RPF Max
user manual

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Revision 1.1.3 dated 27/05/2008

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INTRODUCTION

RPF Max is a motorized filter wheel running by means of the following two ports: 1) a standard bidirectional port (parallel port); 2) a RS232 (serial port).

There are two versions of the wheel:

- RPF Max-8: the 8-positions 2" filter wheel
- RPF Max-16: the 16-positions 1" filter wheel

It stands out for its capability to place the 1" or 2" filters at high speed (50 ms between one filter and the following one). In cascade connection mode, it can control up to 8 RPF Max units by means of the same serial port.
It is possible to set the rotation speed and a different stop position for each filter.
The motor hold current is user adjustable.
This product can be customized, specifying different size, number of filters, input or output adapters.
The typical applications are Photometry, Microscopy and color sequences.

Fig. 1 *RPF Max filter wheel: front and rear views, 8 and 16-positions inner disk*

THE STANDARD SYSTEM INCLUDES:

- assembled unit in light alloy with threaded 2" input;
- RS232/Parallel interface;
- 2.5 m PC parallel link cable;
- managing software for Windows ME/XP/2000;
- 115/230V power supply;
- case, manual and 24 months of warranty.

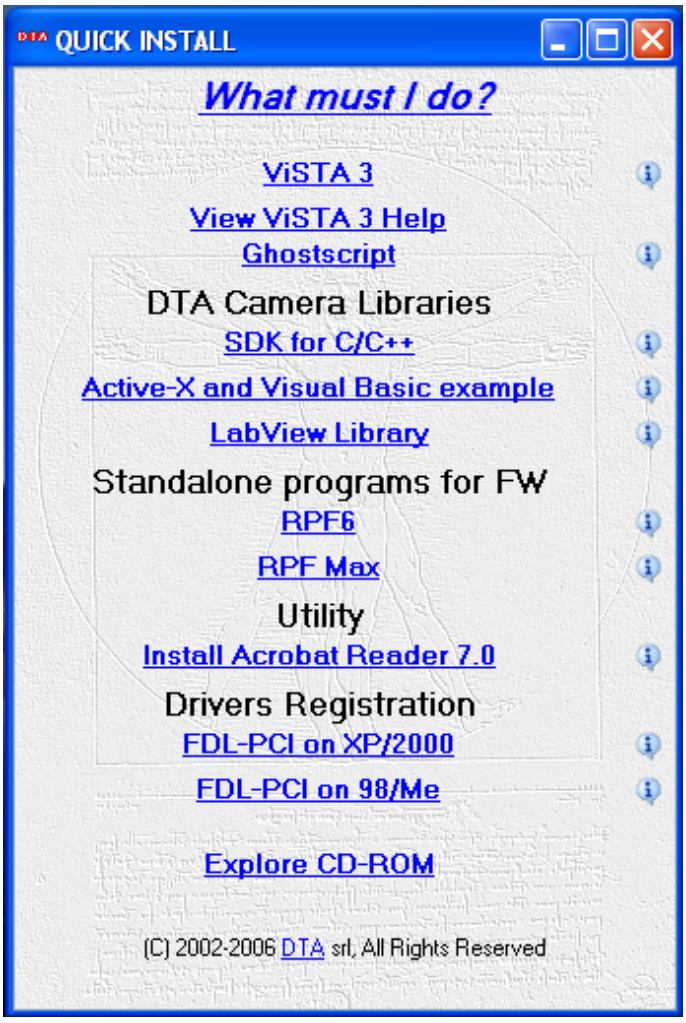
PERSONAL COMPUTER MINIMUM REQUIREMENTS

- CPU Celeron 1 Ghz
- 256 Mb of RAM
- Microsoft Windows ME
- RS232 port connecting the PC to the filter wheel

SOFTWARE INSTALLATION

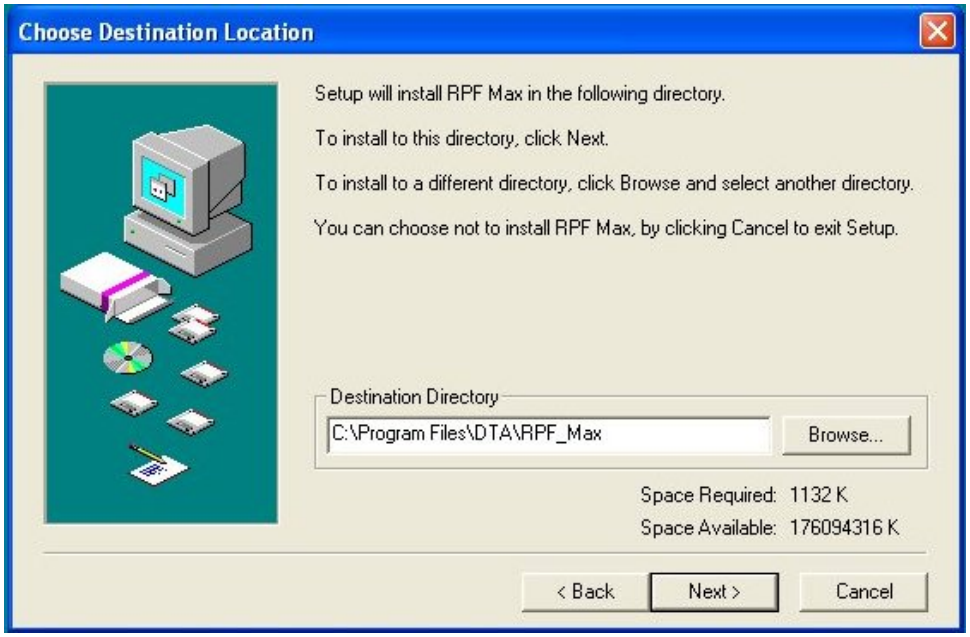
Software installation of this instrument is particularly simple and intuitive. You must conform to the following steps:

1. Insert the CD ROM, provided with the filter wheel and the "Quick Install" will appear. Click on RPF Max by the "Standalone programs for FW" menu:

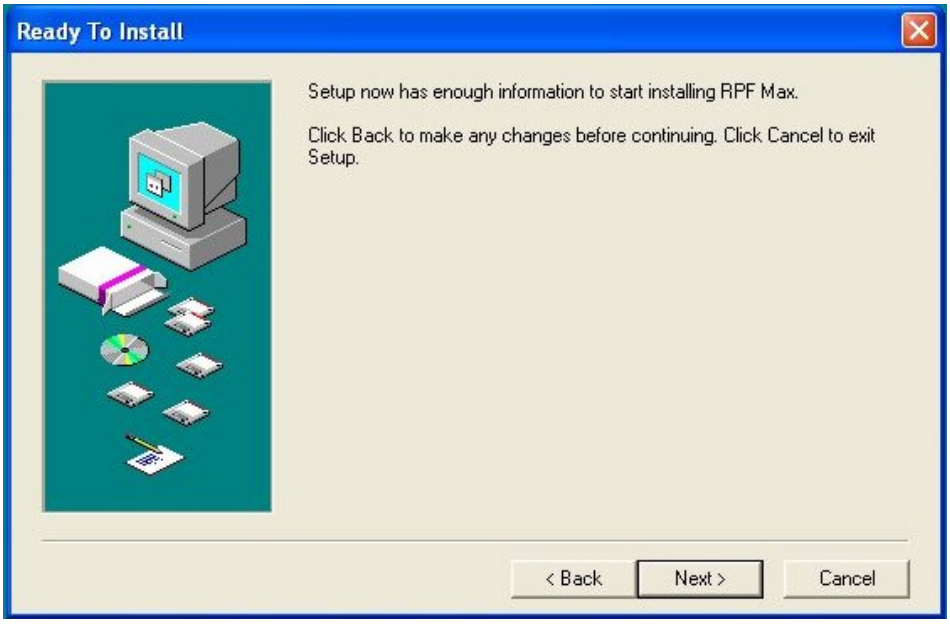


2. Now starts the installation of the program. Click on Next to continue the installation:

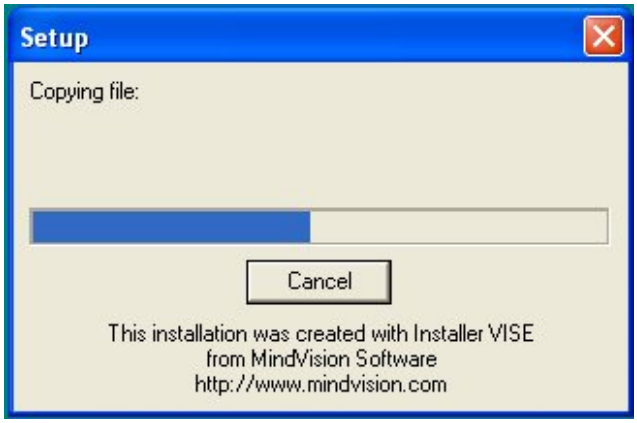
3. Select the folder where to install the RPF Max (we recommend you to choose the destination directory suggested in the window below) and click on Next to continue the installation:



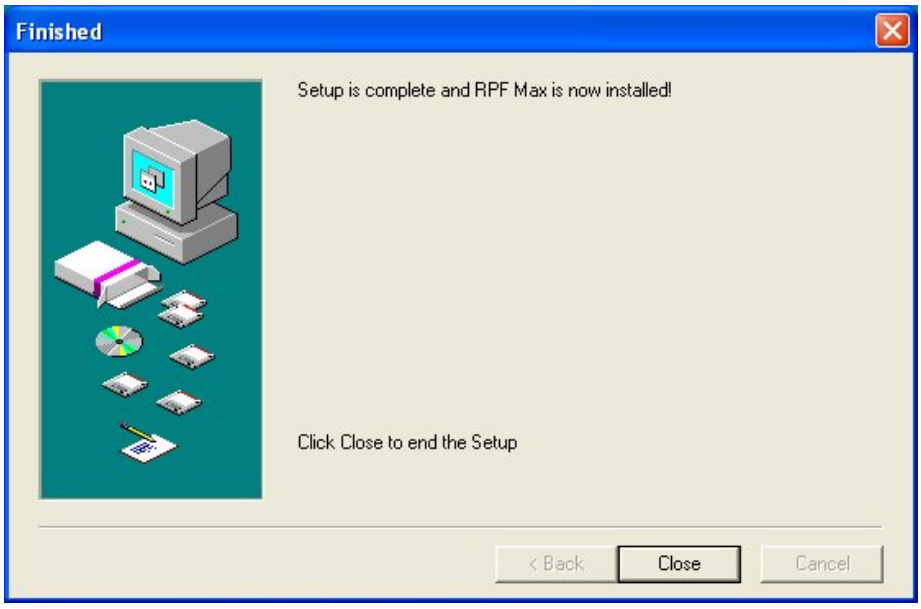
4. Now, the information are enough to start the installation of the RPF Max filter wheel. Click on Next or Back to change any settings:



5. Wait while the Setup installs the software (just few seconds):



6. When the installation has been completed, a window like the one below will appear. Click on Close to end the Setup



INSTALLATION OF THE RPF MAX TO YOUR PC BY MEANS OF THE SERIAL LINK

The following steps are fundamental to install the RPF Max filter wheel to your PC:

- **It is suggested to make the connection operations with computer off.**
- Install the software by the use of the CD-Rom provided with the filter wheel, following the indications there reported.
- From the *Programs/RPF_Max* directory, edit the *rpf.cfg* file by text editor (as *notepad* or similar), verifying the settings are coherent with the required ones. In particular, verify the field relative to the used port.
- Put the provided serial 9-pin female connector of the link cable (see picture below – A) in the selected serial port, then fix it by means of the two side screws placed on the connector.
- Put the 25-pin female connector (see picture below – B) in the respective 25-pin male connector of the RPF Max, then fix it by means of the screws placed on the female connector.
- Put the male jack (out of the 12V power supply provided together with the filter wheel) in the supply female jack (see picture below – C).
- Let run the handly program.

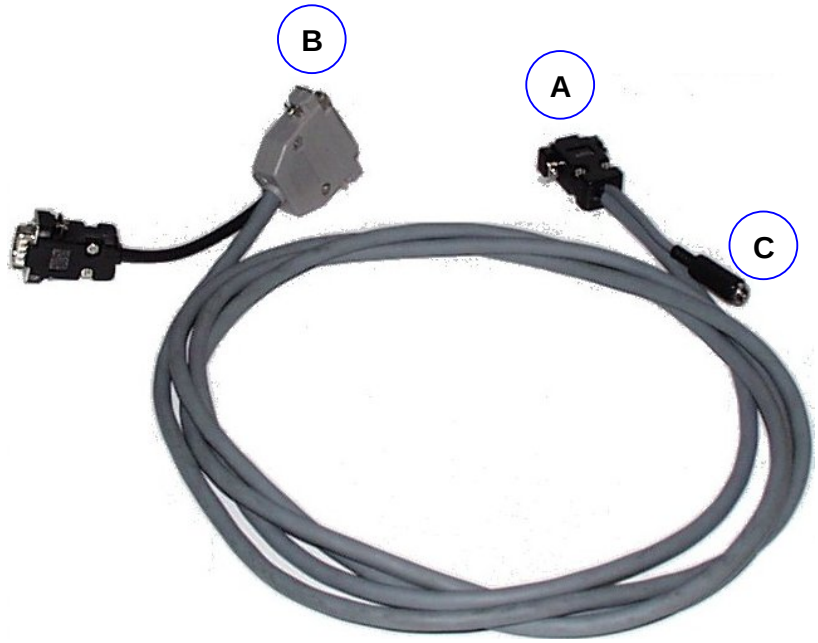
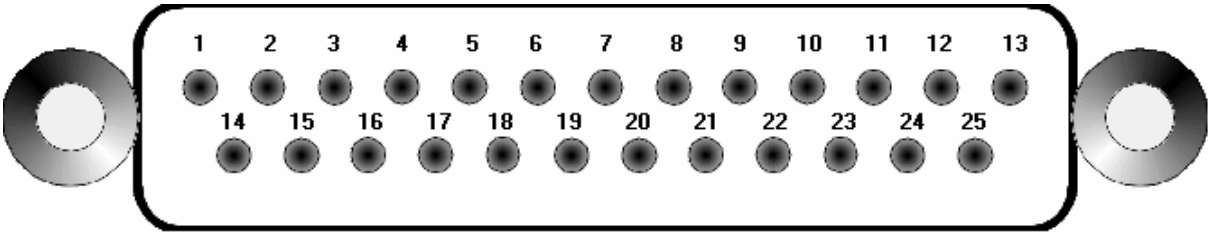


Fig. 2 *Serial link cable*

PARALLEL AND SERIAL INTERFACE

The parallel interface is made up of a link between the RPF Max and the PC on standard bidirectional parallel port, while the serial interface is made up of a link by means of standard RS232.
Hereafter you can see the 25-pin male connector of the RPF Max as well as the detailed description of the included signals.



The following chart represents the signals on the pin of the connector

1	**AD0**	**2**	**AD2**	**3**	**AD4**	**4**	**AD6**	**5**	**/ACK**
6	**ERROR**	**7**	**GND**	**8**	**POW**	**9**	**ADDR**	**10**	**PRG**
11	**GND**	**12**	**TX1**	**13**	**TX0**	**14**	**AD1**	**15**	**AD3**
16	**AD5**	**17**	**AD7**	**18**	**/BUSY**	**19**	**/STROBE**	**20**	**POW**
21	**GND**	**22**	**GND**	**23**	**+5V**	**24**	**RX1**	**25**	**RX0**

- **AD0 – AD7 :** COMMAND[0:7] parallel port (input)
- **/STROBE :** /STROBE parallel port signal (input)
- **/ACK :** /ACK parallel port signal (output)
- **/BUSY :** /BUSY parallel port signal (output)
- **ERROR :** notice of parallel port error (output)
- **GND :** ground
- **POW :** +12V RPF Max power supply (input)
- **+5V :** +5V (output)
- **ADDR :** pin of changing address
- **PRG :** pin of firmware updating
- **TX1, RX1 :** UART1
- **TX0, RX0 :** UART0

- The communication speed on serial port can be 2400bps, 4800bps, 9600bps, 19200bps (see the relevant paragraph).
- This specific kind of link can get up to a maximum distance of 50 m.
- With parallel port up to 20 m.
- All signals are standard CMOS 0-5V.

RPF Max SETTING

RPF Max ADDRESS SETTING

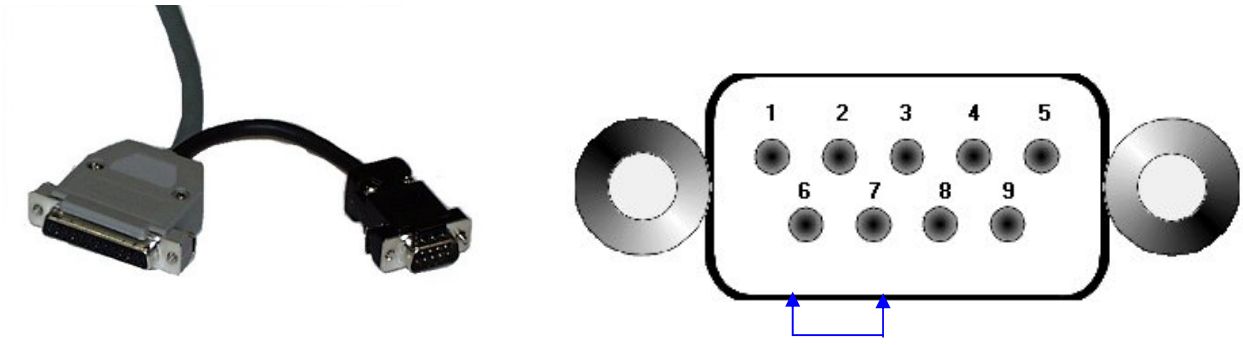
In serial mode RPF Max is identified by an address. Because of it, you can link up to 8 devices one after the other. If the wheel doesn't recognize its input address, it doesn't answer and it stays transparent.
The address recognized by the RPF Max can be found in location 3Fh of the inner eeprom : DTA places it on address 0 (see the relevant section of the " Programmer's Manual") : it usually is a read-only .
To modify the RPF Max address, it is necessary to short-circuit the pin 7 (ADDR) and 6 (+5V) of the 9-pin female connector of the serial cable (see picture 3 – B).

Before performing this step, make sure your device is not powered !

Switch the wheel on and it'll recognize the 0 address. Now the address can be changed by means of a simple writing operation at the 3Fh location of the eeprom : only the lowest significant byte is valid. Once this operation is over, switch the device off and eliminate the short-circuit. When getting started, the filter wheel will recognize the new set address.
Otherwise, you can simply realize the identity address programming by means of the *rpf.exe* handly program, just typing from the command console the following:

rpf /s n

where *n* is the address ranging from 0 to 7.



A **B**

Fig. 3 ***A:*** *Serial cable;* ***B****: detail*

UPDATING OF THE FIRMWARE

RPF Max hosts a powerful microchip running every function with a re-plannable and updatable firmware. To plan the firmware you need to build up a serial cable linking the wheel to the PC. Hereafter you can find the chart.

RPF MAX PORT CANNON 25 F	SIGNAL	UART 1 CANNON 9 F	POWER SUPPLY JACK	NOTES
1	--	--		
2	--	--		
3	--	--		
4	--	--		
5	--	--		
6	--	--		
7	--	--		
8	POW	--	CENTRAL	+12V
9	--	--		
10	TO BE SHORT-CIRCUITED WITH PIN 23/	--		PRG
11	GND	5		SERIAL GND
12	TX1	2		UART1 TX
13	--	--		
14	--	--		
15	--	--		
16	--	--		
17	--	--		
18	--	--		
19	--	--		
20	--	--		
21	GND	--	EXTERNAL	POWER S. GND
22	--	--		
23	TO BE SHORT-CIRCUITED WITH PIN 10	--		VCC +5V
24	RX1	3		UART1 RX
25	--	--		

CHART OF RPF MAX PLANNING CABLE

Please note: the power-supply jack has to be mounted as an output from the connector of UART1.

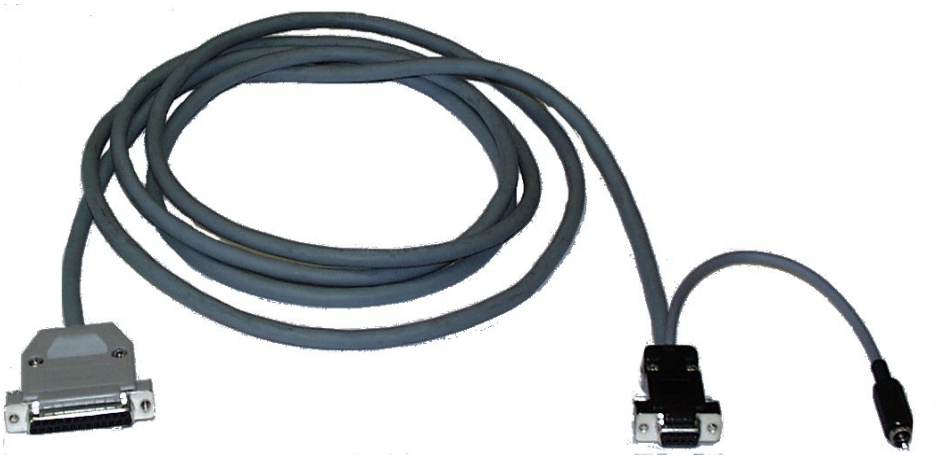


Fig. 4 *RPF Max programming cable*

In order to get to the programming stage, you also need to have the updated software as well as the microcontroller programming software “M16C Flash Start (MSA0806)”

Here follow the steps to do in order to obtain the right updating of the software.

⇒ Switch the PC off, any device included.

⇒ Link the RPF Max to the PC by using the dedicated programming cable.

⇒ Feed the RPF Max and switch the PC on.

⇒ Start the software M16C Flash Start (MSA0806) and follow the instructions.

⇒ Once the programming has been carried out, switch both the PC and the wheel off. Then change the programming cable with the communication one.

⇒ The wheel is ready to be used again.

RPF MAX CASCADE CONNECTION

You can get a cascade connection, up to 8 units, thanks to the serial link. The first cascade RPF Max needs to be connected to the PC, the second by means of the 9 pin female connector(see picture 5 – A) of its own cable to the 9 pin male connector (see picture 5 – B) of the previous wheel and so on.

Fig. 5 *Serial cable*

SOFTWARE SETTING

RPF MAX HANDLER Rev. 1.2

Together with the RPF Max you are given a software controlling the wheel by means of serial port "RPF Max HANDLER Rev. 1.2".
It allows one to manage the wheel with Windows ME/2000/XP.

To install the managing program just start "setup" from the CD you can find in the wheel box.

This software looks for the wheel on the COM1.

Once the setting is finished, the program shows the presence of a single RPF Max as a default, with suitable working parameters set by default.

To enable the control of more than one wheel and change the wheel parameters, it is necessary to edit the file "rpf.cfg" (as shown in the following page of this manual) : it is in the same directory as the software already installed.
Switch the RPF Max on, then start the software. The wheel is ready to be used.

RPF.CFG

```
**** Specify num of filter wheel in the same serial channel, range: 1..8
1
**** Specify num of filters on each fw, range: 8..16
8
**** Specify serial port, range: 0..15, 0 = COM1.. 15 = COM16
0
**** Specify baud rate, range: 3 = 2400, 4 = 4800, 5 = 9600, 6 = 19200
6
**** Enable holding torque: 0 = disable, 1 = enable
1
**** Set holding torque, range: 10..15984. 1 count = 62.5 ns of the ON period
15984
**** Filter offset, range: -127 to + 128. Applied after calibration
0
**** Calibration speed, Freq. (KHz) = 2/n. Range: 20000..10000
20000
**** Slope used in fast positioning, value are motor steps, range: 0..255
224
**** Start speed in fast positioning, Freq. (MHz) = 16/n. Range 32768..65535
65535
**** End  speed in fast positioning, Freq. (MHz) = 16/n. Range 0..65535. 4096 for Sanyo-Denky, 16000 for MAE
4096
**** Enable (1) or disable (0) feedback positioning.
1
**** Delay after positioning (ms). Range: 0..65535. Suggested value: Sanyo-Denky 125, MAE 500
125
```

PLEASE DON'T CHANGE THE ORDER OF THESE PARAMETERS, AND DON'T ADD BLANK LINES BETWEEN THESE.
MAX LENGTH OF A LINE IS 256 CHARS.

RPF Max (Rev 1.2) ***N*** **POSITION FILTER WHEEL**

PROGRAMMER'S MANUAL

RPF Max has two different connection systems : by means of parallel port or serial port.
On the contrary, the programming has been designed to be driven from the serial port only. The filter wheel recognizes if the communication has been set by serial or parallel port automatically.
As soon as the device is on, it starts reading all the start-up settings from the inner EEPROM. Immediately after, thanks to a calibration stage, it is located in filter number 0.
The device is identified by an 8-bit address serially, so you can connect up to 8 RPF Max in the cascade mode.
Hereafter you can find the protocol transmission specifications.

RS232 SERIAL LINK AND TRANSMISSION PROTOCOL

The RS232 serial link is used with the following transmission parameters : either
2400, N, 8, 1 or 4800, N, 8, 1 or 9600, N, 8,1 or 19200, N, 8, 1 (see Appendix A : Setting of transmission speed upon RS232).
The protocol uses printable ascii characters.
Every transmitted string consists of a head "$" character, an end-field "#" character and end-string character represented by the CR (13) character.
Between the # character and the CR one, there are two hexadecimal figures showing the 8-bit checksum of the string (it is calculated from $ character to #, excluding these 2). Immediately after the head "$" character you'll find the RPF Max address (00-FF) one wishes to use. You will be asked to provide 2 hexadecimal figures, up to a maximum range of 8 devices. For every string transmitted to the wheel, it corresponds to another one standing for the answer : it is the command processing confirmation. If the command has been carried out, the answer can be ACKXX, on the contrary NAKXX. Instead of the ACKXX, a requested status can be sent.

Command string format

$ Addr Command # cksm CR

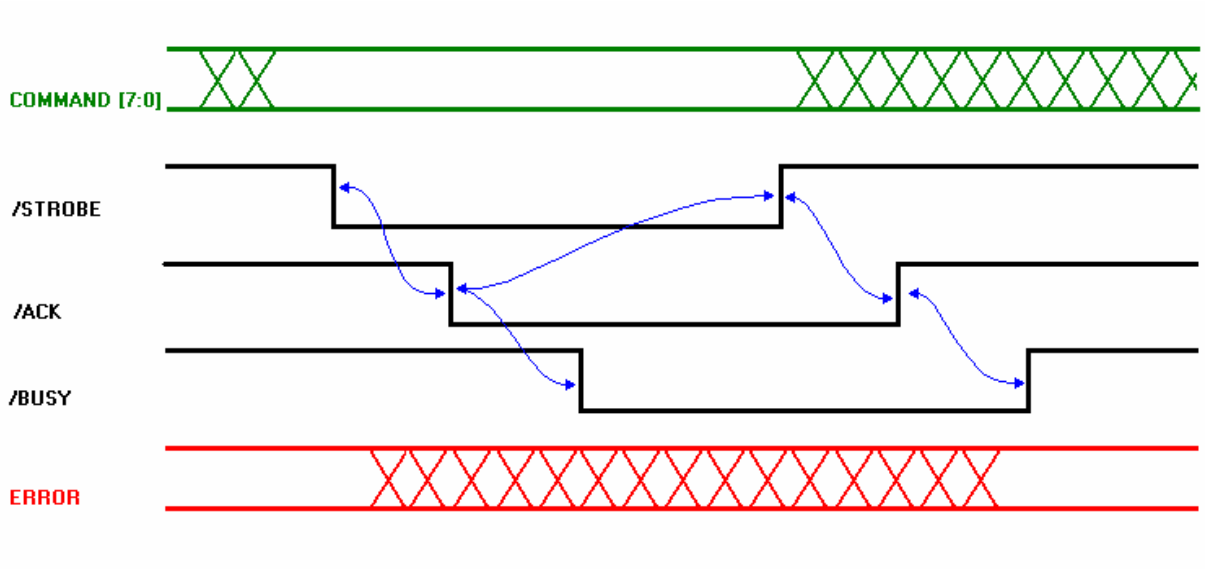
typical answer

$ Addr ACKXX#Cksm CR

If the address field does not include any valid value, no device will answer. Every RPF Max answers after the carrying out of the command, the minimum response time being 20ms.
The checksum is calculated by summing up every character included between the $ character and the # one (excluding these 2) on a 8-bit accumulator.
By means of the Command string, the instructions are given to the wheel. Command has a dimension ranging from from 1 to 7 characters.

PARALLEL LINK AND TRANSMISSION PROTOCOL

The link is performed thanks to a 8-bit standard parallel port.
The protocol is as follows.



- **COMMAND [7:0]** INPUT
- **/STROBE** INPUT
- **/ACK** OUTPUT
- **/BUSY** OUTPUT
- **ERROR** OUTPUT

The RPF Max waits for the input /STROBE signal to become low, then it reads COMMAND [7:0] and lowers /ACK and /BUSY; it waits for /STROBE to come back to 1 in order to bring /ACK back to 1, then it goes on with the interpretation and execution of the command which it has just received. At the end of the execution, it carries /BUSY up to 1 and it sets or resets the ERROR flag according to any error which might have occurred or not.
The word COMMAND [7:0] consists of : the 3 most significant bits (command [7:5]) identify the command, the other 5 bits (command [4:0]) contains the data.

RPF MAX COMMANDS SERIAL MODE

In serial mode, RPF Max shows 24 instructions allowing the control of the wheel and the planning of all parameters (from the address to the number of filters and to the pilotage setting up of the stepping motor). Ai and Di fields are expressed in hexadecimals.

What follows is the comprehensive list of the instructions.

CONTROL INSTRUCTONS

- **VERSION** code 0
  As an answer, RPF Max transmits a string concerning the revision of the firmware ("RPF Max Rev 1.2").
- **CALIBRATE** code 1
  RPF Max performs the adjusting by placing on filter number 0; if the adjustment has been successful, it transmits the string ACK00, otherwise the string ACK01 (it means that the adjustment can't be carried out).
- **PLACEMENT** code 2D_1D_0
  RPF Max goes onto the filter whose number is specified by the 2 figures D_1D_0 in hexadecimal. Once the placement has been carried out, the wheel shows the string ACK00. If the number specified in the instruction isn't valid (as it exceeds the number of filters which the wheel can host), the placement doesn't come to an end and the wheel transmits the string NAK01 (unrecognized instruction). On the other hand, if the placement can't be performed because of a hardware failure, the wheel may transmit the string ACK02 (the placement has not taken place) or the string ACK01 (the recalibration has not taken place).
- **TORQUE** code 9D_0
  This instruction allows one to apply (or not to do so) a holding torque to the motor of the RPF Max (if it is still); $D_0 = 1$ if you need to activate the torque, $D_0 = 0$ if you need to deactivate it. The RPF Max transmits the string ACK00.
- **STATUS** code S
  This instruction allows one to ask for the inner status of the RPF Max corresponding to the latest placement instruction or calibration which has been performed. As an answer, the wheel can either transmit the string STATUS00 showing that no error has occurred, or STATUS1 showing that a calibration error has happened, or STATUS2 in case of a placement error.
- **POSITION** code P
  RPF Max gives back a string specifying the number of the filter currently in placement.
- **DIAGNOSTIC** code T
  RPF Max carries out four series of automatic positioning, able to verify the correct working of both the mechanics and the electronics (see Appendix D). For every performed positioning the wheel transmits either the string ACK00 or ACK01 or ACK02, according to the positioning outcome. At the end of the test, an hexadecimal number is given back showing how many errors have taken place.
- **D_REPORT** code RI_0
  This instruction allows one to enter four strings (I_0 = 0-3) showing the latest diagnostic test (see APPENDIX D).

PROGRAMMING AND SETUP INSTRUCTIONS

You are kindly recommended to use the wheel parameters as shown in Appendix B

- **TORQUE_VAL** code 3$D_3D_2D_1D_0$
  The holding torque value depends on the length of the high level of a 1 Khz square frequency wave applied to the motor. This value is set by means of the four hexadecimal figures D_3 - D_0 (16 bit). Every count is equivalent to an interval of 62,5ns. The minimum value to be set is 000Ah, the maximum 3E70. The RPF Max transmits the string ACK00.

- **OFFSET** code 4D_1D_0
  This instruction allows one to set a number of steps the wheel has to carry out at the end of the calibration, by going on with the rotation trend or by inverting the rotation itself. The number of steps ranges from –127 (D_1D_0 = 00) to + 128 (D_1 D_1 = FF) – the negative sign stands for the inversion of the rotation -. The RPF Max transmits the string ACK00.

- **FILTERS** code 5D_1D_0
  This instruction allows one to set the number of filters you can mount on the wheel (it depends on the internal disk), up to 16 (D_1D_0 = FF). RPF Max transmits the string ACK.

- **STEPS** code 6$D_2D_1D_0$
  This instruction allows one to set the number of motor stepping between one filters and the next one, the number being specified by means of the three hexadecimal figures $D_2D_1D_0$. RPF Max transmits the string ACK00.

- **CIRCLE** code 7$D_2D_1D_0$
  This instruction allows one to set the number of motor stepping to perform a full circle of the wheel, the number being specified by means of the three hexadecimal figures $D_2D_1D_0$. RPF Max shows the string ACK00.

- **MOTOR_S** code 8$D_3D_2D_1D_0$
  This instruction allows one to set the pilotage frequency of the stepping motor during the calibration stage. The frequency (KHz) is equivalent to 2/N (N stands for the number with 16 bit set by $D_3D_2D_1D_0$). RPF Max transmits the string ACK00.

- **RAMP** code AD_1D_0
  This instruction allows one to specify the length (by motor stepping) of the acceleration/deceleration ramp of the motor during the placement stage. RPF Max transmits the string ACK00.

- **MSTEPI** code B$D_3D_2D_1D_0$
  This instruction allows one to set the initial pilotage frequency of the stepping motor as far as the placement stage is concerned. The frequency (MHz) is equivalent to 16/MSTEPI. RPF Max transmits the string ACK00.

- **MSTEPF** code C$D_3D_2D_1D_0$
  This instruction allows one to set the maximum pilotage frequency of the stepping motor as far as the placement stage is concerned. The frequency (MHz)is equivalent to 16/MSTEPF. RPF Max transmits the string ACK00.

- **WRITE_EE** code D$A_1A_0D_3D_2D_1D_0$

This instruction allows one to write in the inner eeprom : it's the place where all pilotage parameters of the device are memorized. By means of A_1A_0, one specifies the inner memory address to be entered (ranging from 00h to 3Fh). The data to be written are given $D_3D_2D_1D_0$. RPF Max transmits the string ACK00.

- **READ_EE** code E$A_1A_0D_3D_2D_1D_0$
  This instruction allows one to read in the inner eeprom : it's the place where all pilotage parameters of the device are memorized. By means of A_1A_0, one specifies the inner memory address to be entered (ranging from 00h to 3Fh). The RPF Max transmits the string including the data of the memory location.

- **DIP_SW** code M
  This instruction allows one to get the status of the 8 inner dip switch (see APPENDIX A)

- **IR_CTRL** codifica VD_1D_0
  This instruction allows one to switch the positioning and calibration sensors on and off. If you set D_1 at 1, the sensor controlling the wheel position turns on; if you set it at 0, it turns off. If you set D_0 at 1, the sensor controlling the wheel calibration turns on; if you set it at 0, it turns off.

- **IR_READ** code I
  This instruction allows one to read the information coming from by both positioning and calibration sensors. Two figures are given back, C_1 C_0, showing (if at data 1) the performed positioning or calibration respectively.

N.B.
C_1 has to be at value 1 for every position of the wheel, while C_0 has to value 1 in position **ZERO** only (calibration positioning).

- **POS_FEEDBACK** code LD_0
  This instruction allows one to enable (or not to do so) the feedback control of the positioning. If D_0 is placed at value 1, the feedback has been activated; if it is placed at value 0, the feedback is deactivated.

  FEEDBACK NOTE
  The feedback function allows the RPF Max micro to check the maintenance of the current position before a new positioning might start. If the current position has gone lost (due to special, external cause), the RPF Max carries out a calibration and then it shifts into the new position.

- **DELAY** code K$D_3D_2D_1D_0$
  This instruction allows one to trim the waiting delay at the end of every positioning of the RPF Max. In this way the oscillations (due to the inertia of the system) are reduced. The delay time corresponds to $D_3D_2D_1D_0$ ms.

RPF MAX COMMANDS PARALLEL MODE

In this mode, the RPF Max includes a reduced command set allowing one to drive the wheel and enter a limited section of its parameters.

- **CALIBRATE**

Command value	00H
Parameter	none

The RPF Max performs the calibration by placing itself on filter number 0 again. If the calibration can't be carried out, it sets ERROR at value 1.

- **POSITION**

Command value	01H
Parameter	0-n, where n=num of filters-1

The RPF Max goes to the filter whose number is specified by the five binary figures $D_4D_3D_2D_1D_0$. If the positioning can't be carried out, the RPF Max sets ERROR at value 1.

- **TORQUE_VAL**

Command value	02H
Parameter	0-1FH

The value of the holding torque depends on the length of the high level of a 1 kHz square frequency wave applied to the motor. This value is set by means of the five binary figures D_0 - D_4. Every count is equivalent to an interval of 625ns. The minimum value to be set is 00001 b, the maximum 11111 b.

- **OFFSET**

Command value	03H
Parameter	00H-0FH for positive offset
	10H-1FH for negative offset

This instruction allows one to set a number of steps the wheel has to carry out at the end of the calibration, by going on with the rotation trend or by inverting the rotation itself. The number of steps ranges from –15 ($D_4D_3D_2D_1D_0$ = 00000) to + 16 ($D_4D_3D_2D_1D_0$ = 11111) – the negative sign stands for the inversion of the rotation .

- **TORQUE**

Command value	04H
Parameter	00H-0FH

This instruction allows one to activate or deactivate the holding torque of the stepping motor. If D_0 is placed at value 0, the holding torque is deactivated; if it is placed at value 1, the holding torque is activated.

O **MOTOR_S**

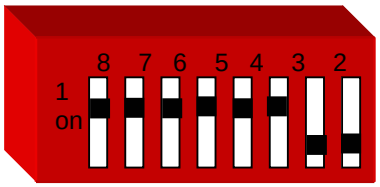
Command value	05H
Parameter	00H-03H

This instruction allows one to set the pilotage frequency of the stepping motor during the calibration stage. The frequency (KHz) is equivalent to 2/N (N stands for the number with 16 bit set by $D_3D_2D_1D_0$). RPF Max transmits the string ACK00.

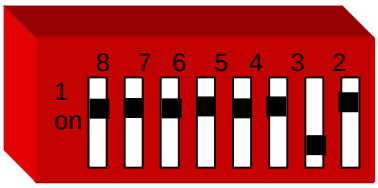
APPENDIX A

SETTING OF THE TRANSMISSION SPEED ON RS232

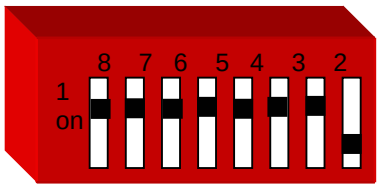
The two serial ports RS232 of the RPF Max (UART0 and UART1) can communicate at a speed of 2400 bps, 4800 bps, 9600 bps and 19200 bps. DTA has set it at 19200 bps; however, you can modify it by using the dip switches 1 and 2 you can find inside the RPF Max. Hereafter you can look at the settings of the two switches to select the four speed.



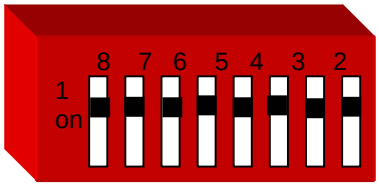
SETTINGS 19200 bps



SETTINGS 9600 bps



SETTINGS 4800 bps



SETTINGS 2400 bps

PLEASE NOTE : THE DIP SWITCH POSITION 3 – 8 are not used!

APPENDIX B

EEPROM MAP

The EEPROM includes every value relevant to any RPF Max parameter. Thanks to this every time the wheel is on the internal microcontroller loads the functioning parameters automatically.

ADDRES	DATA	SANYO MOTOR	MAE MOTOR
Ind. 00h	CPVH	**3E70h**	**3E70h**
Ind. 01h	OFFSET_VAL	00**7Fh**	00**7Fh**
Ind. 02h	FILTERS	00**08h**	00**08h**
Ind. 03h	STEPS	0**064h**	0**064h**
Ind. 04h	CIRCLE	0**320h**	0**320h**
Ind. 05h	MOTOR_S	**4E20h**	**4E20h**
Ind. 06h	RAMP	00**E0h**	00**E0h**
Ind. 07h	MSTEPI	**FFFFh**	**FFFFh**
Ind. 08h	MSTEPF	**1000h**	**3E80h**
Ind. 09h	TORQUE	000**1h**	000**1h**
Ind. 0Ah	OFFSET_PS	000**0h**	000**0h**
Ind. 0Bh	POS_CTR L	000**1h**	000**1h**
Ind. 0Ch	DELAY	**007Dh**	**01F4h**
Ind. 3Fh	ADDRESS	00**00h**	00**00h**

- **CPVH :** length of the high level of square wave running the holding torque (acceptable range 000Ah – 3E70h).
- **OFFSET_VAL :** offset value for calibration.
- **FILTERS :** number of filters of the inner disk.
- **STEPS :** number of motor stepping between one filter and the following one.
- **CIRCLE :** number of motor stepping for the full rotation of the wheel.
- **MOTOR_S :** it sets the pilotage frequency of the motor in calibration mode. Freq.(**kHz**) = 2/MOTOR_S.
- **RAMP :** number of motor stepping of the acceleration/deceleration ramp in the positioning stage.
- **MSTEPI :** it sets the initial pilotage frequency of the motor in the positioning stage. Freq.(**MHz**) = 16/MSTEPI.
- **MSTEPF :** it sets the final pilotage frequency of the motor in the positioning stage. Freq.(**MHz**) = 16/MSTEPF.
- **TORQUE :** if this parameter is set at value 0, the holding torque is deactivated; if it is, set at value 1, it is activated.
- **OFFSET_PS :** if this parameter is equivalent to 0, it means that the OFFSET_VAL value has been set by serial port; otherwise, if this parameter is equivalent to 1, it means that the OFFSET_VAL value has been set by parallel port..
- **POS_CTRL** : if this parameter is set at value 1, the feedback positioning starts working; if it set at value 0, the control is deactivated.
- **DELAY :** it's the gap in ms between a positioning and the other.
- **ADDRESS :** this parameter sets the RPF Max serial address.

N.B.

The not bold value of the eeprom location is not significant.

APPENDIX C

ANSWERING MESSAGES OF THE RPF Max

ERROR MESSAGES

Hereafter you can find a list of error messages the RPF Max can give back as a result of the receipt of an instruction by means of serial port.

- **NAK00 :** receipt error; the input string can't be decoded.
- **NAK01 :** unrecognized or wrong instruction.
- **ACK01 :** the calibration has not taken place; the reason is an hardware problem. Try to clean the infrared positioning sensor with a jet of compressed air : it is placed underneath, outward the filter disk.
- **ACK02 :** the positioning has not taken place; the reason is an hardware problem. Try to clean the infrared positioning sensor with a jet of compressed air : it is placed underneath, inward the filter disk.
- **ACK03** : the operation is not allowed; this string is given back if you try to modify the address of the filter wheel without having shot-circuited the ADDR pin (as specified in the paragraph "Setting of the RPF Max address").
- **AVVIA DIAGNOSTICA :** you have carried out the D_REPORT command without carrying out the diagnostic before.

DIAGNOSTIC MESSAGES OF THE INTERNAL STATUS

Hereafter you can find a list of internal status messages the RPF Max can give back as a result of the receipt of the STATUS instruction (only from serial port).

- **STATUS00 :** the last performed calibration or positioning instruction has been successful, the wheel is working properly.
- **STATUS01 :** the last performed calibration instruction has been unsuccessful. Try to clean the infrared positioning sensor with a jet of compressed air : it is placed underneath, outward the filter disk.
- **STATUS02 :** the last performed positioning instruction has been unsuccessful. Try to clean the infrared positioning sensor with a jet of compressed air : it is placed underneath, inward the filter disk.

SUCCESSFUL EXECUTION MESSAGES

Hereafter you can find a list of messages showing a successful outcome as far as the execution of the instructions given by serial port.

- **ACK00 :** the instruction has been performed properly. This string is the answer to all the given and carried out instructions but the VERSION instruction.
- **RPF MAX Rev. 1.2 :** the VERSION instruction has been properly performed; the string specifies the revision of the internal firmware.

APPENDIX D

DIAGNOSTICS OF RPF MAX

The RPF Max can carry out an auto diagnostic test allowing to check the right calibration of both the mechanics and the electronics as well as the absence of any incorrect working stages. By means of the DIAGNOSTIC (T) command, the wheel is asked to perform four positioning series : first the wheel carries out a calibration, then it is placed on every filter included between 0 and N-1 (N = number of positions of the wheel) like in a sequence. If the positioning fails, the wheel performs a calibration before stepping into the following filter. In the second series, the wheel is placed on the filters according to the following rule :

For X = 0; X<N/2; X++;
{POSITION =N/2+X;
POSITION =X;}

If a positioning fails, the wheel performs a calibration before stepping into the following filter. The other two series are the same as the ones we have just mentioned.

At every series corresponds a string with *N* bit (binary figure) (the first being N + 1 as it also include the outcome of the initial calibration) : here it is shown the outcome of every single positioning (0 means "performed"; 1 stands for "error"). The figure on the extreme left refers to position 0, the other on the extreme right to the position N-1, except for the first string (in this case, on the extreme left you can see the outcome of the calibration). You can get to the strings through the instruction D_REPORT (RI_0) – I_0 ranges from 0 to 3.

APPENDIX E

C SOURCE EXAMPLES

Hereafter it is shown a C example RPF Max string encoding and transmission

```
void TxStr(char *tx, int len)       // *tx is the string code for the RPF Max
{                                   // len is the lenght of the code
      unsigned char cksm = 0, ch;
      int         c;
      TxByte('$');                  // standard function byte transmission
                                    // on a serial port
                                    // send $
                                    // *** start of address sending
      ch = ByteHex((Addr >> 4) & 0x0F);   // this function translate a bynary
                                          // value to an hex character
      TxByte(ch);
      cksm += ch;                         // checksum calculation
      ch = ByteHex(Addr & 0x0F);          // this function translate a bynary
                                          // value to an hex character
      TxByte(ch);                         // *** end of address sending

      cksm += ch;
      for(c = 0; c < len; c++)            // *** start of code sending
      {
            TxByte(tx[c]);
            cksm += tx[c];
      }                                   // *** end of code sending
```

```
      TxByte('#');                          // send #

      ch = ByteHex((cksm >> 4) & 0x0F);   // *** start of checksum sending
      TxByte(ch);
      ch = ByteHex(cksm & 0x0F);
      TxByte(ch);                           // *** end of code sending
      TxByte(13);                           // send CR (13)
}
```

Hereafter it is shown a C example of string decoding from RPF Max

```
int RxStr(char rx, int len, long tout)    //*rx is the decoded string
                                          // from RPF Max
{
      unsigned char cksm = 0, rcksm, add;
      int         c;
      char *bufrx = 0;
      bufrx[0] = bufrx[1] = 0;
      sread(bufrx, &c, tout); //this function receive a string from serial
                              //input the string ends with CR character
      if(bufrx[0] != '$')     //controls that first character is $
            return 1;
      add = HexBin(&bufrx[1]); //decode address from hex char to bin value
      if(add != Addr)
      return 2;
      cksm += bufrx[1];       //checksum calculation
      cksm += bufrx[2];
      for(c = 3; c < 80; c++)       // extract the code returned from RPF Max
      {                             // from serial string
            if(bufrx[c] != '#')
            {
                  cksm += bufrx[c];
                  rx[c - 3] = bufrx[c];
            }
            else
            {
                  c++;
                  rcksm = HexBin(&bufrx[c]);    //controls the checksum
                  rx[c-4]=0;
                  break;
            }
      }
      if(rcksm != cksm)
            return 1;
      *len = c - 3;
      return 0;
}
```


SPECIFICATIONS

POSITIONING SPEED
0.05 s

NUMBER OF POSITIONS
8/16

STANDARD MOUNT
2''

SPEED CONTROL
Yes

SERIAL INTERFACE
RS232 2400 9600 Baud

PARALLEL INTERFACE
8+4 bit input, 1 bit output

MAXIMUM FILTER THICKNESS
12 mm

BACKFOCUS
25 mm

POWER SUPPLY
12V 1A

DIMENSIONS
Φ 225 mm

WEIGHT
1,8 kg

OPTIONS

RGB-Max
50 mm RGB interference filter kit

NIK-Max
Adapter for Nikon lens

MIN-Max
Adapter for 42x1 mm lens

AR-Max
Adapter for HiRes

PAR-Max
Standard parallel port link cable

Link-2
Link cable for 2 RPF Max units with 2.5 m wheel base

Link-4
Link cable for 4 RPF Max units with 2.5 m wheel base

Link-8
Link cable for 8 RPF Max units with 2.5 m wheel base

INDEX

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