718203 Steering

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SISTEMI ELETTRONICI

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7CH4Q45S

MICROPROCESSOR STEERING ASSIST CONTROLLER FOR PM DC MOTORS

- USER'S GUIDE -

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INTRODUCTION

The controller 7CH4Q45S is a 4 quadrant controller for PMDC motors powered by battery 24/36V for steering assist applications.
The torque reference input is obtained by a torque sensor that detects the torque applied to the steering shaft and gives an electrical signal to the steering system (controller + steering gearmotor) for operator steering assistance.
The controller is equipped with a powerful microprocessor for digital control of the speed, current regulation and failures of the motor and an efficient diagnostics of the failures and wrong wiring connections, programmability of the main parameters .
The MOSFET power stage is an "H bridge" configuration operating with 16kHz PWM.
The ripple of the current is very low so the efficiency of the system is very high .
The chopper is designed in accordance with the most important EC standards.

FEATURES

POWER SUPPLY BATTERY	36 V
RATED CURRENT	12A
MAX CURRENT (Ta = 25°C)	30A
FREQUENCY	16 KHz
MAX HEATSINK TEMPERATURE	85 °C
OPERATING TEMPERATURE	-10°C / 40°C
ON BOARD MAIN CONTACTOR	24V-45A CONTINUOS
REGENERATIVE BRAKING	
PARAMETERS PROGRAMMABLE	

SAFETY:

- **OUTPUT SHORT CIRCUIT PROTECTION**
- **MOSFET SHORT CIRCUIT PROTECTION**
- **THERMAL PROTECTION**
- **LOW VOLTAGE AND OVERVOLTAGE PROTECTION**
- **REVERSE BATTERY PROTECTION**
- **OVERLOAD PROTECTION**
- **TORQUE SENSOR AND WIRINGS FAULT**

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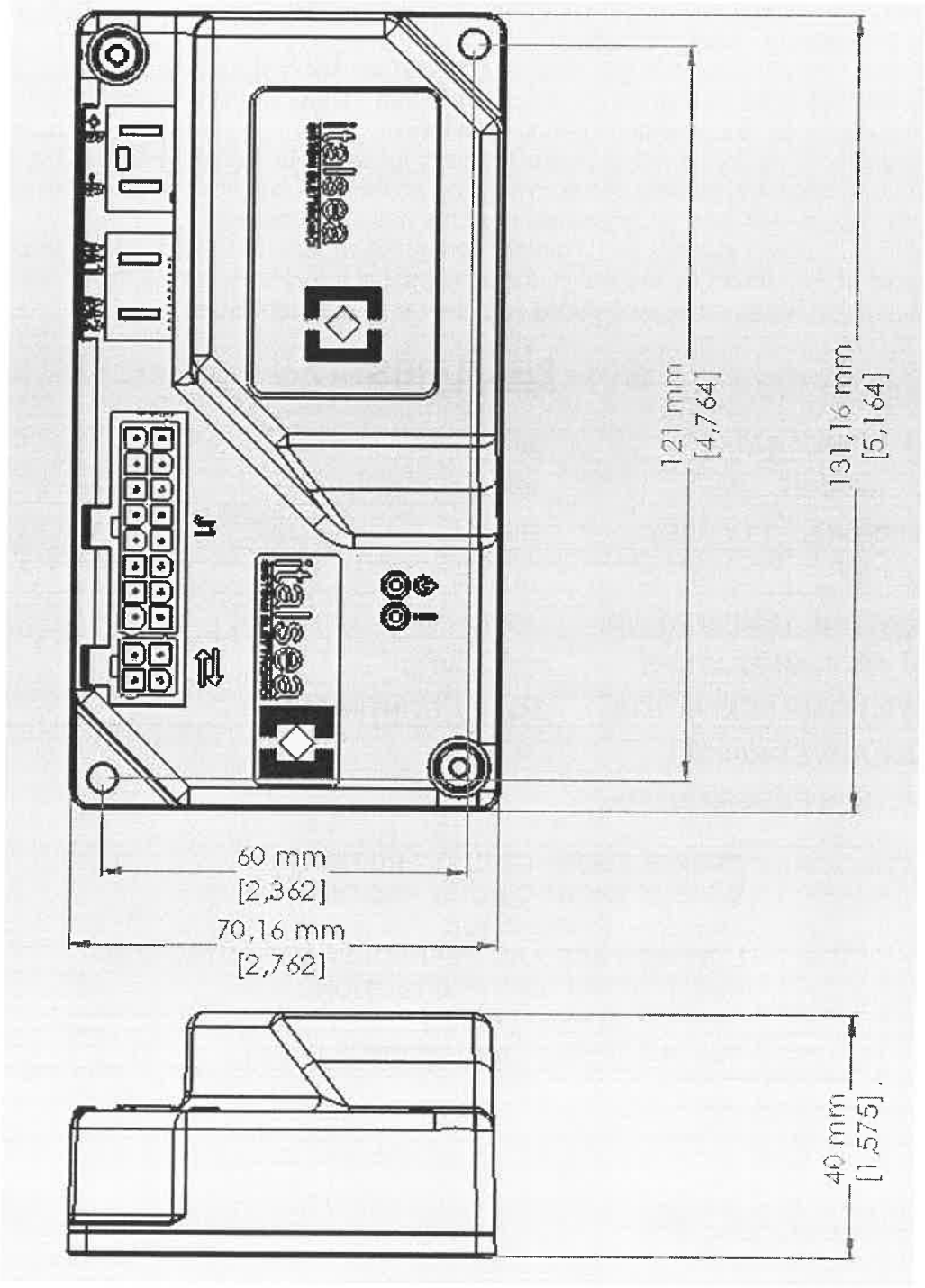
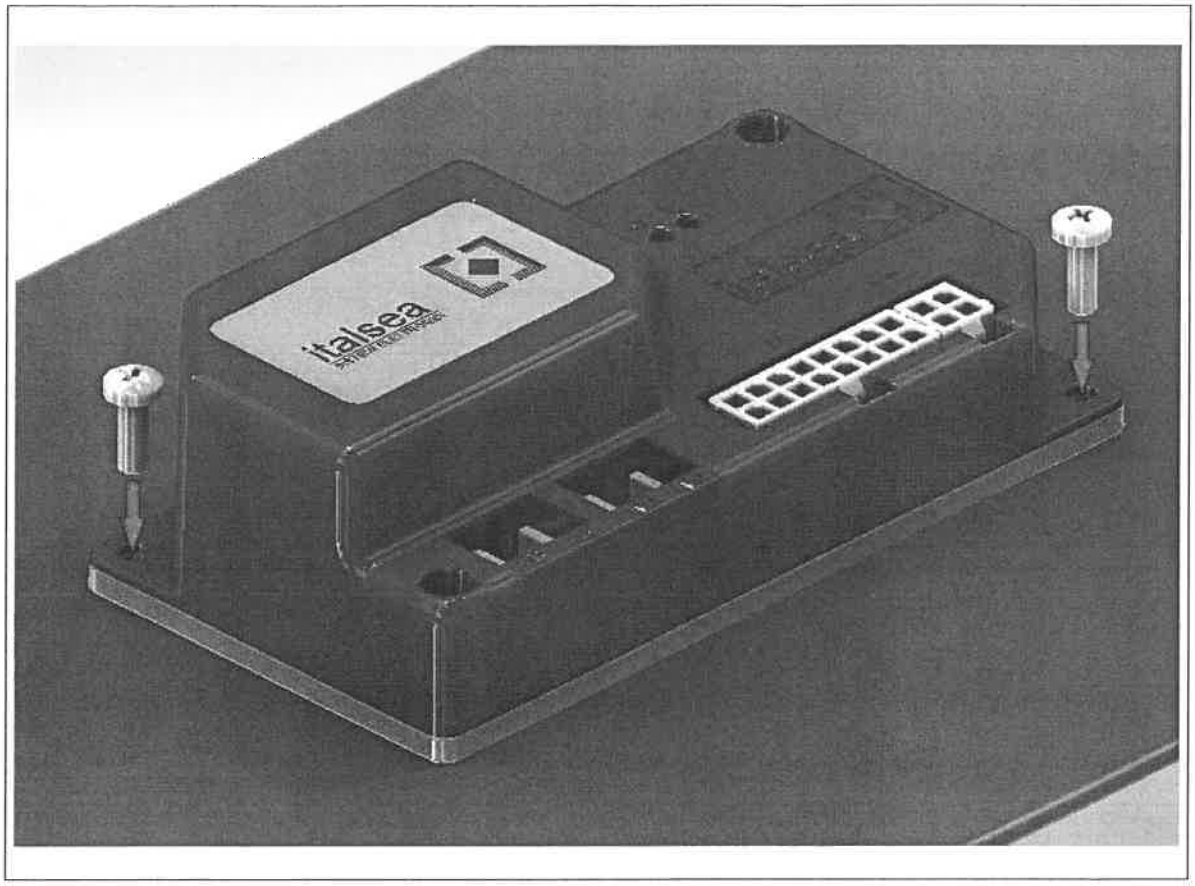
MECHANICAL DRAWING



INSTALLATION



Locate the chopper in a place protected against mechanical abuse, water and dirty.
Fix it with all the screws on a metal surface (aluminum if possible) to reduce the heath and so for longer period of work.
If during the standard operations the thermal protection is activated very often an additional heath-sink or fan is requested to assure longer periods of work.

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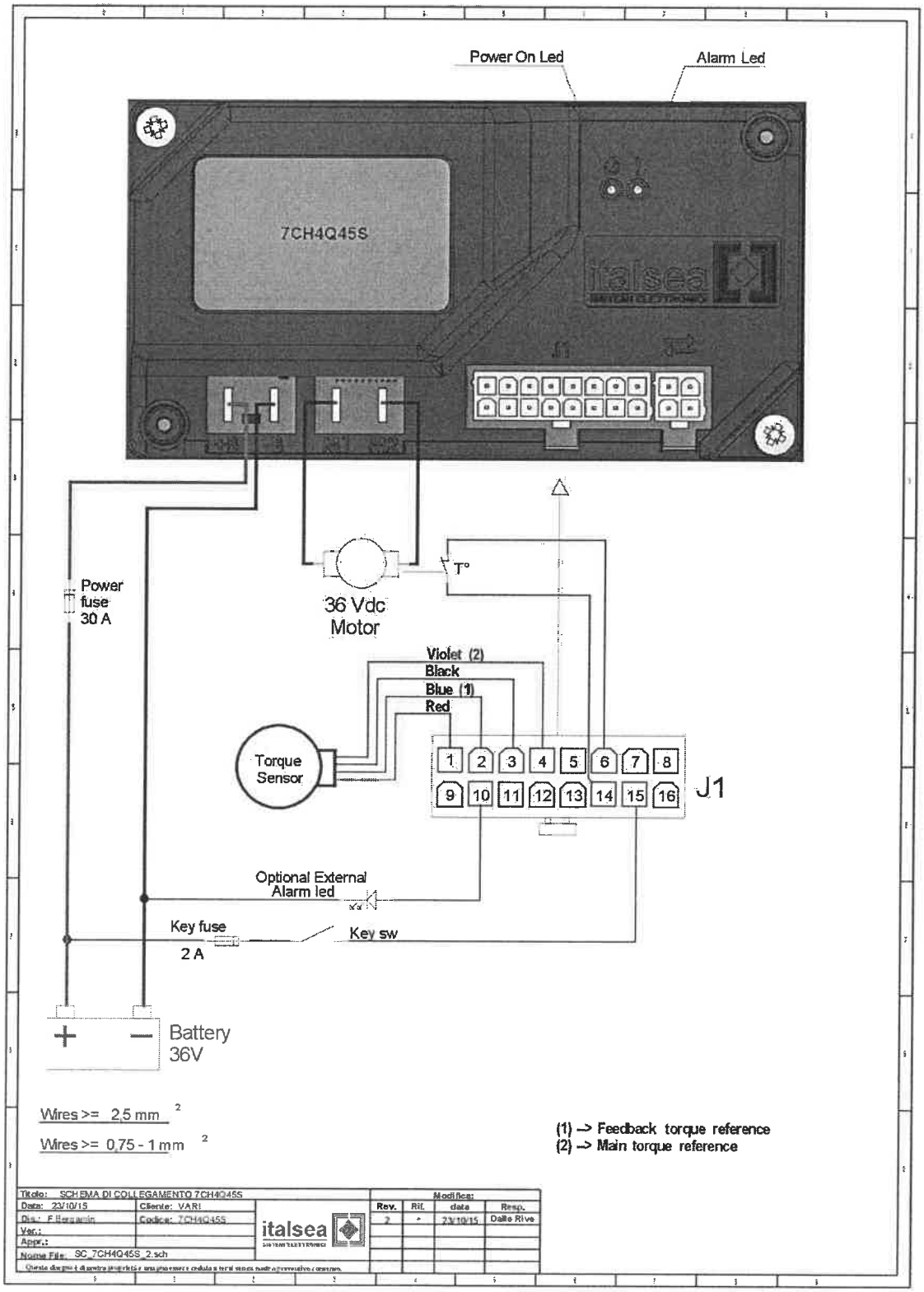
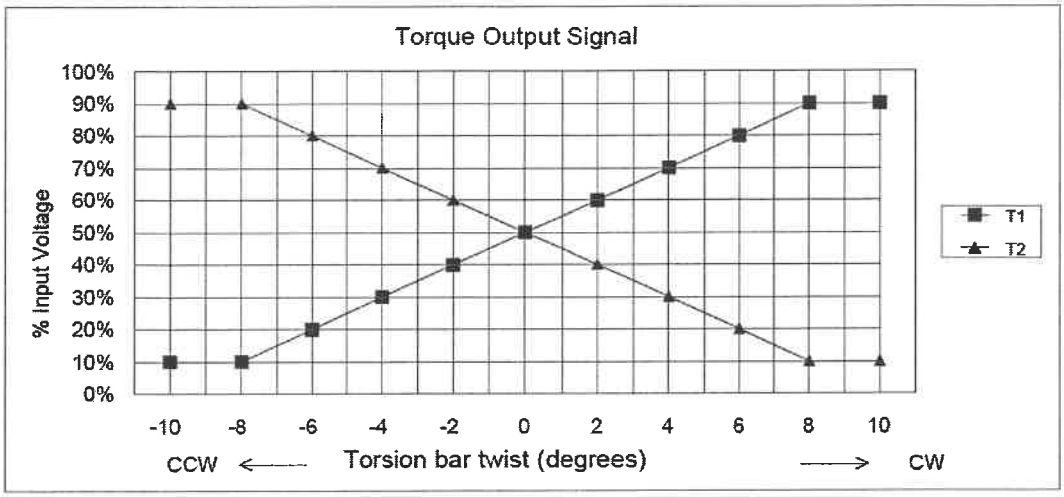
WIRING DIAGRAM



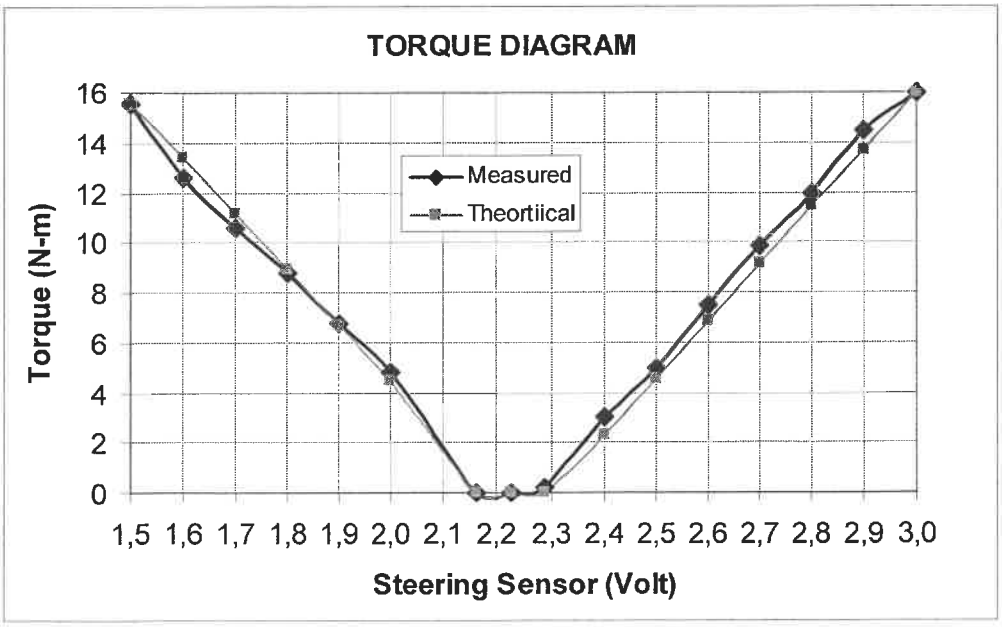
TORQUE SENSOR

The system is equipped with a double output torque automotive sensor as reference for the output current of the controller.
The two outputs are compared to detect a sensor failure; if the comparison fails, alarm A3 (Vref FAULT) is shown.

Next chart shows the outputs level vs. the torsion on steering wheel .

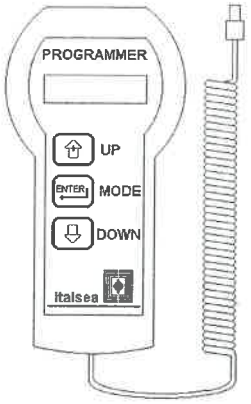


The torque applied on steering wheel is shown on next char (measured on one production system, grey line → theoretical char, blue line → measured char).
In real application, sensor voltage range is about 2.2V +/- 600mV; it means that max torque on steering wheel is +/- 12 N-m.



CONTROLLER SETTING

7PROGLCD HANDHELD PROGRAMMER



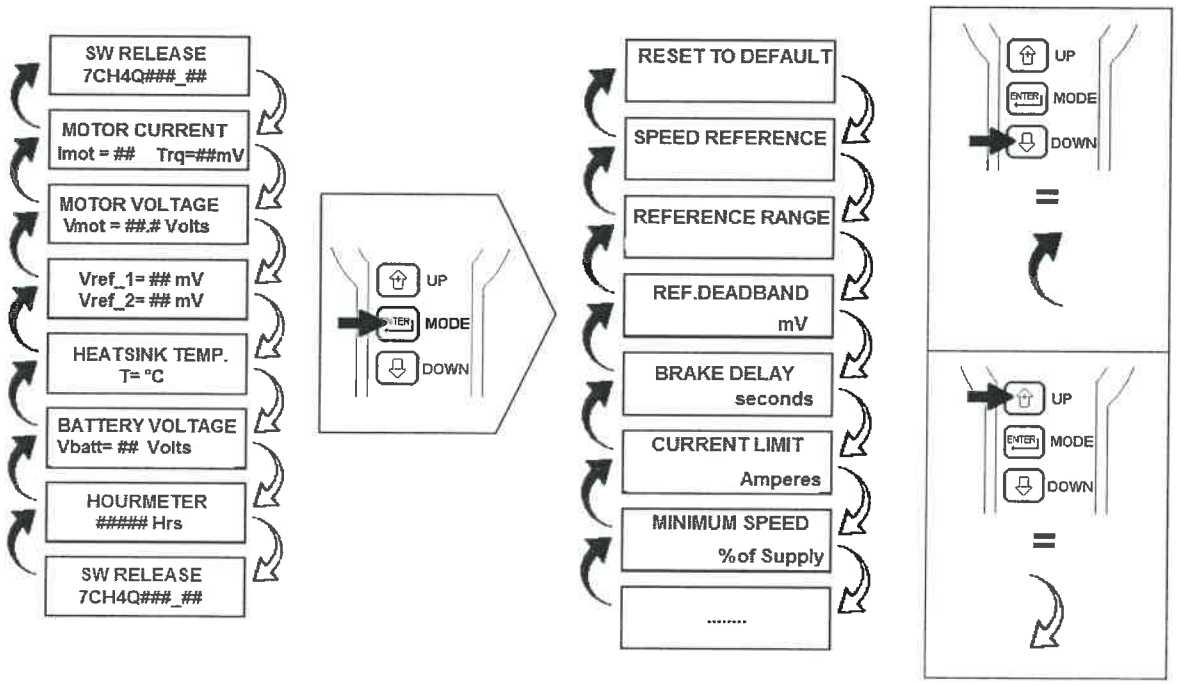
LCD 16X2:
Displays parameters, alarms and measures (description and value).

UP Key:
Rolls up parameters and increases values.

MODE Key:
Confirms a selection and the change of value.

UP Key:
Rolls down parameters and decreases values.

At power-on, handheld programmer displays the "Tester Mode" page.
To start the programming function push the button "MODE" .
Will appear the first parameter; pushing the "UP" button the number of the parameter will be increased and with the "DOWN" button the number will be decreased. When a parameter is selected , push the button "MODE" to enter in the change menu, change the value with the buttons "UP" and "DOWN", then confirm the parameter with the button "MODE". To return to the TESTER menu push together the buttons "MODE "and "UP", or wait few seconds.



TESTER MODE:

By 7PROGLCD handheld programmer is possible to read various electric topics about the system.
When connected, 7PROGLCD shows at first the controller's software release.
By Up and Down buttons is possible to scroll various readings.
Following the complete readings list.

SW RELEASE **7CH4Q45S_#**	Software's release number.
MOTOR CURRENT **Imot= ##.# Trq=###mV**	Imot = Motor current measure (measure unit=Amperes); Trq = Sensor torque reference (measure unit=mV);
MOTOR VOLTAGE **Vmot = ##.# Volts**	Motor voltage measure (measure unit=Volts).
Vref_1 = ## mV **Vref_2 = ## mV**	Speed reference voltage (measure unit=mVolts);
HEATSINK TEMP. **T°= ##°C / ###°F**	Internal heat-sink temperature (measure unit C° and F° degrees)
BATTERY VOLTAGE **Vbatt= ##.# Volts**	Battery supply voltage (measure unit=Volts)
HOURMETER **#### hrs, ## min**	Measure of worked time (when motor is running).

PARAMETERS SETTINGS:

PARAMETER	DESCRIPTION	Min	Default	Max
RESET TO DEFAULT	Reset to default parameters	0	**0**	1
SPEED REFERENCE	Set speed reference value	No set	**No set**	set
REFERENCE RANGE	Reference Dead-band	200mV	**400mV**	1500mV
REF.DEADBAND	Speed reference dead-band	10mV	**150mV**	500mV
TIMEOUT	Unwanted steering input max.time	0 sec	**30 sec**	300sec
TIMEOUT Reset	Timeout Protection reset value	0mV	**100mV**	500mV
CURRENT LIMIT	Controller's current limit	5A	**30A**	45A
MINIMUM CURRENT	Minimum steering current	0A	**0A**	10A
RATED CURRENT	Motor's rated current	5A	**12A**	15A
OVERLOAD TIME	Motor's overload time	2 s	**10 s**	20 s
LOWER CURRENT	Lower current limit (see "soft start function")	0A	**18A**	45A
INCREASE RAMP	Ramp from lower current to peak current (see "soft start function")	0.1 s	**1.8 s**	5.0 s
TIMEOUT CURRENT	current limit at timeout expired (see "soft stop function")	0A	**0A**	30A
DECREASE RAMP	Ramp from peak current to timeout current (see "soft stop function")	0.1 s	**2.0 s**	5.0 s
LOW BATTERY	Discharge Battery limit	15V	**19V**	36V
5-J1-HW CONFIG.	Hardware Pin Configuration	N.O	**N.O**	N.C
6-J1-HW CONFIG	Hardware Pin Configuration	N.O	**N.O**	N.C
11-J1-HW CONFIG	Hardware Pin Configuration	N.O	**N.O**	N.C
5-J1-P.up-down	Hardware Pin Configuration	P.down	**P.down**	P.up
6-J1- P.up-down	Hardware Pin Configuration	P.down	**P.down**	P.up
11-J1- P.up-down	Hardware Pin Configuration	P.down	**P.down**	P.up
12-J1- P.up-down	Hardware Pin Configuration	P.down	**P.down**	P.up
13-J1- P.up-down	Hardware Pin Configuration	P.down	**P.down**	P.up
ENABLE ALARM 3	Alarm 3 enable	Enable	**Enable**	Disable
ENABLE ALARM 4	Alarm 4 enable	Enable	**Enable**	Disable
ENABLE ALARM 12	Alarm 12 enable	Enable	**Enable**	Disable
PASSWORD	Password to engineering par.	0	**0**	65000

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ALARMS DISPLAY:

ALARM A1 **I_read fault**	Led alarm status = 1 blinks. Controller has detected the Current out of maximum range.
ALARM A3 **Vref. FAULT**	Led alarm status = 3 blinks. Controller has detected the Speed Reference voltage out of maximum range (Vref>=4,8V or Vref<=0,2V).
ALARM A4 **VRef OUT Neutral**	Led alarm status = 4 blinks. Controller has detected the Speed Reference voltage out of stop position at power-on
ALARM A5 **Overtemperature**	Led alarm status = 5 blinks. Heatsink temperature is higher than 90°C. Check motor consumption.
ALARM A6 **POWER STAGE**	Led alarm status = 6 blinks. Controller failure on internal power-stage. Change the controller.
ALARM A7 **OVERCURRENT**	Led alarm status = 7 blinks. External short circuit; check the motor's wires.
ALARM A8 **POWER FUSE/RELAY**	Led alarm status = 8 blinks. Controller detects a failure on the external power fuse / power connections or internal relay damaged.
ALARM A10 **OVERVOLTAGE**	Led alarm status = 10 blinks. Battery voltage upper than 45V: check the battery or power connections status.
ALARM A11 **MOTOR OVERLOAD**	Led alarm status = 11 blinks .Motor's ammeter protection.
ALARM A12 **MOTOR OVERTEMP.**	Led alarm status = 12 blinks .Motor's thermal switch ON.
ALARM A13 **KEY-OFF**	Led alarm status = 13 blinks. Key switch was opened: check the key switch connections.
ALARM A14 **EEPROM FAIL**	Led alarm status = 14blinks. Check your parameter settings: if the controller repeats this alarm, change it.

Pin 16 of J1 displays alarm state (no alarm → J1-16 closed to +V, 100mA max output).

OVERLOAD PROTECTION

In the programming mode set the rated current and overload time for the motor:

RATED CURRENT ## Amperes	**DEFAULT: 12 A** MIN: **5 A** MAX: **20 A**
OVERLOAD TIME ### seconds	**DEFAULT:** 10 s MIN: 2 s MAX: 60 s

The protection will be activated each time the current overcome the value In and the overload time is as shorter as higher is the overload according to the function. After the integration time the controller will stop the machine and an alarm (A11) will be activated.

First of all, the ammeter constant (K) has to be calculated using the heat-sink temperature, the maximum current and the rated current as follow:

$$K = (Imax^2 - In^2)*t$$

In = rated motor current,
Imax = max motor current,
t = overload time at the max current,

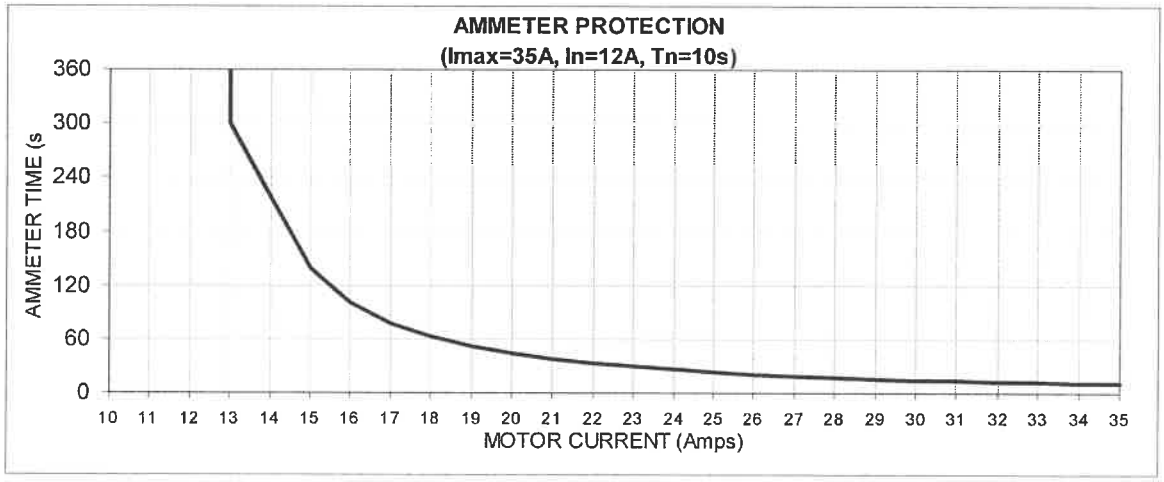
Once calculated the "K", is possible to calculate the ammeter time protection at your working current:

$$t = \frac{K}{(Iwrk^2 - In^2)}$$

In = rated motor current,
Iwrk = working motor current (**Iwrk > In**),
K = ammeter constant,

Protection time higher than 5 minutes are clamped to 5 minutes.

Example:



TIMEOUT PROTECTION

If the steering signal doesn't change sign (direction) within the time settled in TIMEOUT parameter the power is switched-off from the motor to avoid unwanted over-heath.
The controller will start again to supply the motor if the steering wheel is moved in both directions as much as settled in the parameter "TIMEOUT RESET" that represents the sensibility to obtain the reset.

OTHER PROTECTIONS

In not dangerous situations, system keeps working decreasing max output current to its half value.

CURRENT DECREASING CONDITION	RESTORING CONDITION
Heatsink Temperature > 70°C	Heatsink Temperature < 60°C
Batt.Voltage < Low_Battery parameter	Batt.Voltage > (Low_Battery parameter+2V)

CALIBRATION PROCESS

When connecting the system for the first time, a calibration process to set steering stop position is needed.

1. Disconnect the motor (+M, -M output).
2. Using handheld programmer set "Speed reference" parameter from "no set" to "set" value, and confirm it with MODE key.

   SPEED REFERENCE
   set

3. Then speed reference value in stop position is shown (in mV).

   CALIBRATION
   Stop pos = #### mV

   Confirm its value with MODE key.

4. Speed reference stop position is acquired, "Speed reference" parameter is automatically reset to "no set" value and "reset to default" page is shown on the display.

   RESET TO DEFAULT
   no

Offset calibration process is finished.
If different steering wheel contribute is needed:

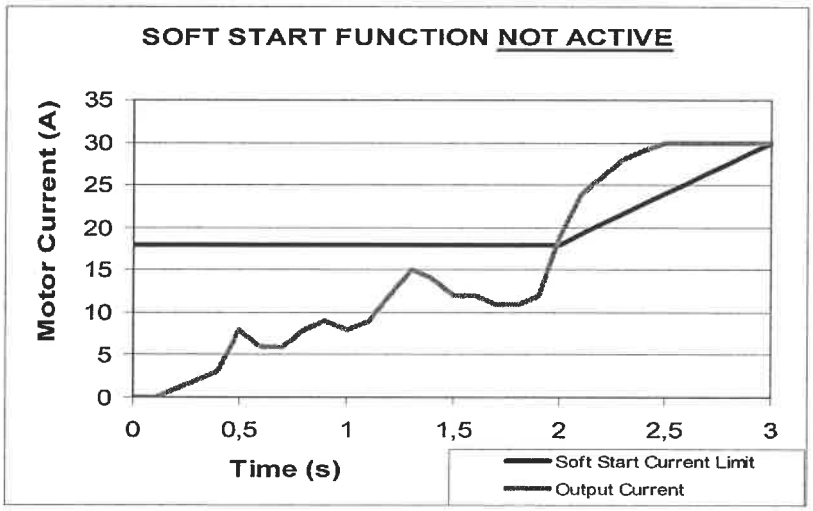
5. Increasing "Current Limit" parameter steering wheel assistance will increase;
6. Decreasing "Current Limit" parameter steering wheel assistance will decrease;

NOTE: "CURRENT LIMIT" PARAMETER SHOULD ALWAYS BE HIGHER THAN "RATED CURRENT" PARAMETER, DO NOT DECREASE IT TO A LOWER VALUE.

SOFT START FUNCTION

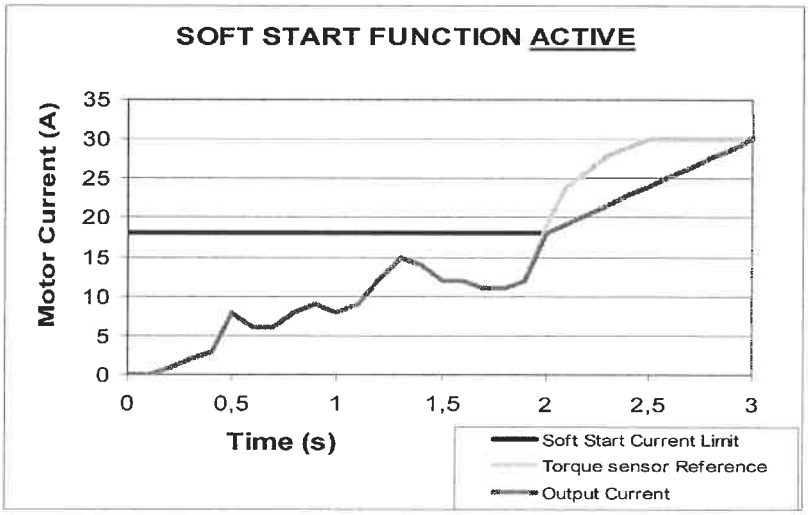
Soft start function limits the quick steering current peaks above a desired value.
In fact, If torque sensor indicates an output current above this level is desired, amperage will start ramping up to the level indicated by the sensor. This ramp is configurable in 0.1 second increments. The 'ramp timer' will keep increasing as long as torque sensor output is above the level that corresponds to the 'lower current limit'; this timer will reset to zero if torque sensor goes below this reading.
Following example shows output current with the soft start function on and off.
Examples sets:

- "lower current" = **18A,**
- "increase ramp" = **1.0 s,**
- "current limit" = **30A,**



Output current (red line) is exactly as asked by torque sensor.

(The limit of soft start function - blue line - is shown only for reference)



Output current (red line) is exactly as asked by torque sensor if its value is smaller than "lower current limit".
When torque sensor asks more current, it is limited by increasing of the "soft start ramp".

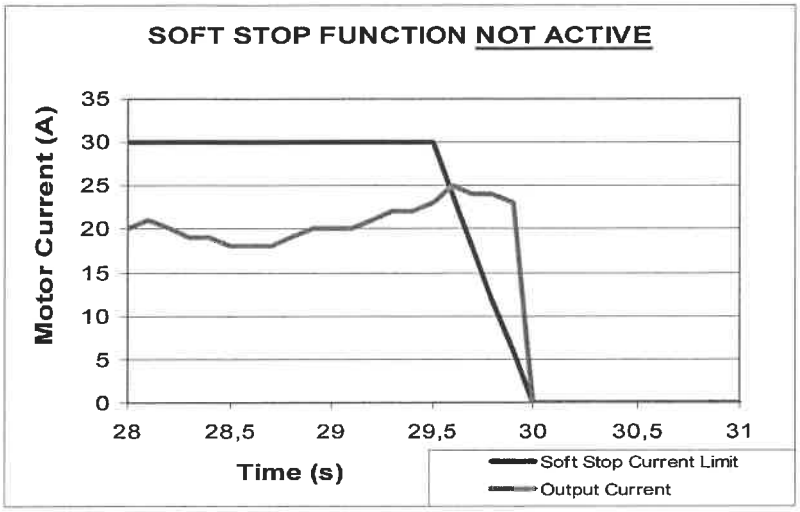
(blue line → limit of soft start function,
grey line → Torque sensor reference)

Note: "Soft Start Function" is always active, "not active" case is only for example

SOFT POWER CUT-OFF FUNCTION

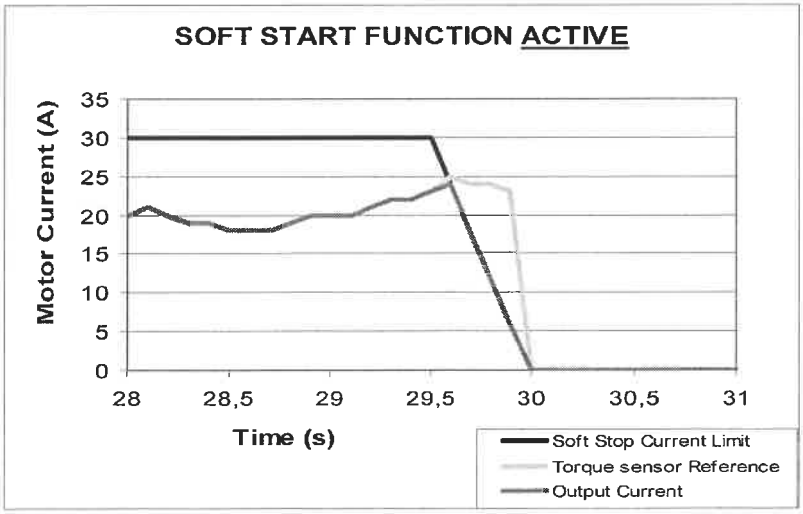
Soft power cut-off function limits the steering current when timeout is quite to expire.
As shown in next example, with the soft stop function "not active" the output current is switched off immediately when timeout expires.
With function "active" , the current is switched off by a decreasing ramp (parameter "decrease ramp") to a final current value (parameter "timeout current").
Examples sets:

- "timeout current" = **0A,**
- "decrease ramp" = **0.5 s,**
- "current limit" = **30A,**



Output current (red line) at final timeout counting; the output current is switched off at timeout.

(The limit of soft stop function - blue line - is shown only for reference)



Output current (red line), at final timeout counting, decreases by the "soft stop ramp".

(blue line → limit of soft stop function, grey line → Torque sensor reference)

Note: "Soft Power Cut-off Function" is always active, "not active" case is only for example

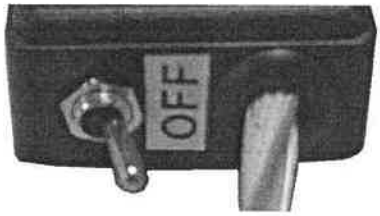
SOFTWARE UPDATE

Drivers for 7RS2USB cable:

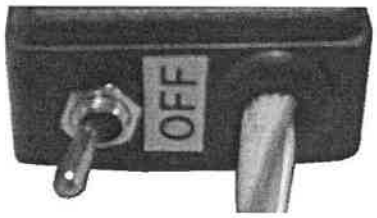
CDM 2.04.16 WHQL Certified

note: see appendix (if included) to check the upgraded release of the drivers. If appendix not present, the drivers are the most upgraded.

7RS2USB cable:



CABLE OFF



CABLE ON

Note: plug and unplug the cable with the "CABLE OFF"

Software to install the updater program:

fdtv403r02.exe
Setup.exe
Macrovision Corporation

note: see appendix (if included) to check the upgraded release of the software. If appendix not present, the software is the most upgraded.

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1 *(INSTALL Usb-Serial Converter Drivers)*

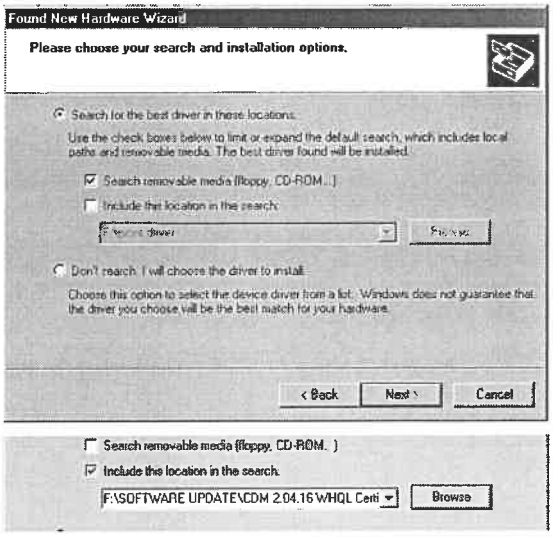
Plug the program cable 7RS2USB into a usb port.
Do not check on web the drivers (as asked on the first window)

Select "Install from a list or specific location" option.

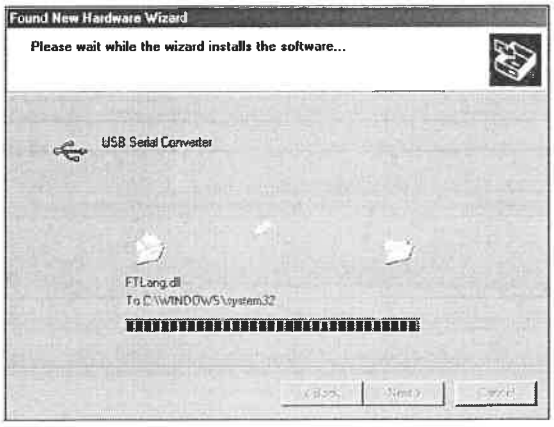
(click "NEXT" to continue)

Select "Search removable media" if drivers are stored on CD or "Include this location in the search" if are stored on another path.

(click "NEXT" to continue)



Wait the installation of drivers…



Installation complete.

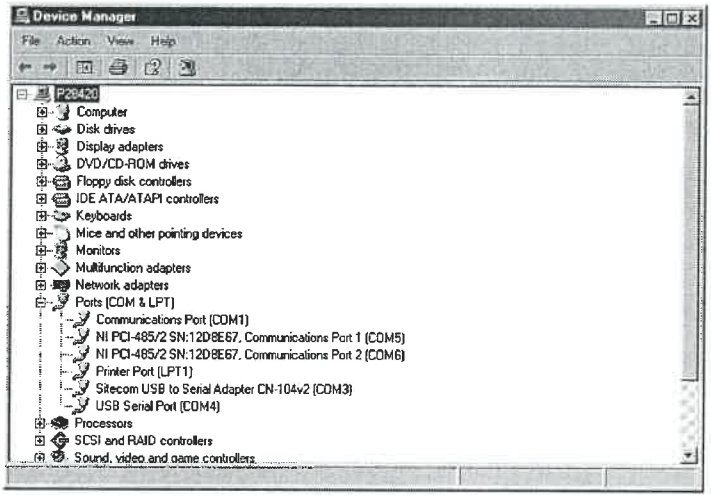
(click "FINISH" to continue)

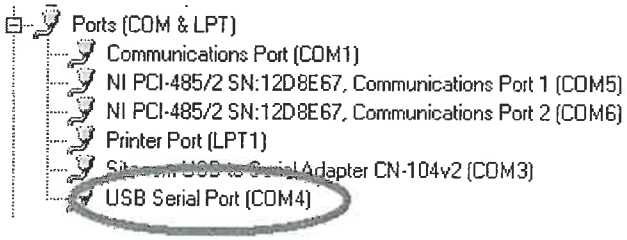
Your PC is now ready to use the 7RS2USB cable.

Browse to:

- *START*
- *SETTINGS*
- *CONTROL PANEL*
- *SYSTEM*
- *HARDWARE*
- *DEVICE MANAGER*

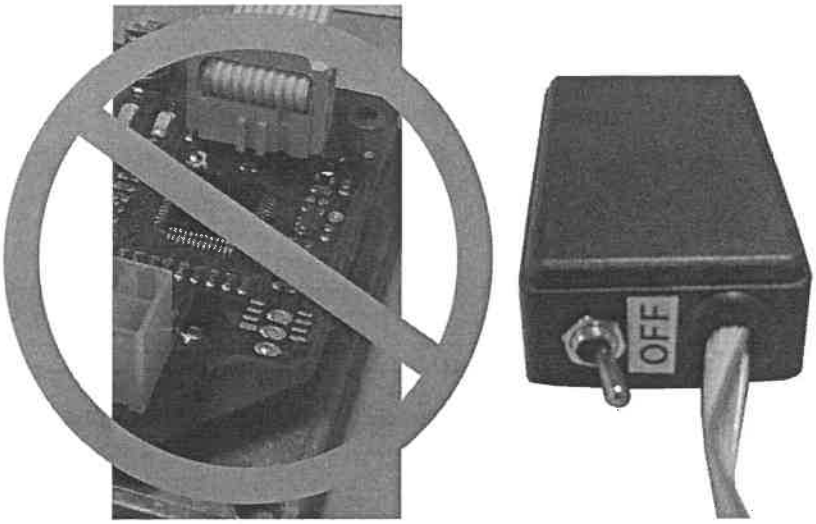
On "Device Manager" window, check the Number of Port where the cable is connected. (COM4 in the example)





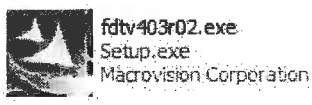
NOTE: only COM1 to COM9 are supported. If windows shows COM10 or upper, change COM ID by "Advanced" proprieties.

2 (*START UP SOFTWARE*)



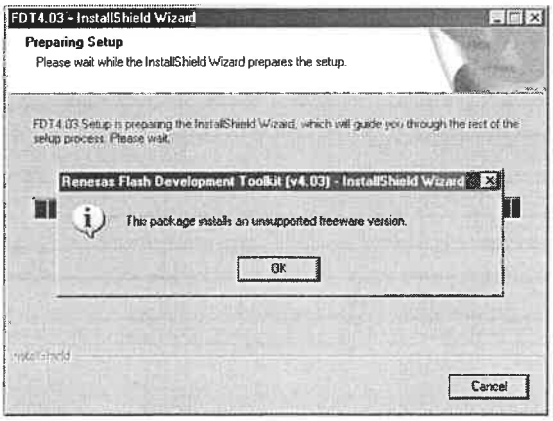
DO NOT connect the flat cable into the plug and don't power-on the cable in this steps.

Double click on "fdtv403r02.exe" icon to begin the software installation.
(if present, see appendix to check the latest release)



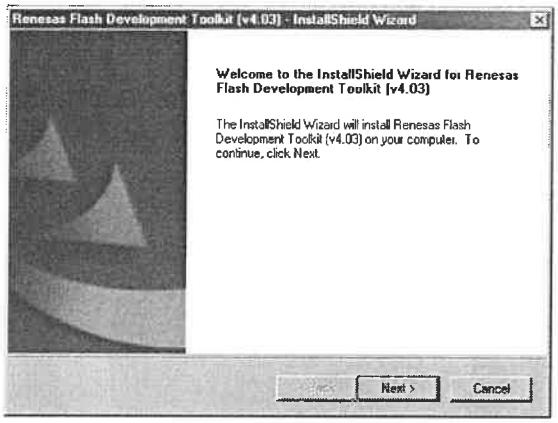
InstallShield Wizard window

(click "OK" to continue)



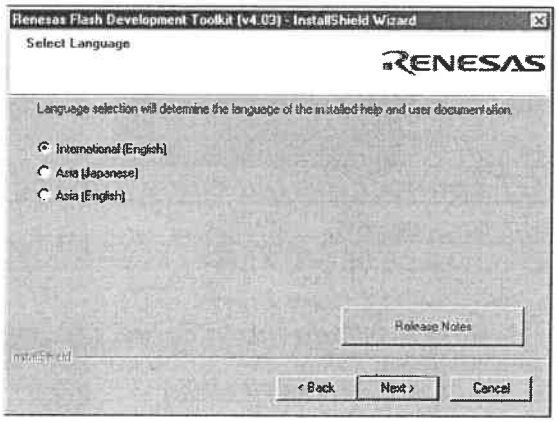
Welcome window

(click "NEXT" to continue)



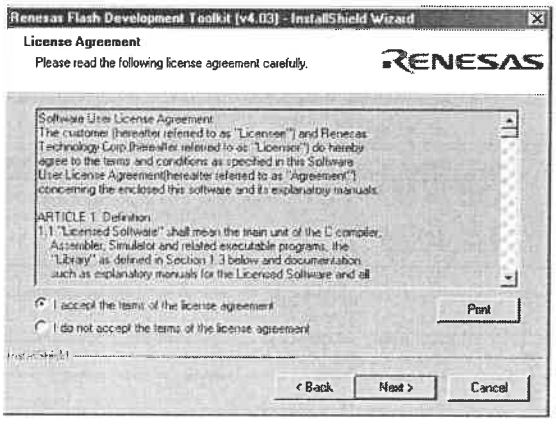
Select language window

(click "NEXT" to continue)



License Agreement window

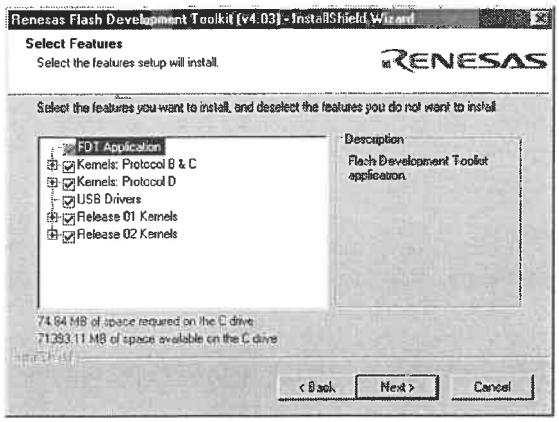
Select " *I accept…*" and click "*NEXT*" to continue.



Features window:

All boxes have to be selected.

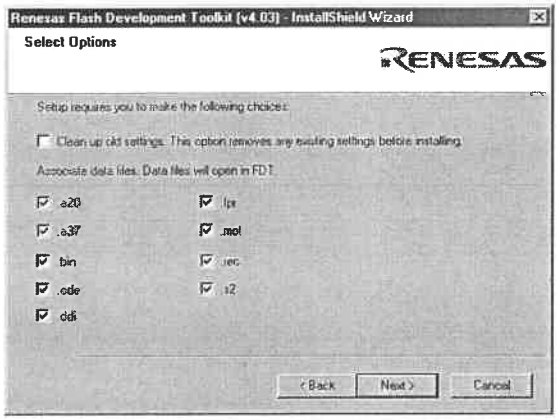
(click "NEXT" to continue)



Options window:

All boxes have to be selected.

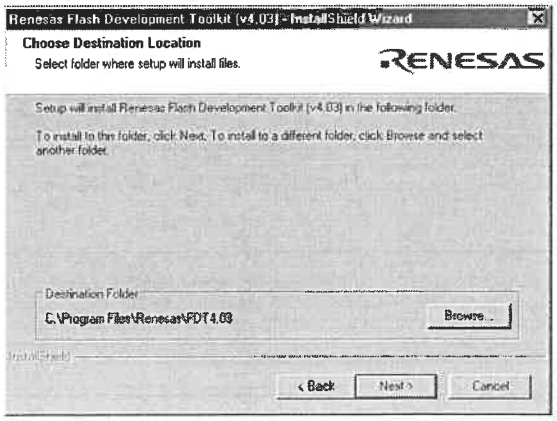
(click "NEXT" to continue)



Destination window:

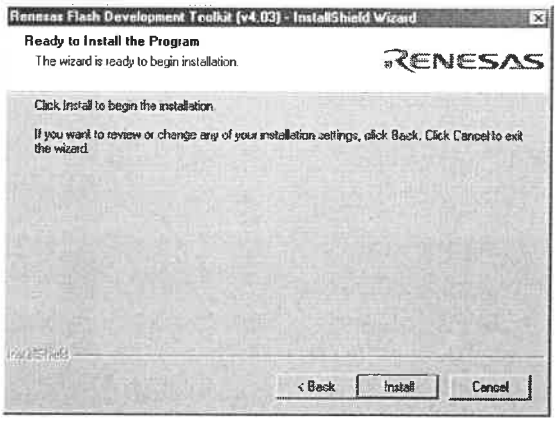
Choose where to install the application.

(click "NEXT" to continue)

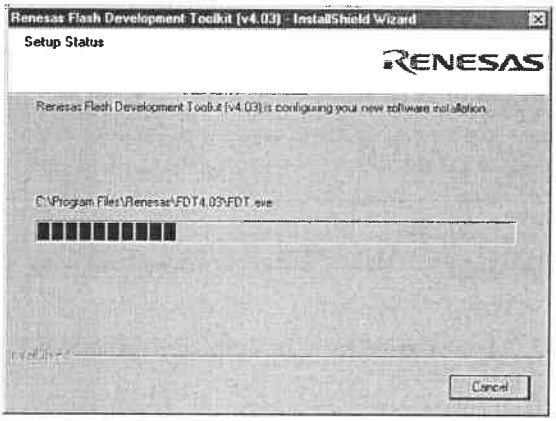


Installation window:

(click "INSTALL" to continue)

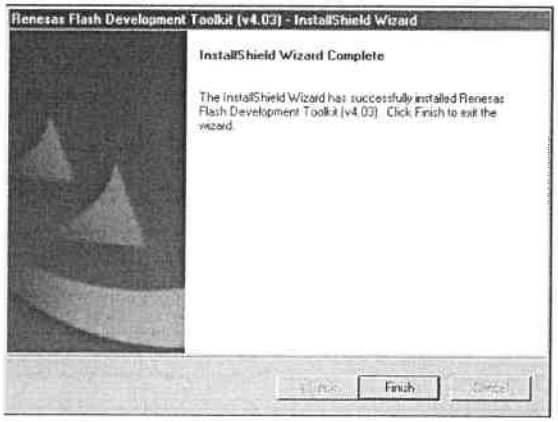


Installation in progress…

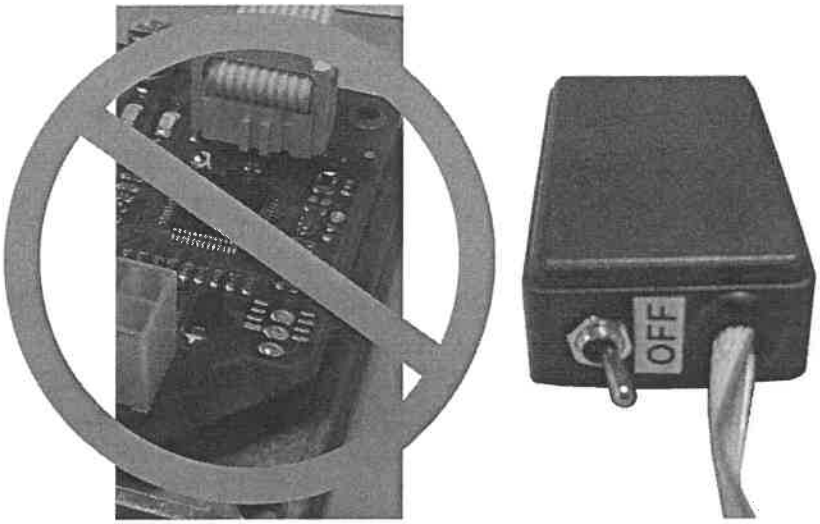


Confirmed installation window:

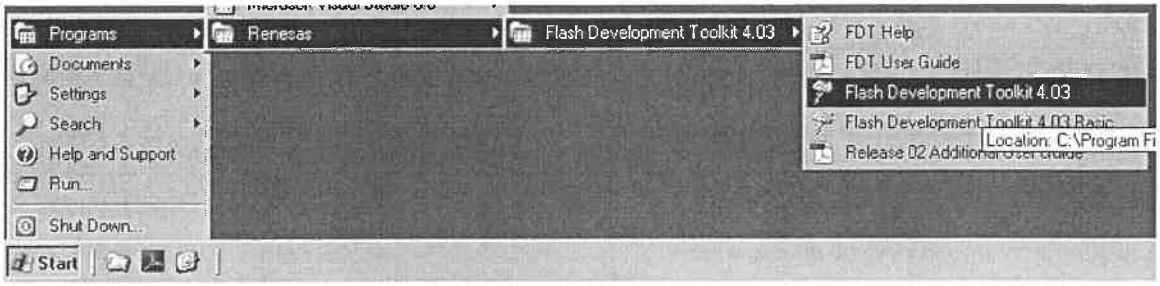
(click "FINISH" to continue)



3 *(DEVICE AND COMMUNICATION SETTINGS)*



DO NOT connect the flat cable into the plug and don't power-on the cable in this steps.

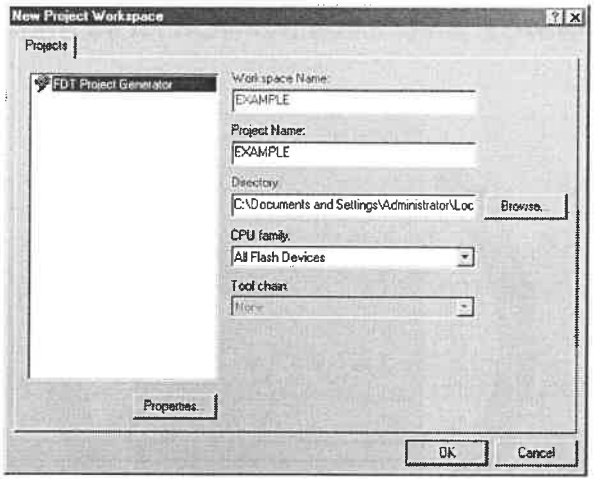


Window 1

Choose **"Create a new..."** option and confirm pressing **"OK"**.

Window 2

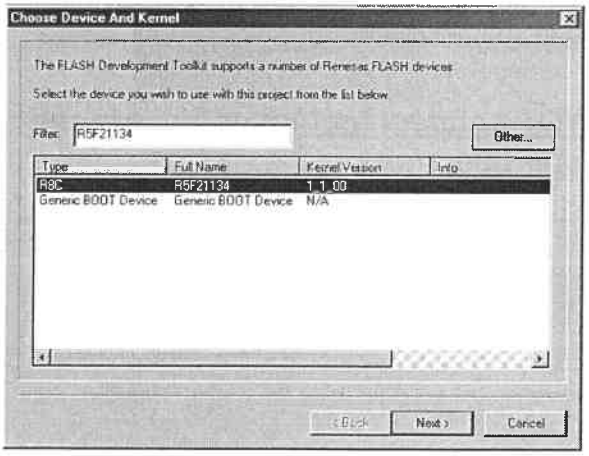
Insert a name in **"Workspace Name"**, the path where to save it and confirm pressing **"OK"**.



Window 3

Select the device type (device name, example **R5F21134**), and confirm it pressing "**NEXT**".

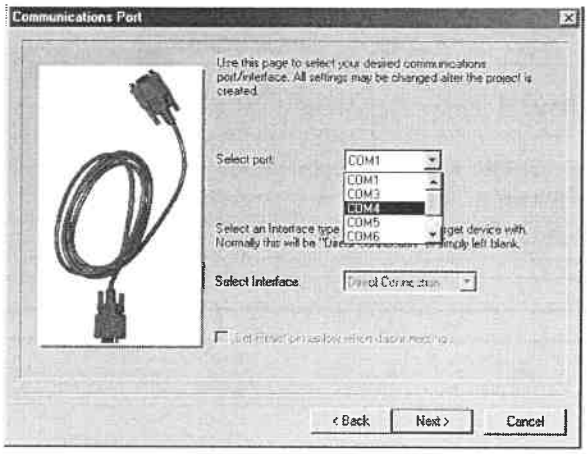
FOR 7CH4Q45S SELECT R5F21356 DEVICE



Window 4

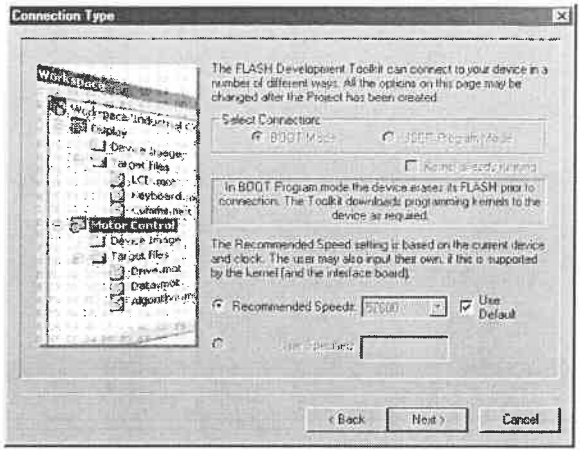
Select the communication port where the programming cable 7RS2USB0 is connected.

Confirm the choice with "**NEXT**"



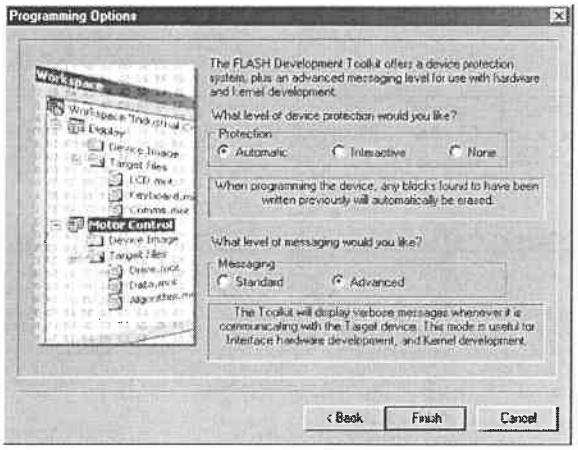
Window 5

Set the **"Recommended speed"** as shown, and confirm with "NEXT".



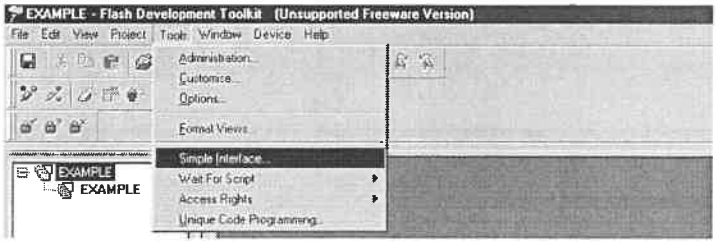
Window 6

(click "FINISH" to continue)



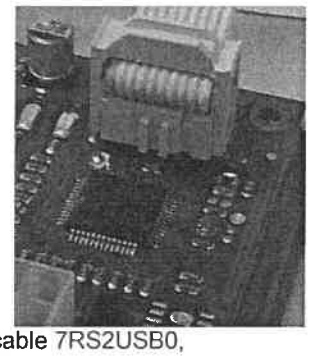
Window 7

From menu **"Tools"**, select **"Simple Interface"** to jump to the simple programming windows.
The use of this tool is explained in Chapter 4.

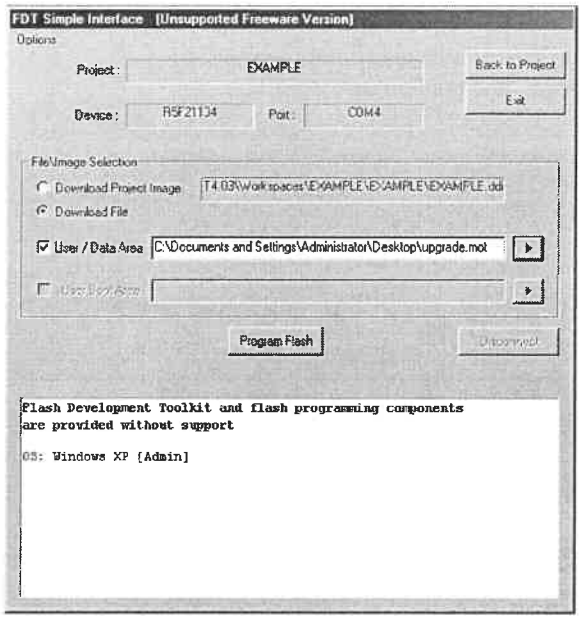


4 (SIMPLE PROGRAM)

Step 1



1) Power-off the cable 7RS2USB0,
2) Connect the 7RS2USB0 to device,
3) Select **"User Area"** and **"Download File"** options; upload the file .mot (the software that you have to download on device) choosing the path (you can browse it by the button on the left side of the window).

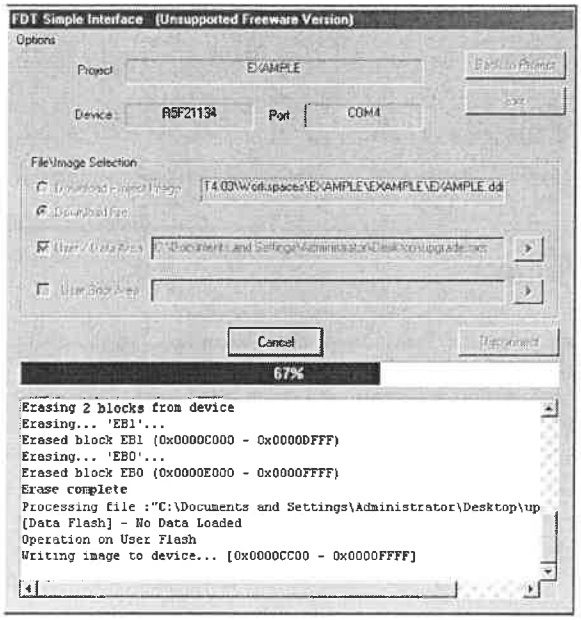


Step 2

1) **Power on** the cable (switch on),

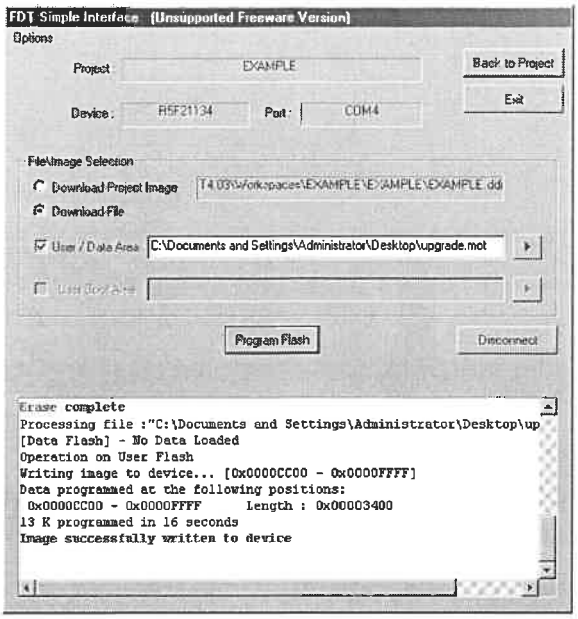
2) Press the **"PROGRAM FLASH"** button .

In case of **programming failure**, Power off the cable, wait a couple of seconds and try again.



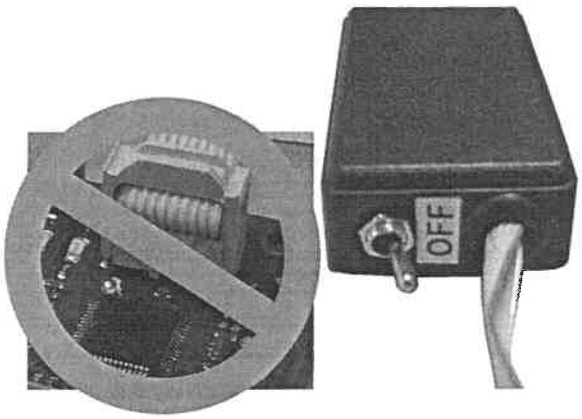
Step 3

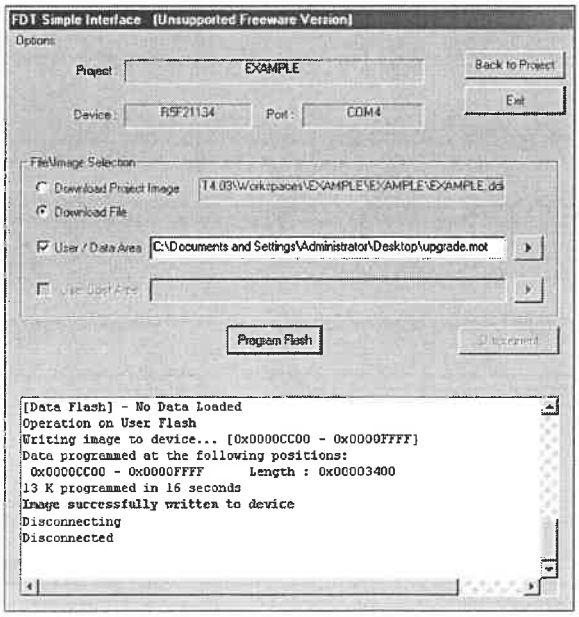
At the end of programming, the green message **"Image successfully written to device"** will appear.



Step 4

1) Press the **"DISCONNECT"** button and wait the **"Disconnected"** message,
2) **Power off** the cable (switch-off),
3) Disconnect the 7RS2USB0 from device.





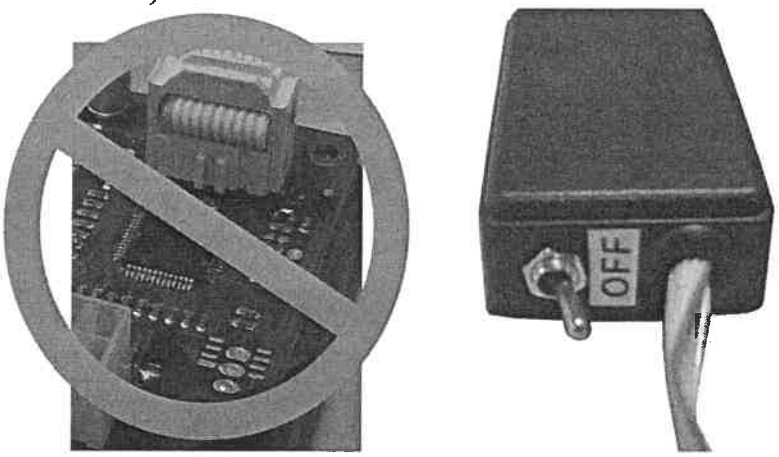
- To program another device, connect the **7RS2USB0** and start from **Step 2**,
- To end program, press **"EXIT"** button.

NOTES:

1) *Next time that **"FDT#.##"** will be opened, the **"Simple Interface"** will appear automatically.*

2) *If you plug the 7RS2USB cable in another usb port, check the new com number.*

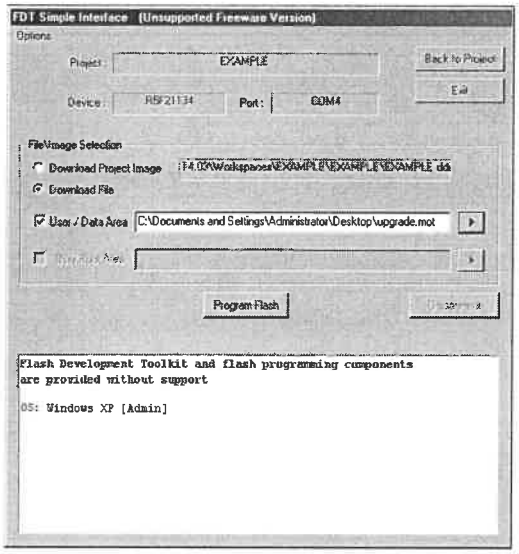
5 (CHANGE PORT)



DO NOT connect the flat cable into the plug and don't power-on the cable in this steps.

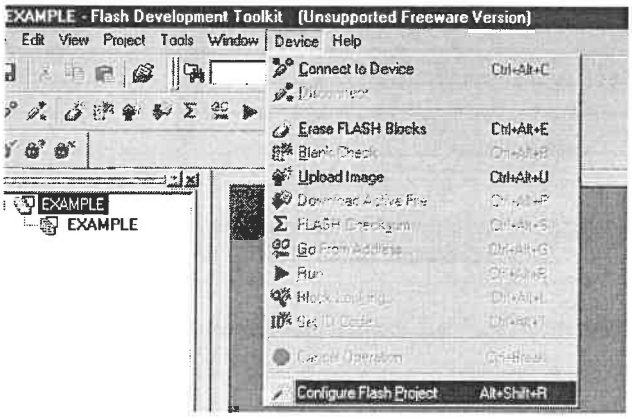
Step 1

On "FDT Simple Interface" window, click on "Back to Project" button to switch to the main window.



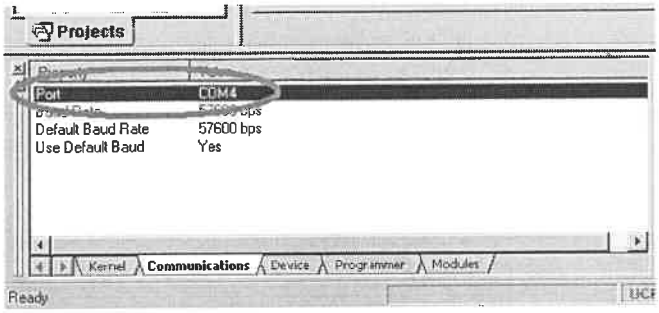
Step 2

On FDT's main window, select the option "Configure Flash Project" on menu "Device".



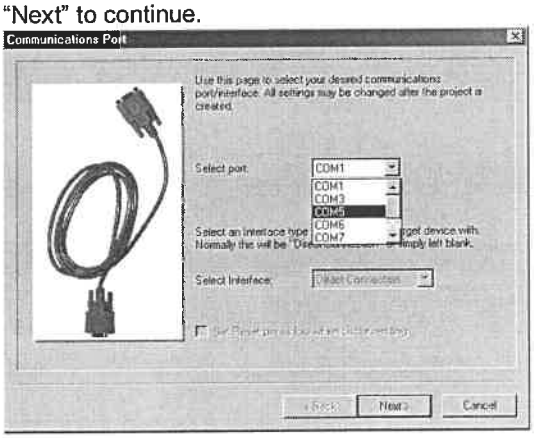
Step 3

Double click on "Port COM#" to access to the change of used port.

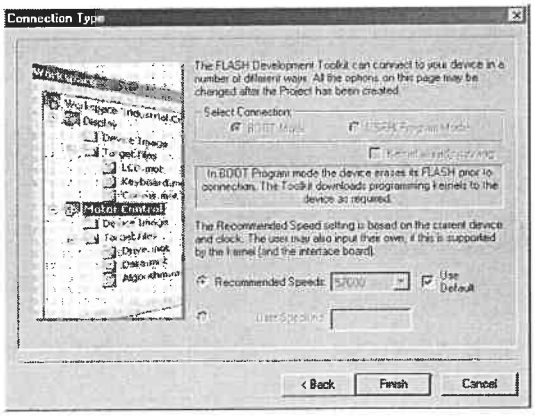


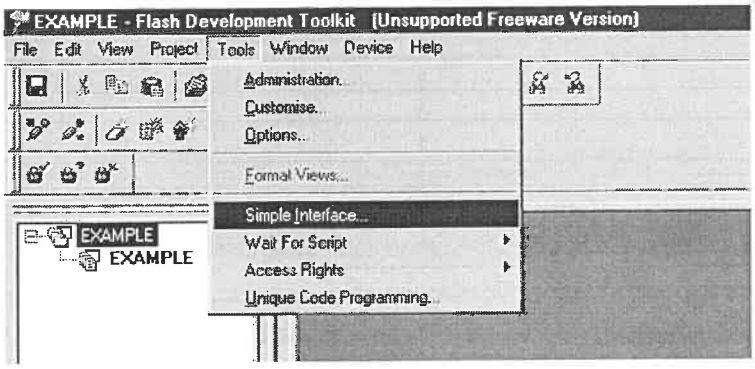
Step 4

On "Communication Port" window, select the new COM number (COM5 in the example) and than click "Next" to continue.



On "Connection Type" window, set "Use Default" option and "Finish" button.



Step 6

On FDT's main window, select the option "Simple Interface" on menu "Tools" to end the change of settings.