIONS

<b>Power supply:</b>	19–40 Vdc, 19–28 Vac 50-60Hz, max 2.5W; 1.6W @ 24 Vdc.			
<b>Communication port:</b>	2 wire RS485 serial with settable speed: 1200 to 57600 baud.			
<b>Protocol:</b>	Modicon MODBUS – RTU.			
<b>Voltage input:</b>	bipolar with f.s. 50 mV, 200 mV, 2 V, 5 V and 10 V, input impedance 1 M $\Omega$ , resolution 0.01%.			
<b>Current input:</b>	bipolar with f.s. 20 mA, loop supply available, input impedance 100 $\Omega$ , resolution 0.01%.			
<b>Input PT100 / NI100: (RTD)</b>	3/4 wire measurement, range –200..+600°C (NI100: -60..+180°C), energising current 0.56mA, resolution 0.1°C, cable or RTD interruption detection.			
<b>Thermocouple input:</b>	type J,K,R,S,T,B,E,N; resolution 5 $\mu$ V, TC interruption detection.			
<b>Potentiometer input:</b>	up to 15000 $\Omega$ on 3 scales 0-3500, 0-8700, 0-15000, resolution 0.01%, energising current 0.56 mA.			
<b>Errors:</b>	<b>Calibration</b>	<b>Linearity</b>	<b>Thermal stability</b>	<b>Other</b>
Voltage / Current	0.1% o.r.	0.05%	0.02%/°C	1% o.s. (3)
Resistance:	0.2% o.r.	0.05%	0.02%/°C	0.1°C + 1% o.s. (3)
Thermoresistance:	0.2% o.r.	0.2 °C	(0.015+0.01% o.r.)°C/°C	0.1°C + 1% o.s. (3)+(1)
Thermocouples J,K,E,T	0.2% o.r.	1°C beyond 0°C	0.02%/°C	1% o.s. (3)+(2)
Thermocouples R,S	0.2% o.r.	1°C beyond 250°C	0.02%/°C	1% o.s. (3)+(2)
Thermocouple B	0.2% o.r.	3°C beyond 600°C	0.02%/°C	1% o.s. (3)+(2)
<b>Cold junction compensation</b>	2°C between 10 and 40 °C ambient.			
<b>Active output:</b>	0..20 / 4..20 mA (not insulated from input circuit), resolution 4000/3200 points with interrupted or faulty loop detection, max. error 0.2%.			
<b>Ambient conditions:</b>	Temperature: 0..55°C, min. humidity: 30%, max 90% at 40°C non-condensing.			
<b>Protection rating:</b>	IP20			
<b>Weight, dimensions:</b>	140g, 100 x 112 x 17.5			
<b>Standards</b>	The instrument complies with the following standards: EN50081-2 (electromagnetic emission, industrial environment) EN50082-2 (electromagnetic immunity, industrial environment) EN61010-1 (safety)			

(1) influence of cable resistance 0.005%/ $\Omega$  max 10  $\Omega$

(2) influence of cable resistance 0.5 $\mu$ V/ $\Omega$

(3) for any electromagnetic interference

**IMPORTANT** A program known as Z-PROG can be downloaded from the [www.seneca.it](http://www.seneca.it) site for the initial programming and testing of the product.



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The Z-PID module is designed to be fitted on DIN 46277 guide bus in a vertical position. For optimal operation and long life, adequate ventilation must be provided for the module(s), avoiding positioning channels or other objects that obstruct the ventilation louvers. Avoid fitting modules above equipment that generates heat; you are advised to fit them at the bottom of the panel.

### **HARSH OPERATING CONDITIONS:**

When the modules are fitted side by side it may be **necessary to separate them by at least 5 mm** if the temperature of the panel is above 45°C and operating conditions are harsh.

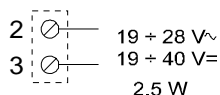
The following constitute harsh operating conditions:

- High power supply voltage (> 30Vdc / > 26 Vac).
- Loop power supply 4..20 mA input and/or output.

**NOTE:** Use of the DIN guide connectors supplied on request (ordering code Z-PC-DINx) ensures practical fitting and correct ventilation of the modules, in addition to reducing the number of electrical cables.

## ELECTRICAL CONNECTIONS

### POWER SUPPLY

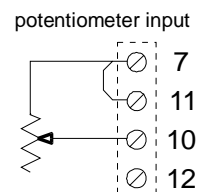
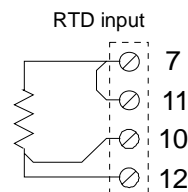
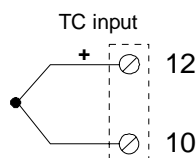
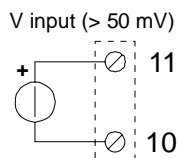
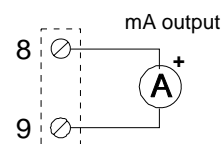
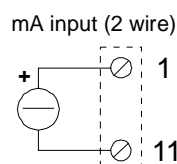
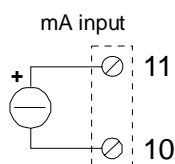
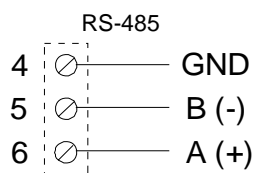


The power supply voltage must be between 19 and 40 Vdc (any polarity) or 19 and 28 Vac; see also section **INSTALLATION**.

**The upper limits must not be exceeded as this can seriously damage the module.**

The power supply source must be protected from any failures in the module by means of a suitably sized fuse. The module can be powered via the DIN guide connectors.

### INPUTS / OUTPUTS



### **CAUTION:**

For the current measurement input, the dip-sw SW1 must be positioned as shown further on.

For voltage measurements with scale end below or equal to 50 mV, the **TC input** must be used.



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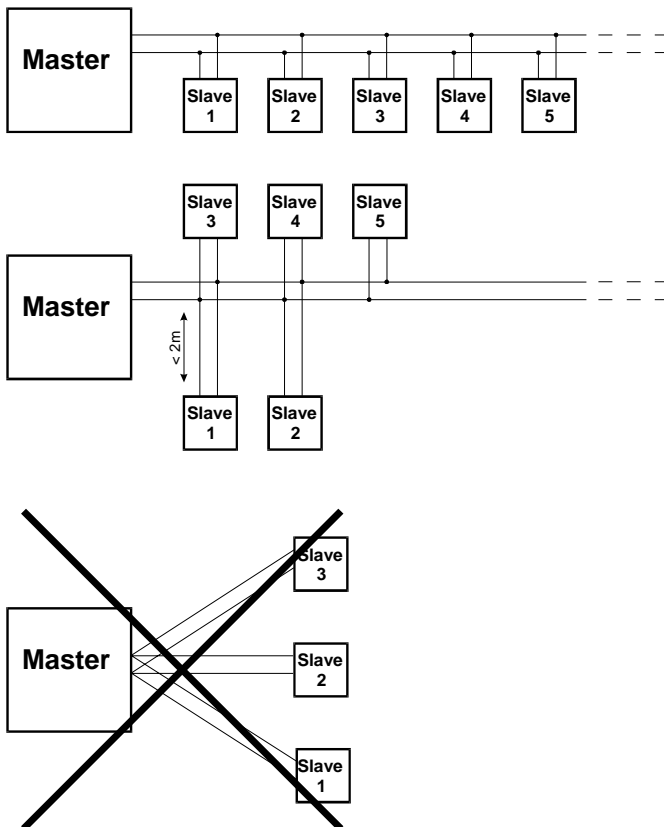
## SERIAL INTERFACE

The RS485 serial interface is based on a balanced differential communication line with typical impedance of 120  $\Omega$ . The maximum length of the connection is not defined but depends on the communication speed, the signal-interference ratio and the cable quality.

Generally the maximum length with guaranteed operation is fixed at 1200 m. The connection cable does not have to be shielded if the distance is only a few metres in a "low noise" electrical environment. For distances between 15 and 100 m a shielded twisted cable can be used without particular specifications whereas for connections over 100 m you are advised to use, for example, CEAM CPR 6003 or BELDEN 9841 cable.

The communication line should preferably be of the chain type, avoiding star configurations and limiting branches to a few metres (see figure below). The ends of the line must be terminated by setting the related dip-sw on the module to ON.

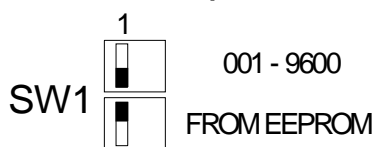
The cable shield must be connected to the **GND** terminal on both sides, and connected to earth on at least one side. If necessary to reduce interference, the other side should be connected to earth by means of a 10 nF capacitor.



## SETTING THE DIP-SWITCHES

One side of the module features the dip-switches which are useful for selecting the following functions:

### Communication parameter selection:



The fixed setting parameters (dip-switch1=OFF) are:

**Address=001, Baud Rate=9600**

During the first programming it is possible to use the settings from EEPROM (dip-switch **ON**) which are programmed originally with **Address=001** and **Baud Rate=38400**.



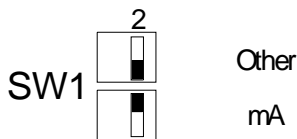
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When reprogramming the module (when address and speed are not known, for example) it is possible to use the default position that sets the fixed parameters visible in the box.

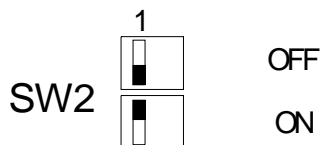
NOTE: At the end of programming, the dip-switch1 must be set to **ON** and the module re-set e.g. removing power supply and then reapplying it.

**Current input selection:**



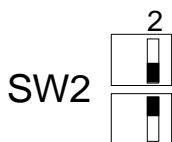
To use the current input, the dip-sw indicated must be set to ON.  
**CAUTION:** the dip-sw must be set to OFF in all other cases.

**RS485 line termination:**



The RS485 line must be terminated only at the ends of the communication line.

**Reserved positions:**



These dip-switch positions are reserved for future use.

**MODBUS REGISTERS**

Below, the numerical values are decimals unless indicated otherwise by the prefix '0x' for hexadecimal values or '0b' for binary values. The suffix (H) indicates the upper part of a word and (L) indicates the lower part.

**MODBUS COMMANDS SUPPORTED**

Command code	Description
3 - Read Holding Register	Permits reading of the <b>RAM and EEPROM</b> registers up to a <b>maximum of 12</b> at a time.
6 – Preset Single Register	Permits writing of the <b>RAM and EEPROM</b> registers individually.
16 – Preset Multiple Register	Permits writing of the <b>RAM</b> registers up to a <b>maximum of 10</b> at a time.

NOTE: MODBUS RTU protocol specifications have changed since 2002. Up to that time, a register numeration system utilised by many application programs and communication libraries that placed the first 9998 "**Holding Register**" in correspondence using numbers from 40001 to 49999 had been defined. The same registers are effectively equivalent to those with hexadecimal numeration from 0x0000 to 0x270E or with decimal numeration from 0 to 9998.

The following table lists and describes the Holding Registers present in the module. For many registers the original copy exists in EEPROM. The address of this copy is given by the register number increased by 64. In the table below, for each address the EEPROM address is indicated if present. When the device is switched on (or at reset controlled by serial line) the RAM registers are initialised with the values contained in EEPROM. The EEPROM registers must therefore be programmed for configuration of

the module. This configuration can be performed both with the module inserted in the bus together with other modules (obviously with a different address) or with module connected to the PC alone.

Address	INITIALS / Permitted values	Function
40001 40066	<b>MTYPE, VERS</b> 0401	Contains the type (H) and number of the version (L) of the module. For the module Z-PID we can have: type=4, version=1. The value read is therefore worth 0x0401=1025. It can be used to automatically recognise a module inserted in the bus to replace a faulty one and appropriately re-programme it.
40002 40066	<b>CNFIN, TFILTRO</b> 1..13(H), 0..6(L)	Pre-sets the type of input (H) and the value of the filter time (L). See below for details.
40003 40067	<b>FSCAM</b> -32000..+32000	Measurement scale end: indicates the scale end in mV if the type of input is voltage, uA if the type of input is current, $\Omega$ if the type of input is resistance. It has no effect for the other types of input.
40004 40068	<b>ISCAM</b> -32000..+32000	Measurement scale beginning: as previously, referring to the beginning of the scale.
40005 40069	<b>FSCALA</b> -32000..+32000	Scale end in technical units: set automatically in the case of temperature measurements. Must be set as required for the other scales.
40006 40070	<b>ISCALA</b> -32000..+32000	Beginning of scale in technical units: as previously, referring to the beginning of the scale.
40007 40071	<b>STRIM</b> 9000..11000	Device span calibration. The rated value is 10000 and can be modified to adjust calibration of the measurement span.
40008 40072	<b>ZTRIM</b> -1000..+1000	Zero of the device. The rated value is 0 and can be modified to adjust calibration of the measurement zero.
40009 40073	<b>BAUDR</b> 0..7(H), 1..255(L)	Communication speed (H) and address (L) of the module. The speed can have the following values: 0=4800bps, 1=9600, 2=19200, 3=38400, 4=57600, 5=115200 (not guaranteed), 6=1200, 7=2400. The address can be between 1 and 255.
40010 40074	<b>TIMEOUT</b> 10..250	Communication control time in tenths of a second. After each communication a timer is reset with the TIMEOUT value. When the timer expires, some module values are restored, reading them from the EEPROM ( <b>only those with the symbol ↗</b> ). This means, for example, that if the serial communication is interrupted for longer than the TIMEOUT, the PID controller can assume a predefined status. E.g.: Status: Manual, Out = 10%, or Status: Automatic, Setpoint = 50% etc. This function can be de-activated: see EPRFLG.
40011 40075	<b>EPRFLG</b> ↗	Flags for setting various functions, see details further on.
40012 40076	<b>SETPOINT</b> ↗ 0..10000	PID regulator setpoint, 10000 = 100 %.
40013 40077	<b>GAIN</b> 0..9999	PID regulator gain, 1000 = 100 %.
40014 40078	<b>INTTIME</b> 0..6000	Integral time in seconds. If set to 0 the integral action is nil.
40015 40079	<b>DERTIME</b> 0..9999	Derivative time in tenths of a second. 100 = 10.0 s If set to 0 the derivative action is nil.
40016 40080	<b>MANRST</b> 0..10000	Manual reset of PID regulator, 5000 = 50%.
40017 40081	<b>OUTH LIM</b> 0..10000	Upper limit for regulator output.
40018 40082	<b>OUTLLIM</b> 0..10000	Lower limit for regulator output.
40019 40083	<b>OUTPUT</b> ↗ 0..10000	PID regulator output, 10000 = 100%.
40020	<b>VALUT</b>	Value measured converted into technical units.
40021	<b>VALLIN</b>	Value measured and scaled 0..10000.
40022	<b>STATUS</b>	Status/error flags, see details further on.



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Details of some registers:

**CNFIN:** This register pre-sets the type of module input. After storing the required type in EEPROM, the module must be switched off and then on again, or re-set by means of the STATUS register RESET flag.

Configuration of the module for temperature measurement inputs (PT100, NI100, TC) also produces automatic programming of the FSCALA, ISCALA registers. In this way, temperature measurement will be available in the VALUT register expressed in tenths of a °C (1000 = 100.0 °C).

The following table gives the CNFIN value for each type of input and related measurement range.

CNFIN	Input type	Scale end
1	voltage input	0.05 ÷ 10 V
2	input from potentiometer	0.35 ÷ 15 kΩ
3	current input	2.00 ÷ 20.00 mA
4	input from PT100	-200.0 ÷ 600.0°C
5	input from NI100	-60 ÷ 180.0°C
6	input from TC type J	-200.0 ÷ 1000.0°C
7	input from TC type K	-200.0 ÷ 1300.0°C
8	input from TC type R	0 ÷ 1750.0°C
9	input from TC type S	0 ÷ 1750.0°C
10	input from TC type T	-200.0 ÷ 400.0°C
11	input from TC type B	0 ÷ 1800.0°C
12	input from TC type E	-200.0 ÷ 800.0°C
13	input from TC type N	-200.0 ÷ 1300.0°C

For the other types of input, the scale in technical units is at the customer's discretion. In any case in the VALLIN register the measurement 0-10000 is available related to the scale ends set.

E.g.: With CNFIN = 1, FSCAM = 200 (mV), ISCAM = -200 (mV), FSCALA = 20000, ISCALA = -20000, we can read the voltage value directly in uV in the VALUT register, while in the VALLIN register we will have a number ranging from 0 to 10000 when -200 mV and +200 mV are applied to the appropriate terminals.

**TFILTRO:** With this register it is possible to set a one-pole digital filter applied to the measurement. The values from 0 to 6 correspond to a filter of 0, 1, 2, 5, 10, 20, 60 seconds respectively.

**EPRFLG:** This register must be considered in binary format, i.e. each register bit activates (1) or de-activates (0) a function.

The table shows the functions associated with each bit.

Bit:	Weight:	Function:
0	1	None
1	2	None
2	4	=1: sets the serial communication response delay. If enabled, there will be a minimum delay of 12 ms.
3	8	sets the use of serial communication parity bit: 0 = no parity, 1 = active parity.
4	16	Sets the type of parity: 0 = even, 1 = odd.
5	32	None
6	64	None
7	128	None
8	256	=1: activates root extraction for the non-temperature type inputs
9	512	Sets sensor breakage reaction (burn-out): 1= positive 0=negative
10	1024	=1: activates PID regulator automatic function
11	2048	=1: sets PID regulator inverse action
12	4096	=1: activates register restore function if the serial communication is interrupted
13	8192	=1: sets analog output with shifted zero (4..20 mA)
14	16384	=1: sets four-wire reading for thermoresistance sensors (PT100, NI100)
15	32768	=1: data communication timer reset on reception of message valid for its address =0: timer reset for any data transmitted on the communication line



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Register setting example: Bit 9=1, Bit 10=1, remaining = 0: the register value is given by the sum of the weights of each bit =1. In our case we have: 512+1024=1536.

**STATUS:** This register must be considered in binary format, i.e. each active bit (=1) of the register corresponds to an error or warning status.  
The table shows the functions associated with each bit.

Bit:	Weight:	Function:
0	1	This bit can be set to 1 to obtain <b>RESET</b> of the module. After the operation it will be automatically reset to 0.
1	2	Reserved, do not set to 1.
2	4	None
3	8	None
4	16	None
5	32	None
6	64	None
7	128	None
8	256	=1: data programming error. Active if the setting of the input type is not among those permitted.
9	512	=1: if the measurement is above FSCAM or FSCALA set +3% (overflow).
10	1024	=1: if the measurement is below ISCAM or ISCALA set -3% (underflow).
11	2048	=1: if BURN-OUT of the sensor has been detected.
12	4096	=1: EEPROM programming error. Active if the last programming of an EEPROM register has failed.
13	8192	=1: A/D converter failure.
14	16384	=1: analogue output current greater than 24 mA.
15	32768	=1: analogue output current less than 3.3 mA.

## ***ERROR CODES***

In some situations the module may respond with an exception message. The following table lists the situations and the related response codes.

Situation	Response code
Command not supported	01
Illegal register address	02
Number of registers requested illegal	04
EEPROM register programming error	08

## ***MODULE PROGRAMMING EXAMPLES***

### **EXAMPLE no.1**

Function requested: Analogue input 1..5 V with scale 0..1000, without filter. Analogue output 4..20 mA independent (not controlled by PID regulator).

Program the following registers with the values indicated:

**40066 = 256** (CNFIN = 1, TFILTRO = 0, therefore:  $1 * 256 + 0$ ).  
**40067 = 5000** (FSCAM = 5000 mV)  
**40068 = 0** (ISCAM = 1000 mV)  
**40069 = 1000** (FSCALA = 1000)  
**40070 = 0** (ISCALA = 0)  
**40075 = 8192** (analogue output 4..20 mA, regulator in manual, other functions disabled)

Switch the instrument off and then on again or write 1 in the STATUS register.

Subsequently the measurement will be available scaled 0..1000 in the 40020 (VALUT) register; to set the analogue output value, write in the register 40019 (OUTPUT).



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### **EXAMPLE no.2**

Function requested: Thermocouple J input, without filter. Analogue output 4..20 mA controlled by PID regulator.

Program the following registers with the values indicated:

**40066 = 1536** (CNFIN = 6, TFILTRO = 2, therefore:  $6 * 256 + 2$ )  
**40075 = 11264** (analogue output 4..20 mA, regulator in automatic, inverse action, positive burn-out, other functions disabled)  
**40076..40082** as required

Switch the instrument off and then on again or write 1 in the STATUS register.

The measurement will subsequently be available in tenths of a °C in the register 40020 (VALUT); the setpoint and the other values relating to the PID regulator will be available in the registers from 40012 to 40019. Normally reading of the registers from 40011 to 40022 provides all the information available with one single interrogation by the master.

## ***PID REGULATOR***

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The PID regulator is available as soon as the related flag is set to AUTOMATIC.

From this moment, the control output is driven according to the following equation:

$$Mn = Kc * En + Ts/Ti * En + Mx + Td/Ts * (En1 - En) + Mr$$

Where:

Mn = Loop output

Kc = Gain

Ti = integration period

Td = differentiation period

Ts = sampling period

Mx = Mn (t-1)

En = Error (t0)

En1 = error (t-1)

Mr = manual reset

As can be noted, the reaction speed increases as the gain increases, but there is also an increase in the instability of the loop regulation (oscillation).

The integral action increases as the set time decreases.

The derivative action increases as the set time increases.

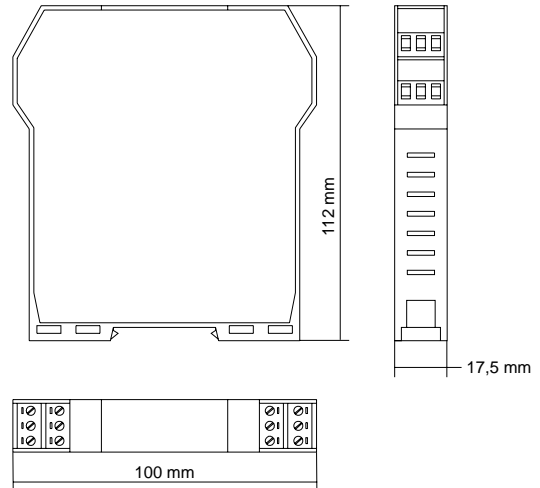
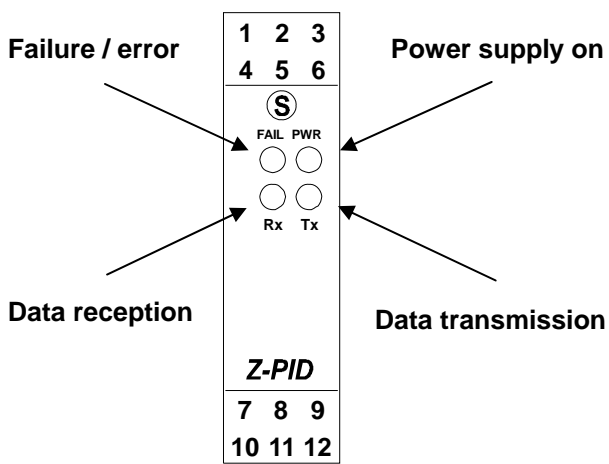
For operation and set-up of the regulator, refer to the specific manuals.






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