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USER INSTRUCTION

UNIVERSAL TRANSDUCER

AR594

Version 2.0.1
2016.03.01

Thank you for choosing our product.
These instructions will facilitate operating the device and enable safe use of the device at its full capacity.
Prior to the installation and startup of the device, please become familiar with these instructions.
In the event of any additional questions, please contact our technical adviser.

CONTENTS

Please pay particular attention to the text marked with this sign.

The manufacturer reserves the right to make changes to the design and the programming of the device without any deterioration of the technical parameters (some functions may not be available in older versions).

1. SAFETY PRINCIPLES

- before you start to use the device, become familiar with the present instructions;
- in order to avoid electrocution or damage to the device, its mechanical and electrical installation must be performed by qualified staff;
- before switching on the power supply, make sure that all cables and wires are properly connected;
- before making any modifications to the wire and cable connections, switch off the device's power supply;
- ensure proper operating conditions compliant with the technical specification of the device (power supply voltage, humidity, temperature - see chapter 5).

2. INSTALLATION GUIDELINES

The device is designed so as to ensure an appropriate level of immunity to most interferences that may occur in industrial environments. In environments of unknown level of interferences, it is recommended to implement the following measures so as to prevent potential interference with the operation of the device:

- do not supply the device from the same lines as high-power equipment without using appropriate power line filters;
- use cable shields on power supply cables, sensor cables, and signal cables, whereby the earthing of the shield should be single-point and located as close to the device as possible;
- avoid running instrument (signal) cables in the direct vicinity of and parallel to power distribution and power supply cables;
- it is recommended to use twisted pair signal cables;
- in the case of sensing resistors in 3-wire connections, use identical wires;
- avoid locating remotely controlled, electromagnetic meters, and high-power loads, loads with phase or group power control, and other devices producing large impulse interferences close to one another;
- ground or zero metal rails on which rail-mounted devices are installed.

3. GENERAL CHARACTERISTICS OF THE TRANSDUCER

- linear processing of measured temperature or another physical value transformed into a digital signal;
- high accuracy, long-term stability, and immunity to interferences;
- universal input:
  - thermoresistance... Pt100, Ni100, Pt500, Pt1000
  - thermocouple ..... J, K, S, B, R, T, E, N
  - analog ..... 0/4÷20mA, 0÷10V, 0÷60mV, resistance 0÷2500ohm
- digital serial interface (RS232 or RS485, MODBUS-RTU protocol)
- triple galvanic isolation (input/output/supply)
- narrow enclosure for installation on the TS35 rail (DIN rail)
- scope of processing, input type, and other parameters configured with:
  - ARSOFT-CFG series software and the AR956 programmer;
  - a user application;
  - an autonomous AR950 programmer;
- a programmable exceeded processing range and set value alarm with hysteresis (type on/off, OC output)
- LED signaling of exceeded processing range, sensor error, or alarm output status (on/off type)
- high accuracy and immunity to interferences;
- available ARSOFT-CFG series software that enables visualization and recording of measurements

NOTE:

- **before starting to work with the meter, you must become familiar with this using instruction, properly prepare the electrical system and the mechanical system, and correctly configure the parameters;**
- **if the characteristics of the transducer are configured with the AR956 programmer, the transmission parameters that must be set in the options of the ARSOFT-CFG, software, at the time of first connection (default parameters) are the following:**
  - **COM port number: assigned by the Windows system after installation of the AR956 controller, available in the "Device Manager" in the "Ports (COM and LPT)" group; see "Quick start programmer AR956"**
  - **transmission speed: 2,400 bit/s**
  - **MODBUS address = 1**

A detailed description of the configuration parameters of the transducer can be found in chapter 9.

4. CONTENTS OF THE SET

- a transducer with a set of connections;
- a user instruction;
- a warranty card.

5. TECHNICAL DATA

1 universal programmable input	**measurement range**
- Pt100 (RTD, 3- or 2-wire)	-200 ÷ 850 °C
- Ni100 (RTD, 3- or 2-wire)	-50 ÷ 170 °C
- Pt500 (RTD, 3- or 2-wire)	-200 ÷ 850 °C
- Pt1000 (RTD, 3- or 2-wire)	-200 ÷ 850 °C
- thermocouple J (Fe-CuNi)	-40 ÷ 800 °C
- thermocouple K (NiCr-NiAl)	-40 ÷ 1,200 °C
- thermocouple S (PtRh 10-Pt)	-40 ÷ 1,600 °C
- thermocouple B (PtRh30PtRh6)	300 ÷ 1,800 °C
- thermocouple R (PtRh13-Pt)	-40 ÷ 1,600 °C
- thermocouple T (Cu-CuNi)	-25 ÷ 350 °C
- thermocouple E (NiCr-CuNi)	-25 ÷ 740 °C
- thermocouple N (NiCrSi-NiSi**)**	-35 ÷ 1,300 °C
- current (R_{in} = 110 Ω)	0/4 ÷ 20 mA
- voltage (R_{in} = 100 kΩ)	0 ÷ 10 V
- voltage (R_{in} > 5 MΩ)	0 ÷ 60 mV
- resistance (3- or 2-wire)	0 ÷ 2,500 Ω
Permissible feed resistance (RTD, Ω)	R_d < 30 Ω (for each line)
Resistance input current (RTD, Ω)	180 ÷ 250 µA
Digital output	RS485 or RS232
Transmission protocol	MODBUS-RTU, SLAVE
Character recording format	8N1 (8 bits, 1 stop bit, no parity bit)
Transmission speed (bit/s)	600, 1200, 2400, 4800, 9600 14400, 19200, 38400

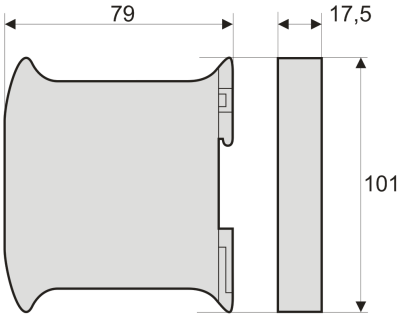
Transmission signaling		Red LED diode (Rx/Tx)
Alarm output		12 V, bistate type OC (open collector, NPT transistor), current limiting resistance 440 Ω
Processing errors (at ambient temperature of 25 °C):		
- basic	- for RTD, mA, V, mV, Ω	0.1% of the measurement range ±1 digit
	- for thermocouples	0.2% of the measurement range ±1 digit
- additional for thermocouples		<2 °C (temperature of cold tips)
- additional from ambient temperature changes		< 0.01% of the input range /°C
Resolution of measured temperature		programmable, 0.1 °C or 1 °C
Resolution of analog input (programmable)		-1999 ÷ 9999 (parameters 3: rAbS , 4: rLoP)
Response time (10 ÷ 90%)		135 ÷ 1500 ms (programmable with parameter 1: FiLt), factory 270 ms
Power supply (Usup)		24 VAC/DC (18÷50 VDC, 14÷35 VAC)
Power consumption		< 500 mW
Operating temperature range		0 ÷ 65 °C
Relative humidity range		0-90 °C (no condensation)
Protection rating		IP20
Operating position		any
Weight		approx. 70 g
Separation (in/out/sup)		1.5 kV, 50 Hz, 1 min.
Electromagnetic compatibility (EMC)		immunity: according to the PN-EN 61000-6-2:2002(U) standard
		emissivity: according to the PN-EN 61000-6-4:2002(U) standard
Transmission parameters for the AR956 programmer		Factory: 2400 bit/s, address MODBUS = 1 (parameter 12: Addr=1 and 13: br=2, see chapter 9)

NOTE:

Measurements performed by the transducer when supplied from the AR956 programmer are not reliable. The AR956 programmer is intended only to supply the transducer during configuration of parameters using the ARSoft-CFG software. During normal operation, the transducer should be supplied in the standard manner.

6. ENCLOSURE DIMENSIONS AND INSTALLATION DATA

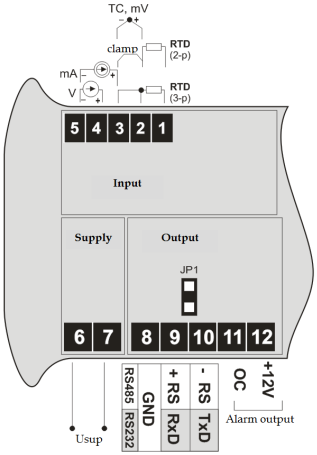
Enclosure type	rail-mounted
Material	polycarbonate, ABS UL94V-0
Enclosure dimensions	79 x 101 x 17.5 mm
Fixing methods	on a 35 mm DIN rail
Conductor cross-sections	2.5 mm^2 (supply, outputs), 1.5 mm^2 (inputs)



7. DESCRIPTION OF TERMINAL STRIPS AND ELECTRICAL CONNECTIONS

Table 7. Numbering and description of terminal strips.

Terminals	Description
1-2-3	input Pt100, Ni100, Pt500, Pt1000, resistance, (2- and 3-wire RTD)
2-3	thermocouple input TC (J, K, S, B, R, T, E, N) and voltage input 0÷60 mV
3-5	current input 0/4÷20 mA
4-5	voltage input 0÷10 V
6-7	power supply input 24 VAC/DC
8-9-10	input RS232C or RS485
11-12	alarm output (on/off type)



Usup - power supply voltage
OC - output of the open collector type, NPN transistor
JP1 - a clamp terminating the lines of the RS485 interface with a 120 Ω resistor (termination switched on when JP1 is closed)

8. LOCATION AND DESCRIPTION OF ELEMENTS OF THE FRONT PANEL

Table 8. Description of the elements of the front panel.

Symbol	Description
PR	programming socket (do not use during transmission from devices connected to the RS232C line or the RS485 line of the AR594 transducer)
A	LED signaling of exceeded processing range, sensor error, or OC alarm output status
Rx/Tx	LED signaling of serial transmission

NOTE:

Connecting other devices than the AR950or AR956 programmer to the PR socket may result in damage to the connected device and the AR594 transducer.

9. SETTING OF THE CONFIGURATION PARAMETERS

All the configuration parameters of the device are stored in the non-volatile internal memory.
When the device is switched on for the first time, an error may occur due to the lack of a sensor or the fact that the sensor that is connected is not one that is factory-programmed. In such a situation, the appropriate sensor or analog signal should be connected or the parameter configuration must be performed.
There are two parameter configuration methods:

1. Use the RS232C, RS485 or PRG interface (AR956 programmer) and the ARSOFT-CFG software:
- connect the device to a computer port and to start and configure the ARSOFT-CFG application
- after the connection has been established, the current measured value is displayed in the window of the software
- setting and viewing of the device parameters is possible in the parameter configuration window
- new parameter values must be approved with the ***Approve changes*** button
- the current configuration can be saved in a file or set using values read from a file

NOTE: 

- before disconnecting the device from a computer, press the ***Disconnect device*** button (ARSOFT-CFG)
- in the event of no response:
  - in the ***Program options*** check the configuration of the port and the ***MODBUS address of the device***
  - make sure that the serial port drivers in the computer have been properly installed for the RS485 converter or the AR956 programmer
  - disconnect for a few seconds and then reconnect the RS485 converter or the AR956 programmer
  - restart the computer
  - if the AR955 programmer is used instead of the AR956 programmer, connect the power supply voltage to the transducer

2. Use the autonomous AR950 programmer to:
- connect the power supply voltage to the transducer;
- use the cable included in the set to connect the AR950 programmer to the device being configured (an AR5xx series transducer);
- the programmer can be connected both before the power supply is switched on and during operation of the device;
- enter the configuration parameters programming mode by pressing (for about 2 s) the **CONF** button until the **CONF** message briefly appears on the display and then the mnemonic name of the first parameter is displayed (**inP**); by pressing the ▲ button, you can move to the next parameter, and by pressing the ▼ button - to the previous parameter (**inP** ↔ **FiLt** ↔ **dbL** ↔...); a list of configuration parameters can be found in the user instruction of the device being configured;
- in order to change or view the value of the current parameter, press SET (edition of the parameter);
- by using ▲ or ▼, you can change the value of the current parameter;
- by pressing SET again, you can save the edited value and return to the parameter name display (e.g. **FiLt**);
- in the parameter edition mode, by pressing **ESC** for a short time, you can cancel the changes and return to the parameter name display mode;
- you can exit the configuration parameters programming mode by pressing the **ESC** button for a long time (approx. 1 s); otherwise, the mode is switched off after approx. 2 minutes;
- in the normal mode, the measured value is displayed;

Detailed information can be found in the user instruction of the AR950 programmer.

In the event of indications different than the actual value of the input signal, the zero and the sensitivity of a sensor can be tuned: parameters 10: CALo (zero) and 11: CALU (sensitivity).

In order to restore the default settings, use the file with the default configuration in the ARSOFT-CFG software.

NOTE: 

The default transmission parameters for the AR956 programmer in the ARSOFT-CFG software are the following: 2400 bit/s, address MODBUS = 1

Table 9. List of configuration parameters

Parameter	**Range of variability of the parameter and description**		Default settings
0: InP Type of measurement input	0: Pt100	thermoresistance sensor (RTD) Pt100 (-200 ÷ 850°C)	Pt100
	1: ni100	thermoresistance sensor (RTD) Ni100 (-50 ÷ 170°C)	
	2: Pt500	thermoresistance sensor (RTD) Pt500 (-200 ÷ 850°C)	
	3: Pt1000	thermoresistance sensor (RTD) Pt1000 (-200 ÷ 850°C)	
	4: tc-J	thermoelectric sensor (thermocouple) type J (-40 ÷ 800°C)	
	5: tc-K	thermoelectric sensor (thermocouple) type K (-40 ÷ 1,200°C)	
	6: tc-S	thermoelectric sensor (thermocouple) type S (-40 ÷ 1,600°C)	
	7: tc-b	thermoelectric sensor (thermocouple) type B (-300 ÷ 1,800°C)	
	8: tc-r	thermoelectric sensor (thermocouple) type R (-40 ÷ 1,600°C)	
	9: tc-t	thermoelectric sensor (thermocouple) type T (-25 ÷ 350°C)	
	10: tc-E	thermoelectric sensor (thermocouple) type E (-25 ÷ 740°C)	
	11: tc-n	thermoelectric sensor (thermocouple) type N (-35÷ 1,300°C)	
	12: 4-20	current signal 4 ÷ 20 mA	
	13: 0-20	current signal 0 ÷ 20 mA	
	14: 0-10	voltage signal 0 ÷ 10 V	
	15: 0-60	voltage signal 0 ÷ 60 mV	
	16: rES	resistance signal 0 ÷ 2,500 Ω	
1: FiLt filtration **(3)**	1 ÷ 10	digital filtration of measurements (response time)	4
2: dot position of the point/resolution**(2)**	0	no point or 1°C resolution for temperature	1 (0.1 °C)
	1	00 or resolution 0.1 °C for temperature	
3: Abot start of input scale (**1**)	-999 ÷ 9999	indication for 0/4mA, 0V, 0Ω on the input - start of input scale	00 °C
4: AtoP end of input scale **(1)**	-999 ÷ 9999	indication for 20 mA, 10 V, 60 mV, 2,500 Ω on the input - end of the input scale	1000 °C
5: outi characteristics of the OC alarm output (chapter 10)	0: rEtr	exceeded range alarm	rEtr
	1: inv	reverse (heating)	
	2: dir	direct (cooling)	
6: SEt i OC output alarm value	in the measurement range of the specific input type		50.0 °C
7. Hi hysteresis of the OC output	00÷9999 °C or 0÷9999 units (**1**)		10 °C
8. bot i start of scale for the exceeded range alarm	in the measurement range of the specific input		-199.9 °C

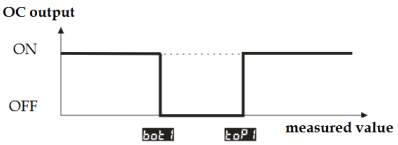
9. toP1 end of scale for the exceeded range alarm	in the measurement range of the specific input		9999 °C
10: CALo calibration of the zero	zero offset for measurements: -1000 ÷ 1000 °C or -1000 ÷ 1000 units (**1**)		00 °C
11: CALG gain	-850 ÷ 1150 %	calibration of inclination (sensitivity) for measurements	1000 %
12: Addr MODBUS address of the device	1 ÷ 247		1
13: br transmission speed [bps]	0=600, 1=1,200, 2=2,400, 3=4,800, 4=9,600, 5=14,400, 6=19,200, 7=38,400,		2 = 2400

Notes: **(1)** – applies to analog inputs (mA, V, mV, Ω),
(2) – applies only to display of data in the connected programmer (AR950, AR956),
(3) – for FiLt=1, the response time is approx. 0.135 s; for FiLt=10 - approx. 1.5 s. Higher degree of filtration means a more smooth measured value and a longer response time, which is recommended in the case of turbulent measurements (e.g. water temperature in a boiler).

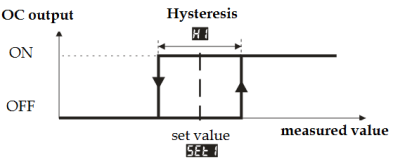
10. CONFIGURATION OF THE ALARM OUTPUT

The type of alarm characteristics for the OC output is determined by parameter 5: out1 (see chapter 9, Table 9).
For out1=rEtr, the OC output is connected after the measured value exceeds the range defined by parameters 8: bot1 and 9: toP1. In this mode, the alarm condition is additionally indicated by the blinking of the **A** LED diode on the front panel.
When the out1 parameter becomes equal to inv or dir parameter 6: SEt1 and 7: H1 apply, the status of the output is indicated by the **A** LED (it is on when the output is switched on).
The principle of operation of the OC output in the individual operating modes is shown in the figures below.

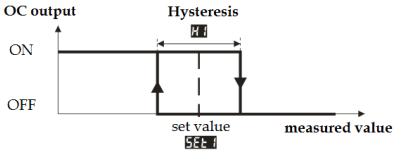
a) exceeded range alarm: : out1=0: rEtr



c) direct characteristics : out1=2: dir



b) inverse characteristics : out1=1: inv



11. SIGNALING OF MEASUREMENT ERRORS

The transducer detects the following measurement errors:
- exceeded processing time, downward or upward (se chapter 10, figure **a**);
- connected sensor or input signal other than the one set in the configuration parameters;
- defective sensor circuit.

Methods of signalization of measurement errors:
- blinking of the **A** LED (when parameter 5: out1=0: rEtr);
- measured value equal to -19999 or 19999 (see chapter 14, table 14.6, register address = 0).

12. RS485 COMMUNICATION INTERFACE (acc. to EIA RS-485).

The installation specification for the RS485 interface is the following:
- maximum cable length - 1 km (observe the installation guidelines, chapter 2);
- maximum number of devices in a RS485 line: 30, in order to increase the number, use RS485/RS485 amplifiers;
- termination and polarizing resistors when the MASTER is at the start of the line (Fig. 12):
  - at the start of the line - 2 x 820 Ω to the ground and +5 V of the MASTER and 150 Ω between lines;
  - at the end of the line - 150 Ω between the lines (or clamp JP1 closed, see chapter 7);
- termination and polarizing resistors when the MASTER is in the center of the line:
  - at the converter - 2 x 820 Ω, to the ground and +5 V of the converter;
  - at both ends of the line - 150 Ω between the lines (or clamps JP1 closed, see chapter 7).

Equipment from different manufacturers that form the RS485 network (e.g. RS485 converters/USB) may have integrated polarizing and terminating resistors; in such a case there is no need to use external elements.

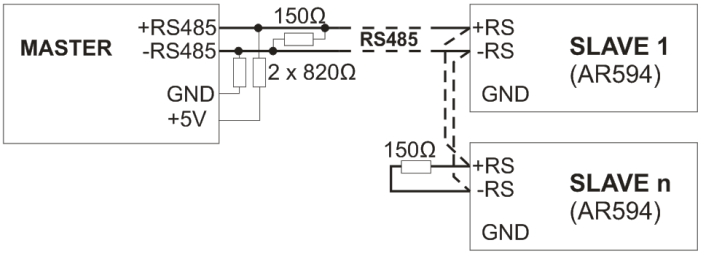
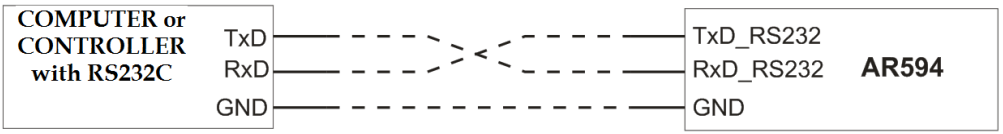


Fig. 12. Pictorial diagram of the RS485 network

13. RS232C COMMUNICATION INTERFACE (acc. to EIA RS-232C)



Maximum cable length: 10 m.
Maximum number of devices connected to the computer: 1.

14. MODBUS–RTU SERIAL TRANSMISSION PROTOCOL

Character format : 8 bits, 1 stop bit, no parity bit
Available functions : READ - 3 or 4, WRITE – 6, minimum query repetition period: 135 ms

Table 14.1. Claim frame format for the READ function (frame length - 8 bytes):

address of the device	function 0x04	read register address: 0 ÷ 19 (0x0013)	number of read registers: 1 ÷ 20 (0x0014)	CRC check sum
1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 14.1. (readout of the measured value, parameter 12: Addr=1): 0x01 - 0x04 - 0x0000 - 0x0001 - 0x31CA

Table 14.2. Claim frame format for the WRITE function (frame length - 8 bytes):

address of the device	function 0x06	write register address:	write register value	CRC check sum
1 byte	1 byte	2 bytes (HB-LB)	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 14.2. Entry in a register with address 10 (0xA) with the 0 value: 0x01 - 0x06 - 0x000A - 0x0000 - 0xA9C8

Table 14.3. Response frame format for the READ function (minimum frame length - 7 bytes):

address of the device	function 0x04	number of bytes in the data field (max. 20*2=40 bytes)	data field - register value	CRC check sum
1 byte	1 byte	1 byte	2 bytes (HB-LB)	2 bytes (LB-HB)

Example 14.3. Response frame for register value equal to 0: 0x01 - 0x04 - 0x02 - 0x0000 - 0xB930

Table 14.4. Response frame format for the WRITE function (frame length - 8 bytes):

copy of the claim frame for the WRITE function (Table 14.2)

Table 14.5. Special answer (errors: function field = 0x84 or 0x83 in the case of the READ function and 0x86 in the case of the WRITE function, High Byte in the data field = 0):

Error code (HB-LB in the data field)	**Error description**
0x0001	non-existing register address
0x0002	erroneous value of parameter to be saved
0x0003	improper function number

Example 14.5. Error frame for a non-existing read register address:
0x01 - 0x84 - 0x02 - 0x0001 –0x5130

Table 14.6. Map of registers for the MODBUS-RTU protocol

Register address HEX (DEC)	**Value (HEX or DEC)**	**Description of register and access type** (R- read only register, R/W - read and write register)	
0x00 (0)	-19999 ÷19999	measured value	**R**
0x01 (1) and 0xC8 (200)	5940	device type identifier (AR594)	**R**
0x02 ÷ 0x05 (2 ÷5)	-	reserved (do not use)	**R**
0x06 ÷ 0x13 (6 ÷ 19)		Reading/writing of parameter (inP, FiLt, dot,…) Register address = parameter number from Table 9 (chapter 9) **+ 6**	**R/W**

15. CONNECTING THE CONTROLLER TO A COMPUTER AND AVAILABLE SOFTWARE

It may be useful (or necessary) to connect the transducer to a computer in order to configure parameters, which also enables copying the setting to other transducers of the same type.
As a standard, the transducers are equipped with a **PR** port, which enables connecting to a computer using an AR956 programmer. Attention should be paid to the configuration of transmission parameters in the options of the ARSOFT-CFG software.
During the first startup, the (default) transmission parameters should have the following values:
Speed = 2,400 bit/s, MODBUS address = 1.
The following applications are available (on a CD supplied with the AR956 programmer or to be downloaded from the Internet at ***www.apar.pl***, *Download* section, for operating systems Windows Vista/7/8/10):

Name	Software description
ARSOFT-CFG (free)	- display of current measurement data from the connected device - configuration of the type of measurement input, the indication range, the alarm options, the display, etc. - creation of a disk with a "cfg" extension, containing the current configuration of the parameters to be used again (duplication of configuration) - the software requires communication with the device via the **PR** port (AR956 or AR955)

The detailed descriptions of the aforementioned applications can be found in the installation folders.

NOTE:
Before a c ion is established, make sure that the MODBUS address and the transmission speed in the options of the ARSOFT-CFG software are the same as the settings of the device. Moreover, in the ARSOFT software options, set the number of the COM serial port in use (in the case of the RS956 or AR955 programmer it is the number assigned by the operating system during installation of the drivers).

16. USER'S NOTES