TMC428 Evaluation Kit V2.0

Manual

English

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Version

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2.00	2002-07-29	OK	Created from version 1.02
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1 Introduction

The TMC428 Evaluation Kit makes it possible to evaluate and to test all the functions of the TMC428. It contains the following components:

- The evaluation board equipped with the TMC428 and three stepper motor drivers
- A simple two phase stepper motor
- A CD containing the PC software as well as data sheets and other documents
- A null modem cable for connecting the evaluation board to the PC

On the evaluation board the Atmel AT90S2313 microprocessor is used to control the TMC428. The microprocessor's FLASH ROM contains a programme which configures the TMC428 after a reset and controls the communication with the PC via the RS232 interface. A PC software running under Windows enables access to all the registers and functions of the TMC428 from a PC. Furthermore, some simple functions can be controlled by keys on the evaluation board.
Up to three two phase stepper motors can be controlled.

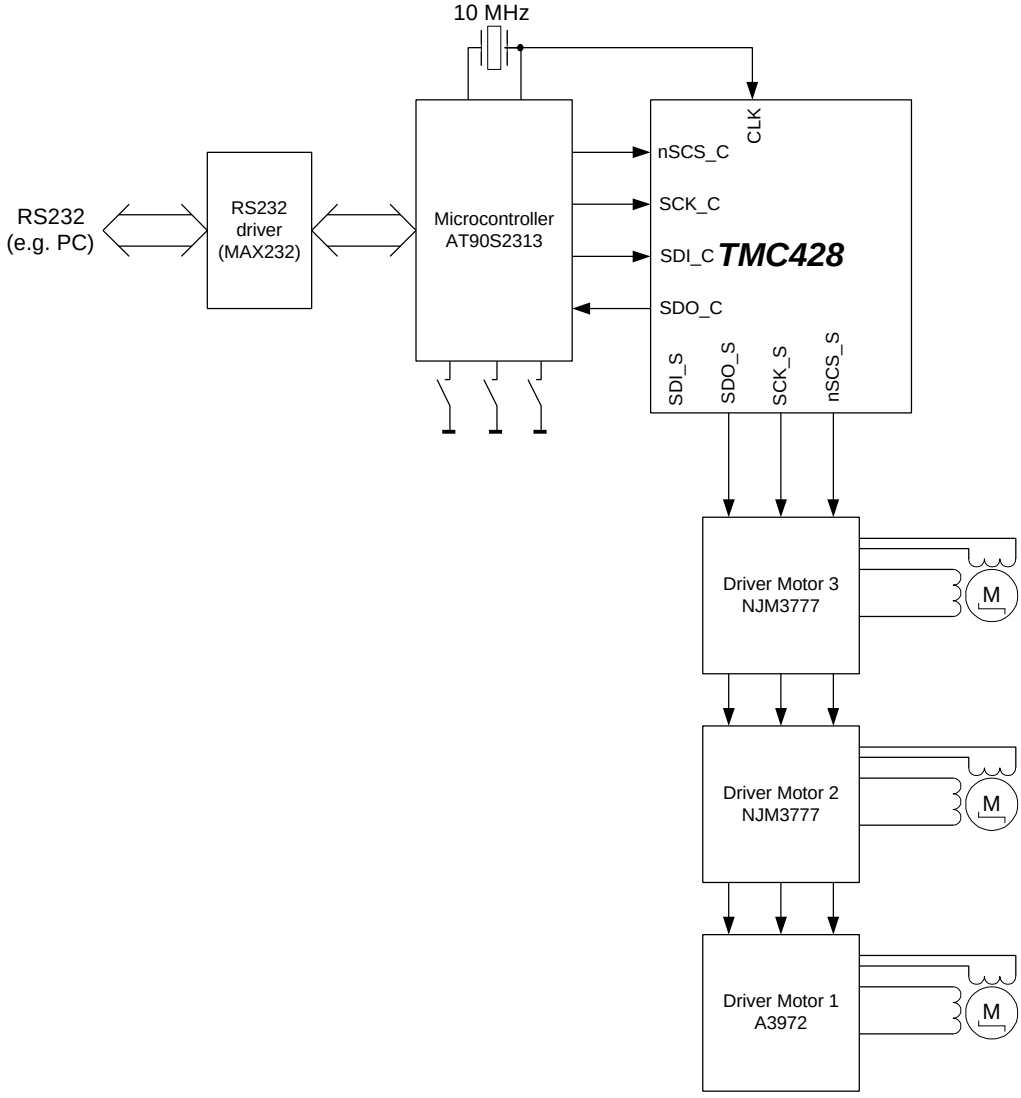

Figure 1.1: The structure of the evaluation board

2 Quick Start

For a first quick start, connect at least one stepper motor to the connectors MOTOR1, MOTOR2 or MOTOR3 (as shown in Figure 3.1). **Please note that the stepper motors may only be connected to or disconnected from the evaluation board while the board is disconnected from power, as otherwise the motor drivers could get damaged!**

Now, connect a power supply of about 25 VDC and at least 1A to the power connector. The positive pole is marked "+UB". When the power supply is working, the "Power" LED will light up. Also the other two LEDs will flash once after powering on.

Now the following functions can be used:

- The "MOVE1" key: After pressing the "MOVE1" key, all motors start rotating using different accelerations and velocities and the left activity LED lights up.
- The "STOP" key: When the "STOP" key is pressed once, all motors will be decelerated using different decelerations. If this key is pressed again while the motors are being decelerated all motors will be stopped immediately.
- The "MOVE2" key: The functionality of this key is similar to that of the "MOVE1" key, but the motors rotate in the opposite directions and the right activity LED lights up.

The functions MOVE1 and MOVE2 are indicated by LEDs. It is also possible to press the other "MOVE" key while the motors are running. The motors will be decelerated and then accelerated in the opposite directions.

The RESET key will reset the microprocessor which then reinitialises the TMC428.

Please note that the NJM3777 stepper motor drivers get very hot during operation. They will switch off automatically for a short time if they overheat.

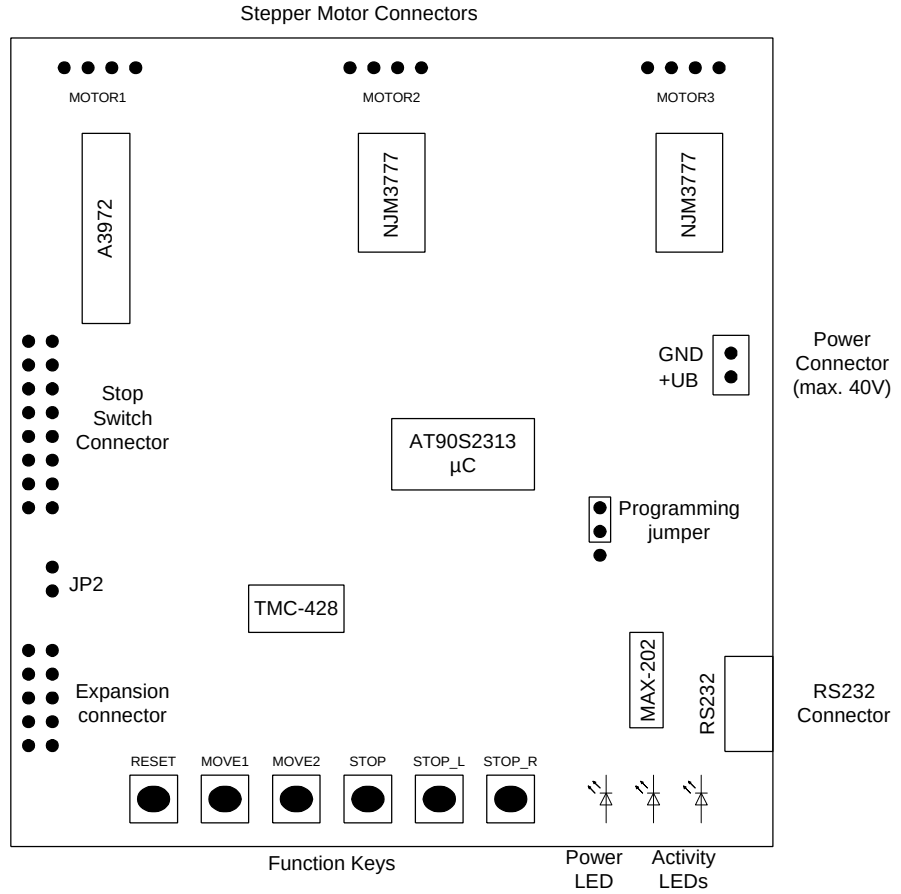

Figure 2.1: TMC428 evaluation board overview

3 The Hardware

Please see also the enclosed schematics of the evaluation board (supplied as PDF files on the CD) for a better understanding of this description.

3.1 Connectors

The evaluation board is equipped with the following connectors:

- RS232 (9-pin Sub-D plug): This is the RS232 interface for connection to a PC. The interface uses 19200 Baud, 8 data bits, no parity and one stop bit. Only the pins 2, 3 and 5 (RxD, TxD, GND) are connected.
- +UB/GND: socket for power supply. The positive pole is marked "+UB". A diode protects the board against wrong polarity. The voltage connected to it must not exceed 40 volts DC.
- Reference switch connector: Every reference switch pin is pulled to ground by a 1k resistor. The pinout of the connector is marked on the board.
- MOTOR1, MOTOR2 and MOTOR3: Stepper motor connectors. Motor #1 is driven by the A3972 driver and the other two motors are driven by the NJM3777 stepper motor drivers. Please note that the motor connected to the MOTOR1 connector will run in opposite direction than the motors connected to the MOTOR2 and MOTOR3 connectors.
- AVR-PROG: Atmel ISP connector. This permits changing the microprocessor's firmware using an Atmel ISP.
- Programming jumper: selection of the reset source for the microprocessor. If the pin marked with "Operation" is connected to the middle pin by a jumper the reset chip on the board will be used. If, however, the pin marked "Programm" is connected to the middle pin, the reset signal from the ISP connector will be used. So, for normal operation the pin marked "Operation" and the middle pin must be linked, whereas for programming the microprocessor using an ISP the pin marked "Programm" and the middle pin have to be linked.
- Expansion connector: Other stepper motor drivers can be connected here. To use this feature, the 0 ohms resistor beneath the JP2 jumper has to be de-soldered. **Please be extremely careful with the VDD pin, as this pin is connected directly to the +UB pin of the power connector. Shorting this pin with any other pin on the evaluation board may damage the evaluation board!**

3.2 Pin assignments of the connectors

The pin assignment of each connector is marked on the board. Please connect the stepper motors to the MOTOR1, MOTOR2 and MOTOR3 connectors as shown in the drawing below (Figure 3.1).

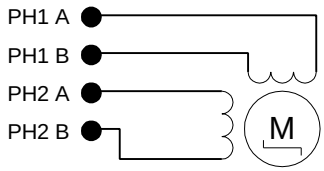

Figure 3.1: How to connect a stepper motor

3.3 Motor drivers

The TMC428 evaluation board comes with three motor drivers: One Allegro A3972 and two NJM3777. The A3972 supports 6 bit microstepping, whereas the NJM3777 stepper motor drivers – controlled by discrete D/A converters – support 3 bit microstepping. Furthermore the NJM3777 produces much more heat than the A3972. Both types of stepper motor drivers switch off for a short time if they overheat, which may result in a disturbed running of the motor. The maximum output current of the A3972 stepper motor driver is 1.5A, but it is limited to 750mA when using the evaluation board with standard settings. To use the full output current, a different configuration table has to be loaded (see section 4.3.3 on how to do that). The maximum output current of the NJM3777 stepper motor drivers is 600mA.

3.4 Communicating with a PC

The RS232 interface uses the following communication parameters: 19200 Baud, 8 data bits, no parity bit, one stop bit. The evaluation board expects data telegrams which contain at least one command byte and, depending on the command byte, some data bytes. Depending on the command byte, some data bytes will be sent back as a response. There are the following command bytes (noted in hexadecimal):

$23: Send an SPI telegram to the TMC428. The evaluation board expects four data bytes which form the SPI telegram that will be sent to the TMC428. The response from the evaluation board consists of four bytes which contain the SPI telegram that has been sent back from the TMC428.

$45<address><data><checksum>(one byte each):Change the contents of the microprocessor's EEPROM. The EEPROM of the microprocessor contains 128 bytes which are copied to the configuration RAM of the TMC428 after each reset. <Address> may be a value between 0 and 127. The following formula is used to calculate the checksum:
<Checksum>=(<Address>+<Data>) modulo 255
On success ACK ($06) will be sent back, otherwise NAK ($15) will be sent back.

$FF: The evaluation board will send a ten byte identification string, containing the firmware version number. Data bytes are not expected by this command.

Examples:

Reading Motor #0 position register
Command from PC: $23 $03 $00 $00 $00
Response from evaluation board: $15 $00 $00 $00

Querying the identification string:
Command form PC: $FF
Response from evaluation board: EV428 V2.0

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4 The PC Software

The PC software supplied with the TMC428 evaluation kit is a programme running under Windows 95/98/NT/2000 and allows access to all the registers of the TMC428. You can install the programme simply by copying the file "EVAL428.EXE" from the diskette or CD to your hard disk. After that, the software can be run simply by double clicking the file "EVAL428.EXE".
Before starting the software, the evaluation board should be connected to an RS232 interface of your PC using the null modem cable supplied with the evaluation kit.

4.1 The Main Window

After starting the software the main window will be shown (Figure 4.1). First, select the interface to which your evaluation board is connected and click the "Open" button. If the connection to the evaluation board could be established successfully, the message "The board is active" will be displayed. If a message like "The board does not respond" is displayed, please check the power supply and the connection to your PC again (COM1 or COM2?).
Now, the TMC428 status register is displayed in the "TMC428 status bits" section. Using the controls in the "Motor 1", "Motor 2" and "Motor 3" sections, the motors can be run. Just enter all necessary parameters and click the appropriate "Go!" button. You can stop a motor by clicking the appropriate "Stop!" button. Use the buttons "All Go!" and "All Stop" to run or stop all motors simultaneously.

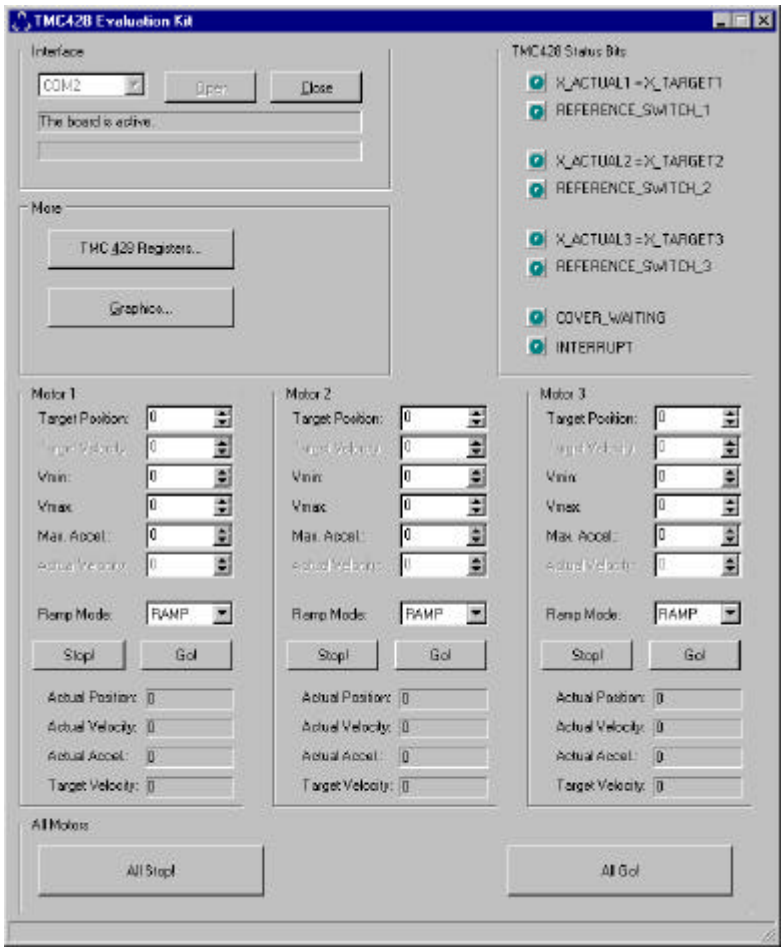
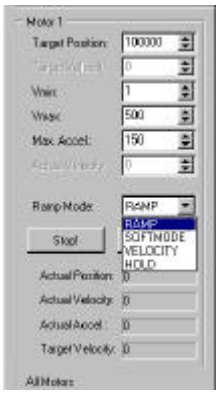


Figure 4.1: The main window

Always select the "Ramp Mode" first, then fill in the other necessary parameters and last start the motor or all motors. You will find an explanation of all the parameters in the TMC428 data sheet and also in the example in Chapter 4.1.1.
By clicking the "TMC428 Registers" button the register window opens and gives you access to every TMC428 register (Chapter 4.3). Click on the "Graphics" button to open the graphics window which displays the driving ramps of all motors (Chapter 4.2).

4.1.1 An example



In this example it is assumed that a motor is connected to the MOTOR1 connector.
First, set the ramp mode of motor #1 to "RAMP". Then enter the following parameters:

- Target Position: 100000
- Vmin: 1
- Vmax: 500
- Max Accel.: 150

Now click the appropriate "Go!" button. The motor will now be running until position 100000 is reached. After that, enter zero as "Target Position" and click the "Go!" button again. The motor will run back to position zero. You can also try to change the position "on the fly", whilst the motor is running. Just enter a different position, click the "Go!" button and see how the motor reacts. Also open the graphics window (Chapter 4.2) and watch the ramps.
Now try also the other modes: The "SOFTMODE" is nearly similar to the "RAMP" mode, except that the motor starts and stops softer. Please note that in the "RAMP" and "SOFTMODE" modes, the "Vmin" parameter must not be zero because otherwise the target position sometimes can not be reached. Hint: Some other parameters which are not displayed in the main window are calculated and set up automatically according to the acceleration parameter.
When using the "VELOCITY" mode, you can enter the acceleration and the "Vmax" parameter. The motor is then accelerated to that velocity and keeps running constantly until you change the velocity and click the "Go!" button again. The motor will then be accelerated or decelerated to the new velocity using the acceleration parameter you have entered.
If you set the ramp mode to "HOLD", you can only enter the "Actual velocity" parameter, click the "Go!" button and so control the velocity directly.
Please see also the files "tmc428_rhz.xls" and "tmc482_rhzva.xls" in the "TMC428_Examples" directory of the CD for calculating the TMC428 parameters and converting them to or from physical units.

4.2 The Graphic Display Window

The graphic display window (Figure 4.2) shows the driving ramps of all the stepper motors. The following values are displayed:

- Green: the actual position of the motor
- Red: the actual velocity of the motor. The value is shown as an absolute value, so negative velocities will also be shown as positive values
- Blue: the actual acceleration, also shown as an absolute value
- Yellow: the actual target velocity of the motor, also displayed as an absolute value

Please note that this is only a rough and not an exact diagram.

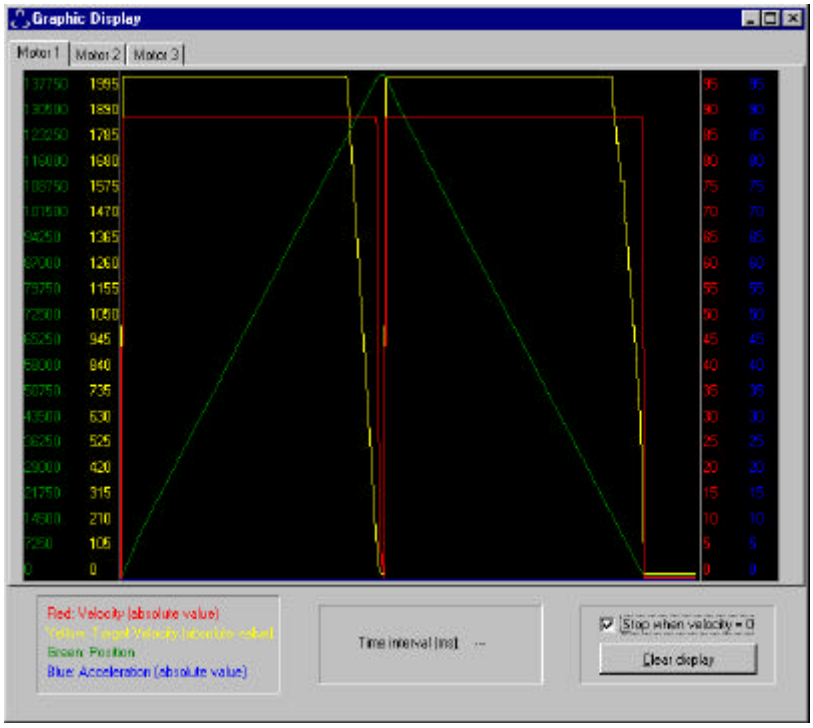


Figure 4.2: The graphic display window

The value "Time Interval" shows the time between two pixels on the X axis. This value mainly depends on the performance of the PC and will be slower when the register window is open (the display then gets slower because more values are queried from the evaluation board). The scales of the Y axis are automatically adapted to fit the entire curves. The curves are also displaced one pixel against each other for a better view.
If "Stop when velocity = 0" is activated the display will be stopped when the velocities of all motors are zero. All curves are cleared by clicking the "Clear display" button.

4.3 The register window

The register window makes the direct access to all TMC428 registers possible. It contains five pages on which all registers are displayed sorted by functional blocks. You can read more about the registers in the TMC428 data sheet.

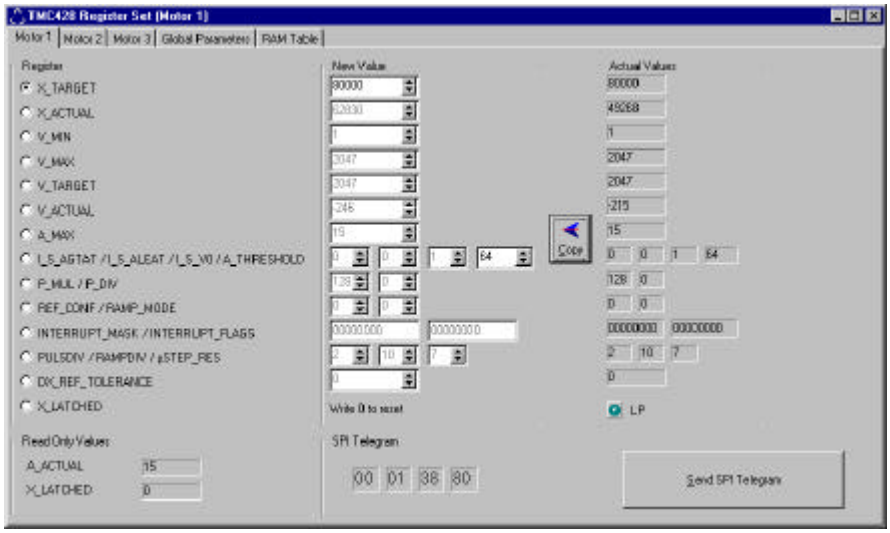


Figure 4.3: The register window showing the "Motor 1" page

4.3.1 The “Motor 1”, “Motor 2” and “Motor 3” pages

On these pages, all registers belonging to the motors #1, #2 and #3 are displayed (Figure 4.3). In the “Actual Values” and “Read Only Values” sections, the contents of all readable registers are displayed. These values are updated permanently.
To change the contents of a register, first click on its name in the “Registers” section. Then change the value in the appropriate edit field in the “New Value” section. You can also copy the actual values into the edit fields by clicking the “Copy” button.
In the “SPI Telegram” section, the necessary SPI telegram to set the selected register to the desired value is shown. Click the “Send SPI Telegram” button to send it to the evaluation board, and the value will be set.

4.3.2 The “Global Parameters” page

This page (Figure 4.4) contains all the TMC428 global parameter registers. It is made up just like the motor register pages. The contents of the read only registers (including the reference switch flags) are shown in the “Read Only” section. In the “Read/Write” section all writable registers are displayed. In the “Actual Values” section the actual contents of the registers are shown and updated permanently. To change a register, just select it in the “Registers” section, then fill in the new value in the “New Value” section. Using the “Copy” button, you can copy the actual contents into the edit fields.
In the “SPI Telegram” section, the necessary SPI telegram to set the selected register to the desired value is shown. Click the “Send SPI Telegram” button to send it to the evaluation board, and the value will be set.

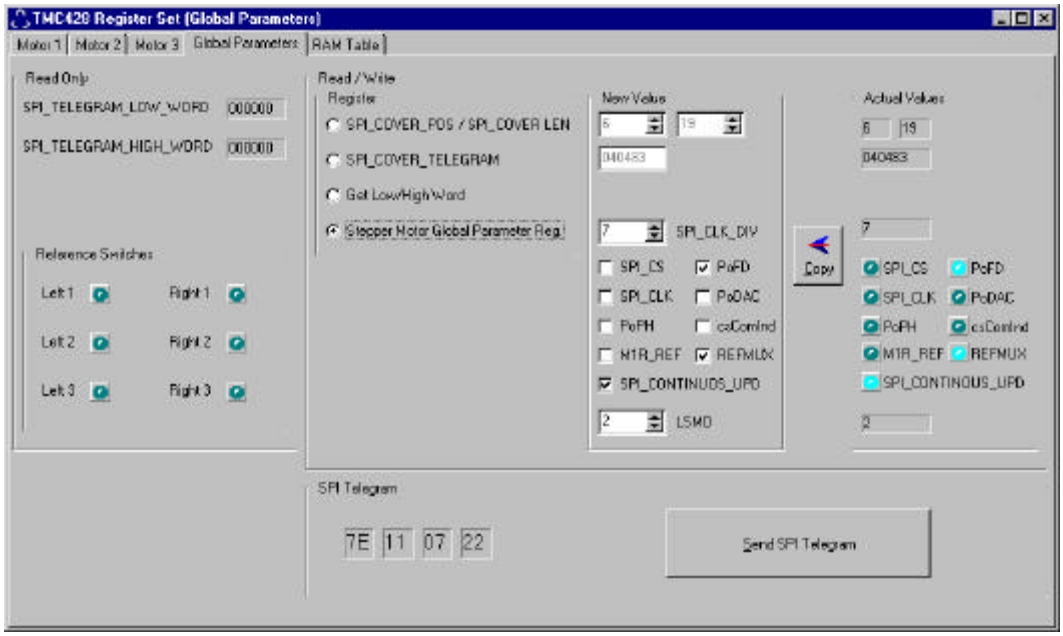


Figure 4.4: The register window showing the "Global Parameters" page

4.3.3 The “RAM Table” page

On this page (Figure 4.5), the internal configuration RAM of the TMC428 chip (which contains the driver configuration and the microstepping table) can be viewed and modified. Furthermore, any SPI data telegram can be entered and sent to the evaluation board and the response can be viewed.

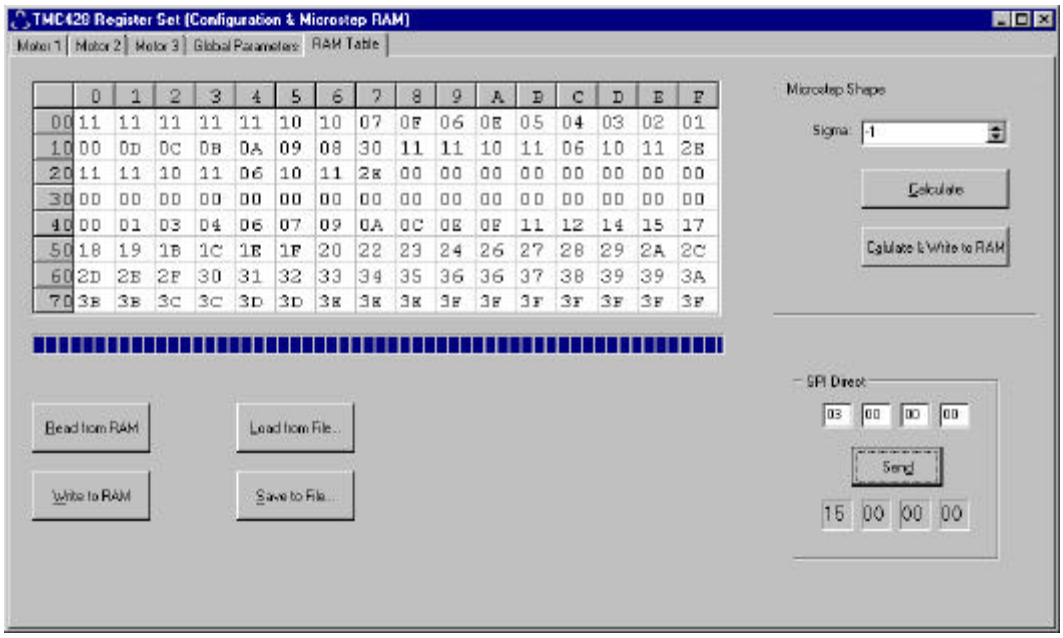


Figure 4.5: The register window showing the "RAM Table" page

Click the “Read from RAM” button to read the contents of the TMC428 RAM into the RAM editor. The progress bar below the RAM editor shows the reading progress. After that, the values can be modified. By clicking the “Write to RAM” button, the values will be written back to the TMC428 RAM, which is also shown by the progress bar. Use the “Save to file” function to save the contents of the RAM editor to a file and the “Load from file” function to read the file back into the RAM editor.

The "Microstep Shape" function is used to calculate enhanced microstepping tables. To do this, first set the "Sigma" value to the desired value (any floating point number between –1 and +1). By clicking the "Calculate" button the new microstepping table will be written to the RAM editor only, and by clicking the "Calculate & Write to RAM" button, the values are not only written to the RAM editor, but also to the TMC428 microstepping RAM. The driver configuration bytes will not be modified by this process.
In the "SPI direct" section, any SPI telegram can be entered and sent to the TMC428 by clicking the "Send" button. The response sent from the TMC428 is then displayed below the "Send" button.

4.4 The "Calc428" programme

The software CD also contains the programme "Calc428". This programme serves as a help to calculate the "PMul" and "PDiv" parameters (see the TMC428 datasheet for an exact explanation of these parameters). It can be run simply by double clicking the file "CALC428.EXE".

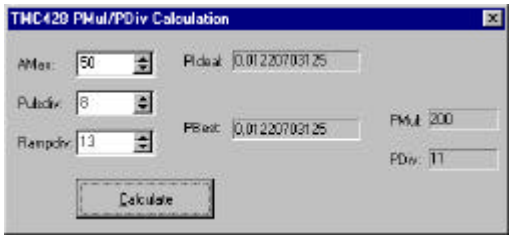


Figure 4.6: The "Calc428" programme

First, enter the parameters on the left side. After that, click the calculate button and the values will be calculated and displayed on the right side of the window.

4.5 The "Eval428EEP" programme

Using the programme "Eval428EEP", you can modify the contents of the EEPROM of the microprocessor on the evaluation board via the RS232 interface. The contents of the EEPROM are copied to the TMC428 RAM after each reset. So, for example, a modified microstepping table could be stored in the EEPROM and will be present immediately after powering on the evaluation board. To do this, you will first have to edit the RAM contents using the RAM editor (see Chapter 4.3.3) and store it in a file. The contents of such a file can then be stored in the EEPROM using the "Eval428EEP" programme.
Start the programme simply by double clicking the "EVAL428EEP.EXE" file.

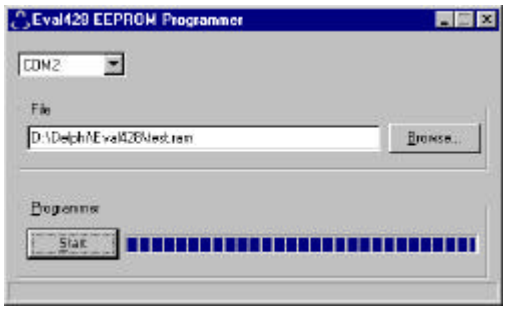


Figure 4.7: The "Eval428EEP" programme

Then select the interface your evaluation board is connected to and make sure that it is connected and powered on. Now select your RAM file either by entering its path directly or by clicking the "Browse" button and selecting a file in the file selection dialogue. Last, click the "Start" button. After a confirmation, the programming process starts. This is also shown by the progress bar.
At the end of the programming process, a message dialogue shows if the programming process has been successful.