TMC428 Evaluation Kit V2.5

Manual

English

Version: 2.50
July 1st, 2003

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Version

Version	Date	Author	Remarks
2.50	2003-07-01	OK	Created from version 2.01

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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 Atmega32 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. Up to three two phase stepper motors can be controlled.

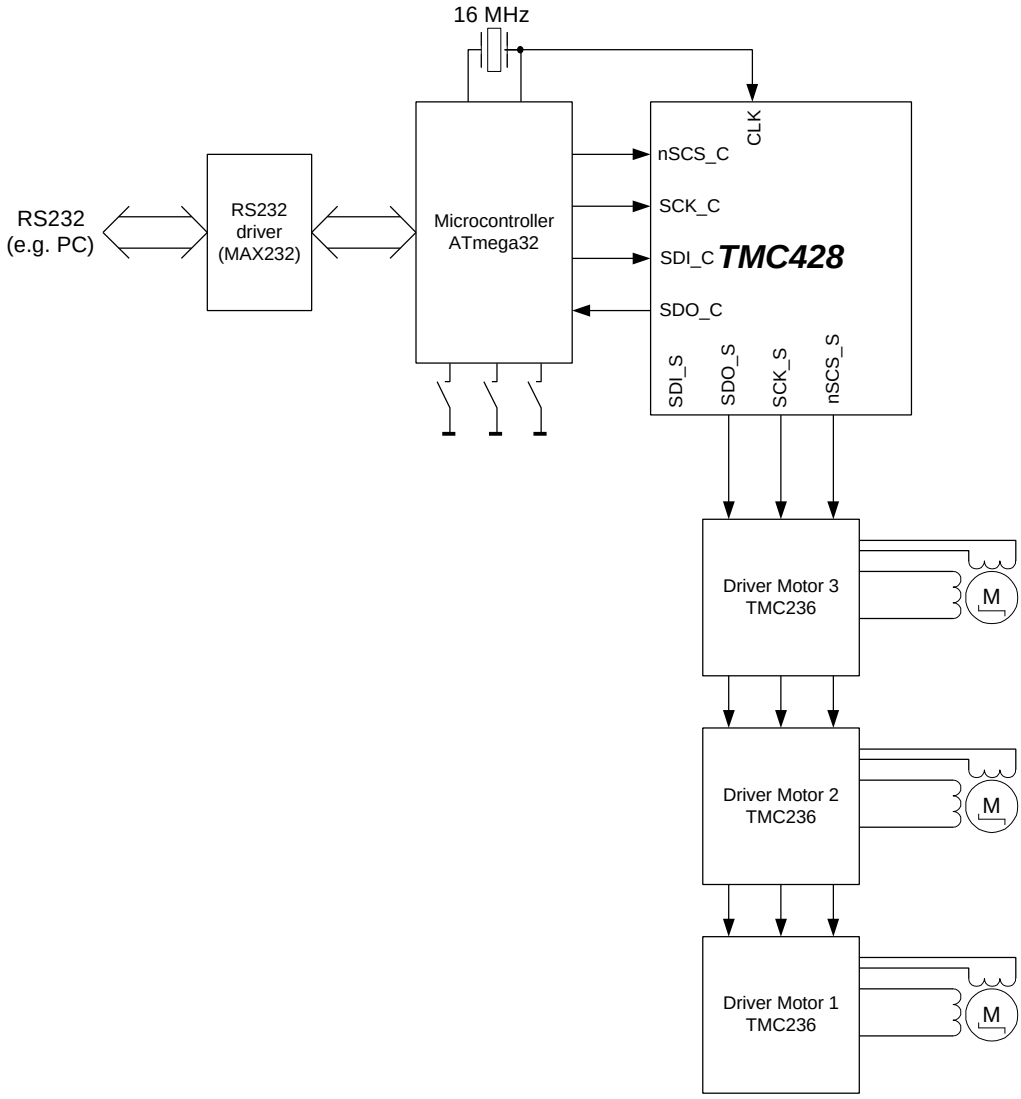


Figure 1.1: The structure of the evaluation board

2 Overview

The evaluation board is equipped with a TMC428 stepper motor controller and three TMC236 stepper motor drivers. The board is controlled by an ATmega32 microprocessor. All connectors are marked on the board. To put the evaluation kit into operation, connect at least one 2-phase stepper motor to one of the motor connectors (marked “MOTOR0”, “MOTOR1” and “MOTOR2”) on the board. **Never connect or disconnect stepper motors while the power supply is turned on. Always disconnect the board from the power supply before connecting or disconnecting motors, as otherwise the motor drivers may get damaged!** Then, connect the board to your PC using the null modem cable supplied with the evaluation kit.
Now, connect your power supply (12-24V DC or AC) to the power connector (marked “DC/AC 12-24V”) and turn it on. The LED on the board should be flashing now. The polarity of the power supply does not matter, it may even be AC. Do not exceed 24V!
Use the PC software to control the evaluation board.

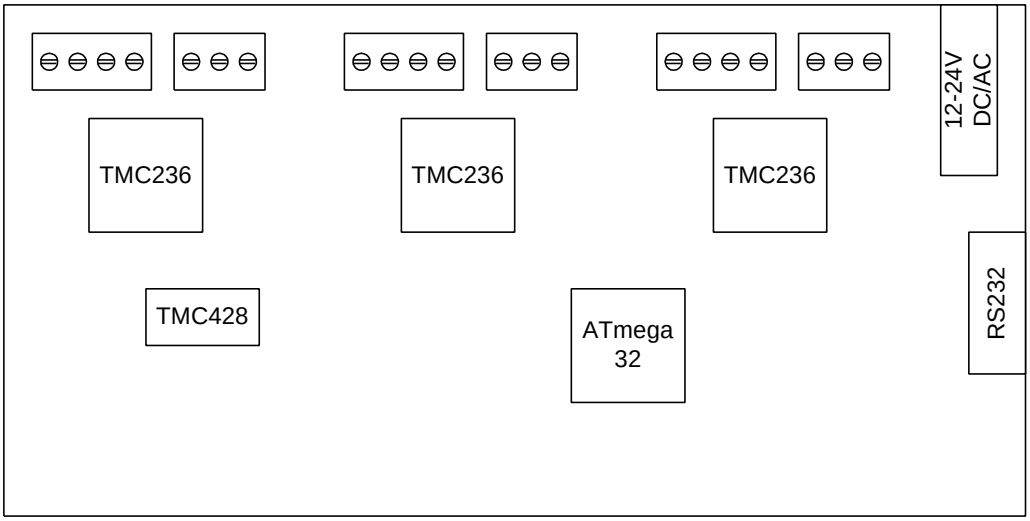


Figure 2.1: TMC428 evaluation board overview

3 The Hardware

This chapter describes the evaluation board hardware, especially the connectors of the board. Please see also Figure 1.1 and the board itself for a better understanding of this chapter.

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.
- DC/AC 12-24V: socket for power supply. Connect your power supply here, either to the socket marked “X500” or to the clamp marked “X504”. Polarity does not matter, it may even be AC.
- Stop switch connector: You can connect the left and right stop switch for each motor to the clamps marked STOP0, STOP1 and STOP2.
- MOTOR0, MOTOR1 and MOTOR2: Connect your stepper motors here. Please see also section 3.2 on how o connect the stepper motors. **Never connect or disconnect motors while the board is powered.**
- Programmer (X101): Atmel ISP connector. This permits changing the microprocessor’s firmware using an Atmel ISP.

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).

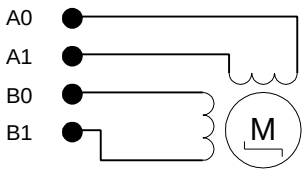


Figure 3.1: How to connect a stepper motor

3.3 Motor drivers

The TMC428 evaluation board comes with three TMC236 motor drivers. The maximum output current of the TMC236 stepper motor driver is 1.5A, but it is limited to 750mA when using the evaluation board with standard settings. The maximum coil current can be set to a different value (in 255 steps between 0 and 1.5A) by using the PC software (see next chapter).

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.

$50<motor><value>: Set the maximum motor current. This command expects one byte as the index of the motor (0, 1, or 2) and one byte to determine the maximum motor current, where 0 means 0A and 255 means 1.5A.

$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 V2.5

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.

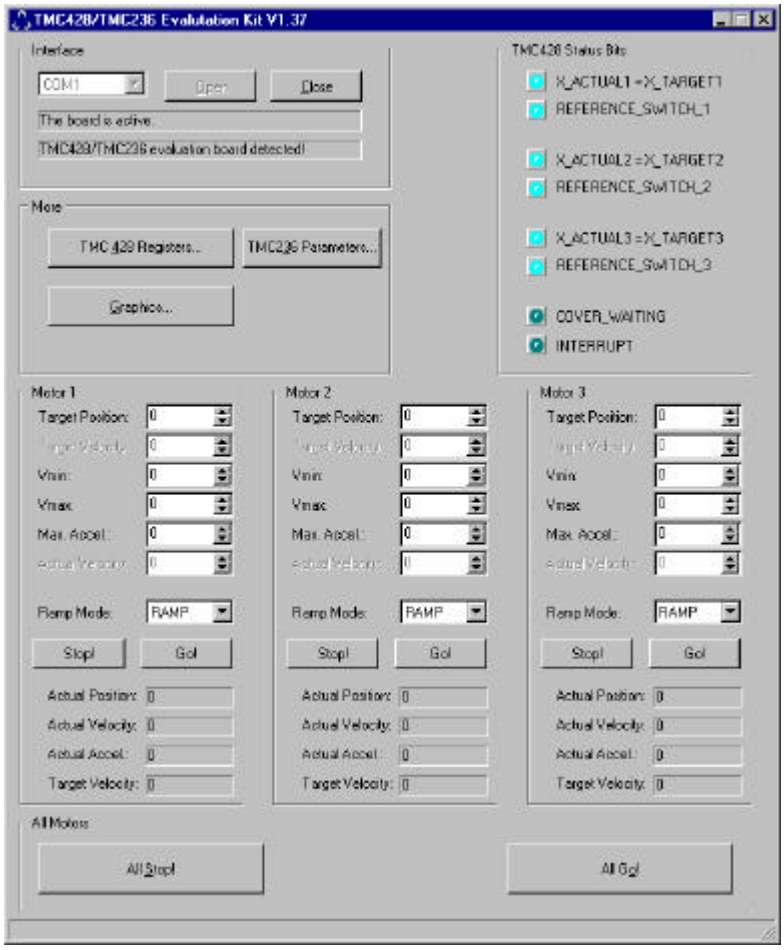
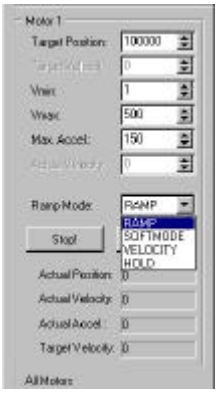


Figure 4.1: The main window

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.

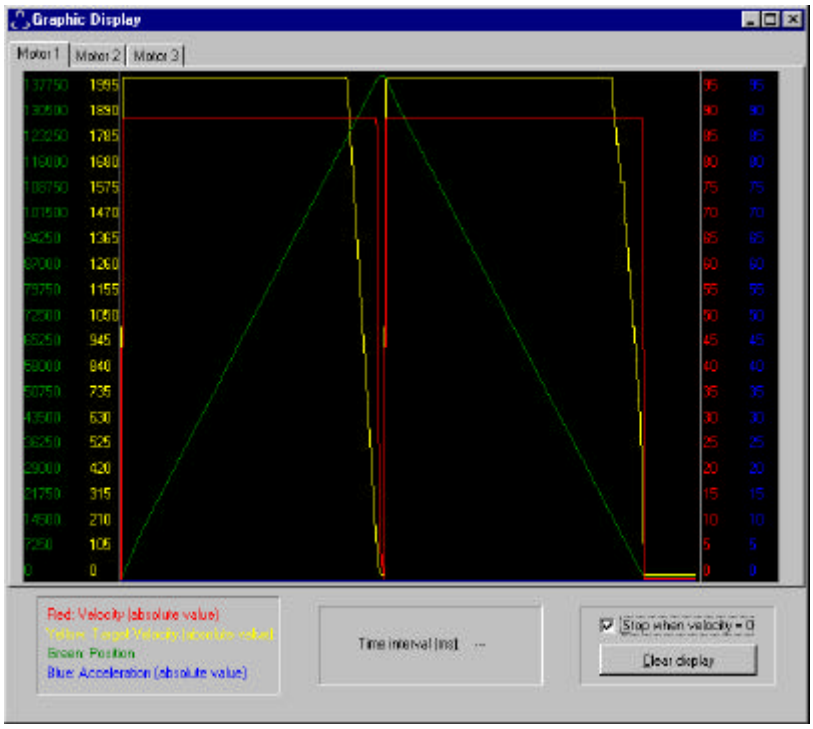


Figure 4.2: The graphic display window

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.

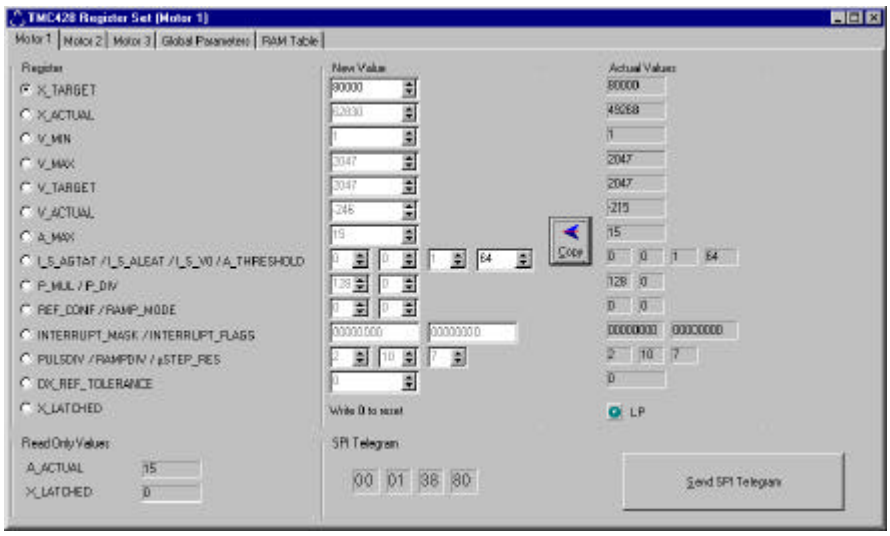


Figure 4.3: The register window showing the "Motor 1" page

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.

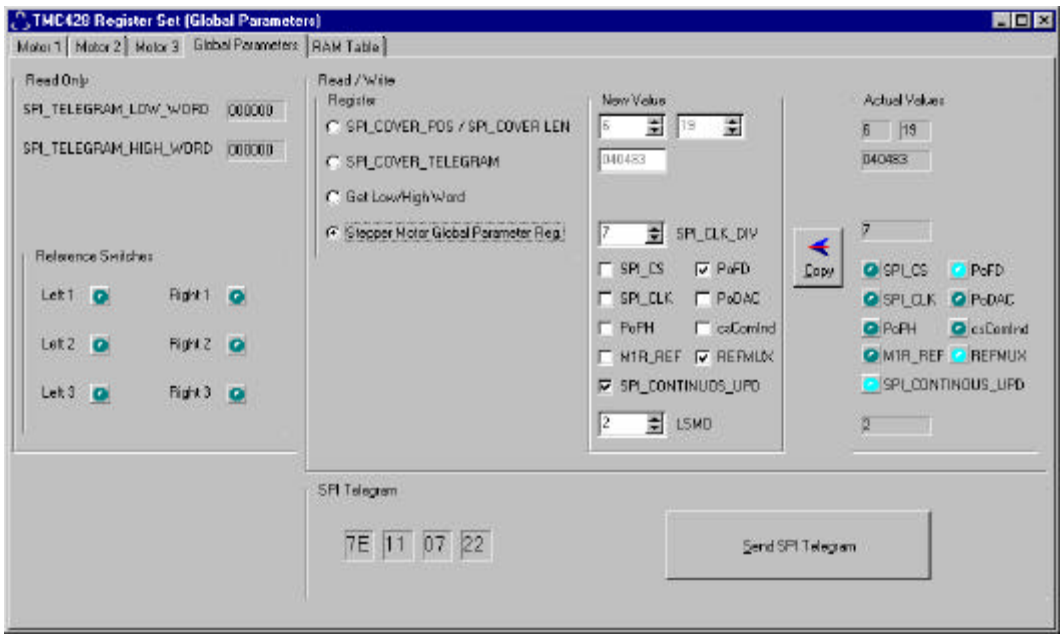


Figure 4.4: The register window showing the "Global Parameters" page

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.

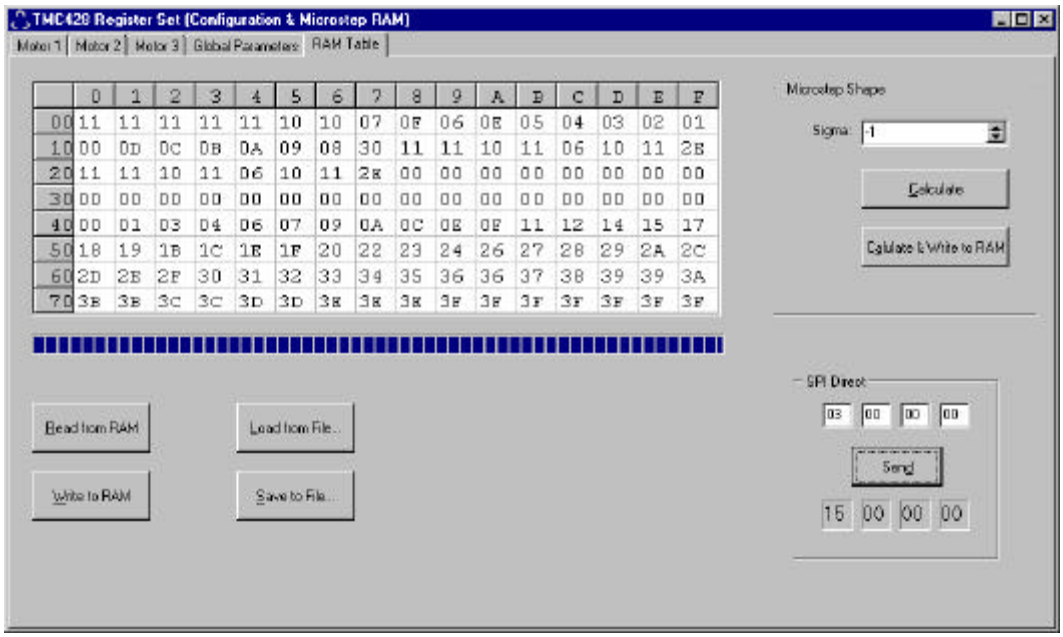


Figure 4.5: The register window showing the "RAM Table" page

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 “TMC236 Parameters” window

After clicking the “TMC236 Parameters” button in the main window, the TMC236 parameters window will show up. Here, the maximum current for every motor can be set between 0 and 1500mA. Just change the values, then click the “Apply” button.

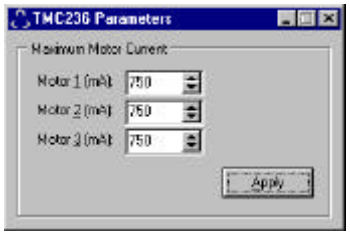


Figure 4.6: The TMC236 parameter window

4.5 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”.

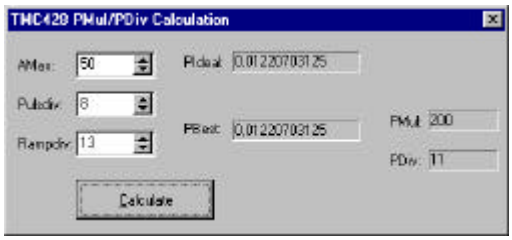


Figure 4.7: The "Calc428" programme

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.

4.6 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.

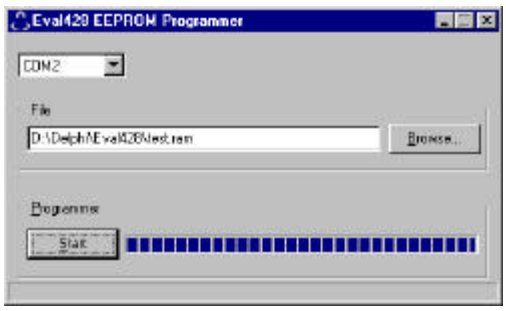


Figure 4.8: The "Eval428EEP" programme

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.