

Using the Stepper Motor (SM) eTPU Function

Covers the MCF523x, MPC5500, and all eTPU-equipped devices

by: Milan Brejl
System Application Engineer, Roznov Czech System Center

1 Introduction

The stepper motor (SM) Enhanced Time Processor Unit (eTPU) function is one of the functions in the standard set of eTPU functions (set1). This application note is intended to provide simple C interface routines to the SM eTPU function. The routines are targeted at the MCF523x family of devices, but they could be easily used with any device that contains an eTPU.

2 Function Overview

The SM function provides the eTPU with the capability of driving two-phase or three-phase stepper motors in full-step or half-step modes. The eTPU can accelerate the motors, run them at constant speed (or slew), and decelerate the motor independently of the device's CPU. The CPU need only initialize the function once, and then supply a desired position each time a move is required. The acceleration/deceleration profile is freely configured by the user via a table of step rates.

The SM eTPU function is based on the table stepper motor (TSM) TPU function. The SM eTPU function

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Function Description

expands the TSM TPU functionality in the following items:

- Support of 3-phase motors
- Acceleration table size is unlimited (limited only by the amount of available memory)
- 16-bit acceleration ratios
- 24-bit position values (current position and desired position)

3 Function Description

The SM function supports full- and half-step, unipolar and bipolar driving of two- or three-phase stepper motors, using one, two, four or six adjacent eTPU channels. Given a move request by the CPU, the eTPU independently accelerates, slews, and decelerates the motor to the desired position, thus relieving the CPU of almost all overhead associated with controlling the motor. The current motor position is maintained by the eTPU as a 24-bit parameter that can be read by the CPU at any time.

The CPU requests a move by writing a 24-bit desired position value. When the eTPU has completed moving the motor to the desired position, it issues an interrupt request to the CPU. If the appropriate interrupt enable bit is set, then a CPU interrupt will result, allowing optional interrupt driven control.

The algorithm employed in the eTPU re-evaluates the requested destination on every step. This means that the CPU can change the desired position at any time during a movement, and the eTPU will adjust its strategy to get to the new desired position as quickly as possible. For example, if the motor is currently moving clockwise from position A to position B at a given slew rate when the CPU writes a new desired position C, which is anticlockwise from the current position, the eTPU will immediately decelerate the motor, reverse direction, accelerate, slew, and decelerate in the anticlockwise direction, to reach position C.

The SM function generates the actual step patterns to drive the motor via synchronized output matches on a defined number of channels. The step patterns generated are defined by the user. The SM function operates on a master channel and an adjustable number of slave channels. The master channel is chosen by the user and the slave(s) are then defined immediately after the master, in numeric order.

The SM function uses the same user-defined step period profile during acceleration and deceleration. The user specifies this profile via a table in eTPU DATA_RAM. A 24-bit start period defines the period of the first and last steps in any move, i.e. the start/stop rate (pull-in rate) of the motor. The acceleration profile is programmed into a table of 16-bit constants; they are used sequentially to fractionally multiply the start period during acceleration to obtain the 'nth' step period.

The user also specifies a slew period that defines the exact maximum running speed of the motor. When accelerating, the eTPU uses a new value from the acceleration table for each step until the calculated step period (table parameter \times start period) is smaller than the slew period. When this point is reached, the eTPU switches to the slew period. The eTPU also uses the slew period if it reaches the end of the acceleration table. The slew period parameter allows the terminal speed of the motor to be controlled independently of the acceleration table length and content.

3.1 Example Configurations

The SM function is designed to provide as much flexibility as possible in the generation of the step patterns that drive the motor. This flexibility allows the SM function to meet the needs of unusual drive schemes. However, since the primary purpose of the SM function is to drive stepper motors in a conventional manner, it has been tested using the configurations depicted in Figures 1 to 9.

Each of the configurations defines a pin sequence, number of channels, and mode (full-step/half-step). The bipolar and unipolar versions of any configuration are the same from the eTPU point of view, because the generated step patterns are equal in both versions.

During initialization, each SM channel pin is initialized low or high to match the value of the corresponding channel bit in the pin sequence. For example, if 0x333333 is the initial pin sequence in the full-step drive of a 2-phase motor, then the master channel is initialized pin high, according to bit 0 of the pin sequence, and the following slave channel is also pin high, according to bit 1 of the pin sequence (see Figure 1). To change the initial pin states, replace the pin sequence by one of its rotated versions: 0x666666, 0xCCCCC or 0x999999 (in `etpu_sm.h` file).

To generate a step, the pin sequence is rotated left or right once, depending on the motor direction (left when direction is decremental, right when direction is incremental). The master channel pin level for the next step is defined by the LSB of the rotated pin sequence. The pin levels of the slave channels are determined by the next bits of the pin sequence. In full-step mode, every bit is used. In half-step mode, every second bit is used. The figures show the effective positions of the bits that determine the pin levels of the master and slave channels.

Function Description

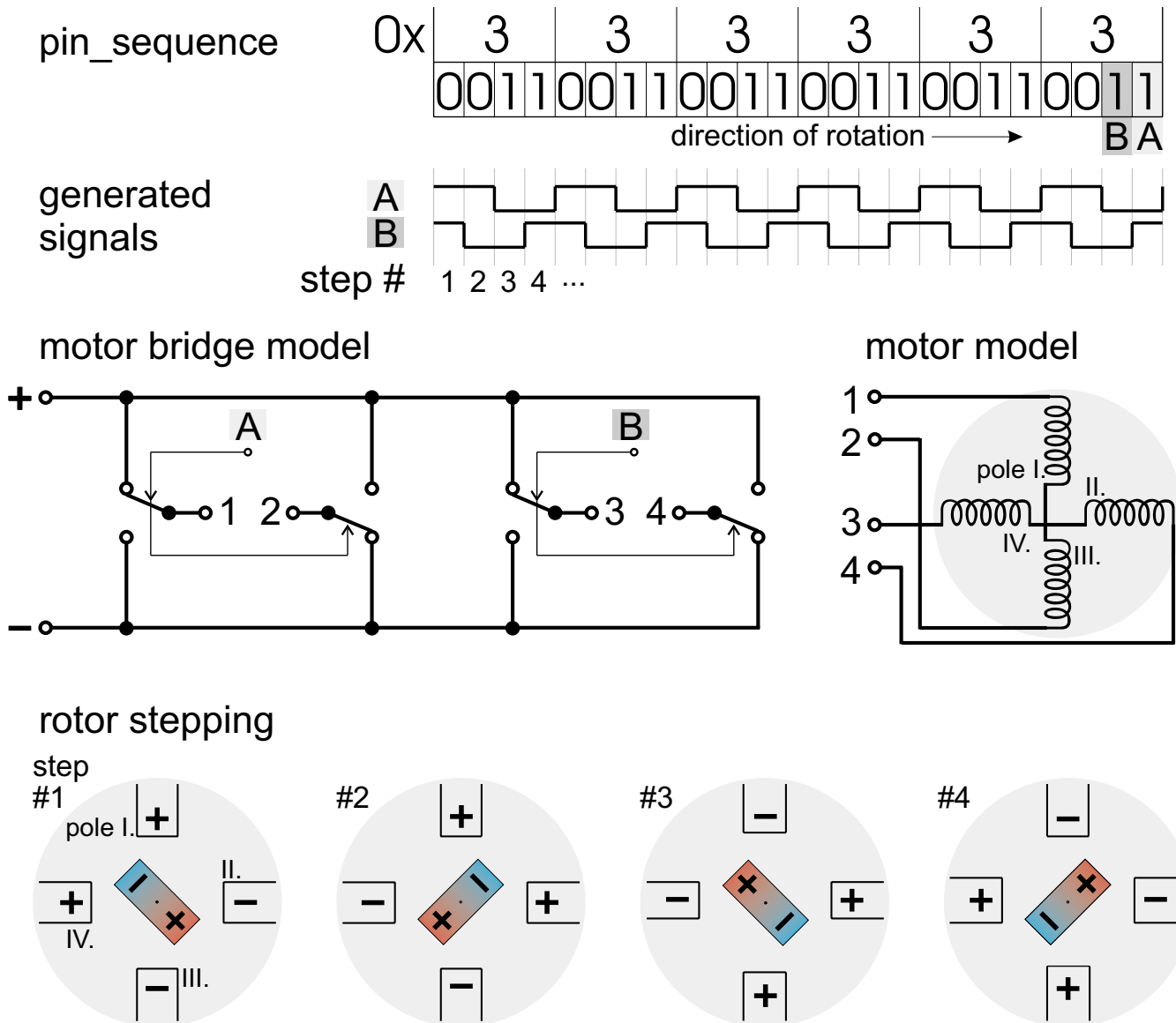


Figure 1. . Full-step bipolar drive of a 2-phase motor.

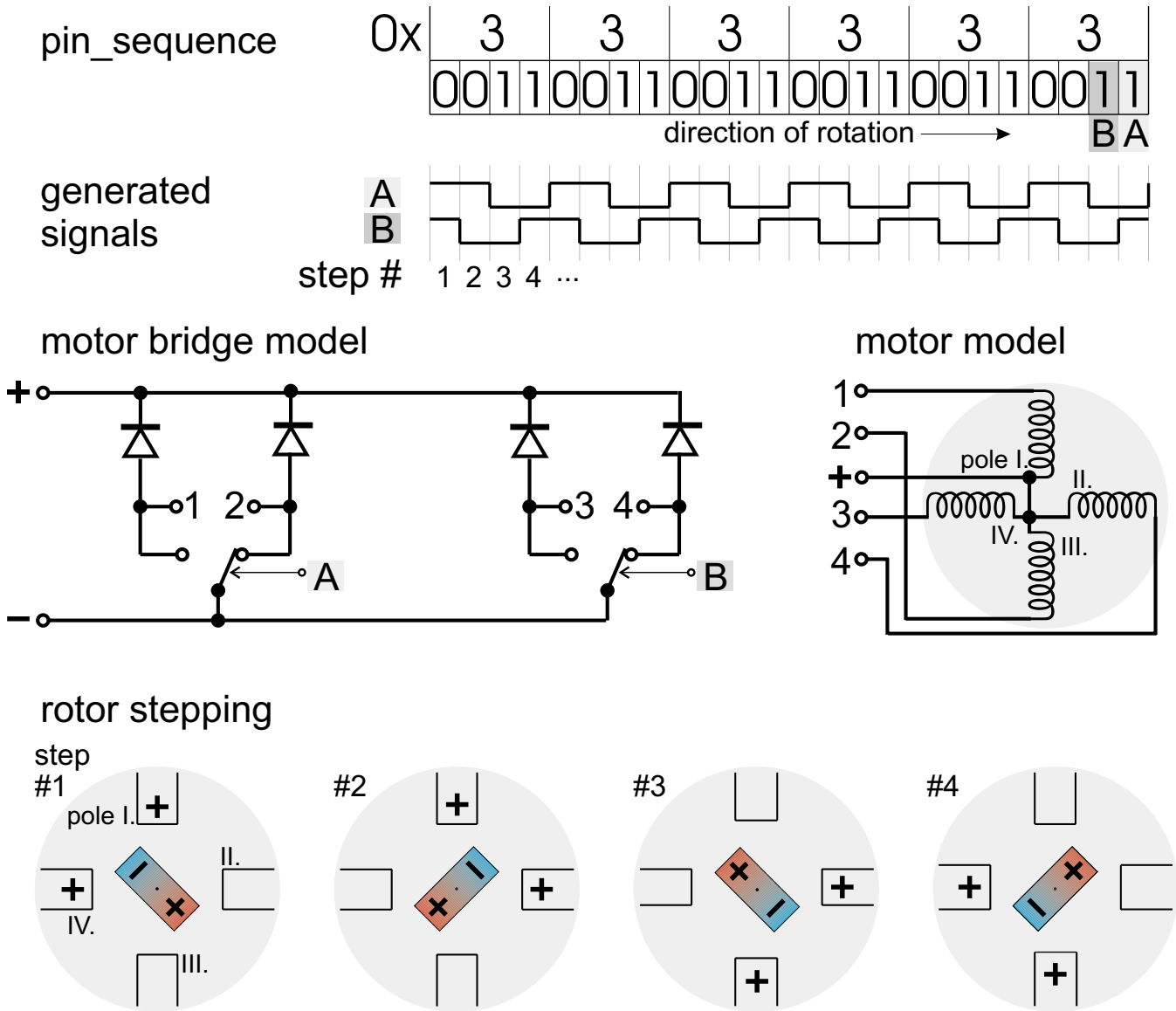
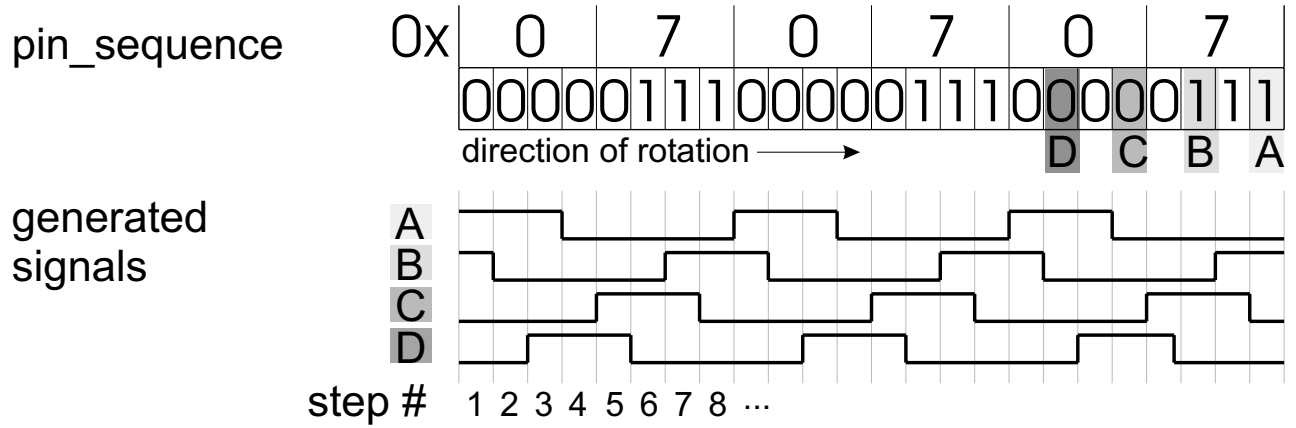
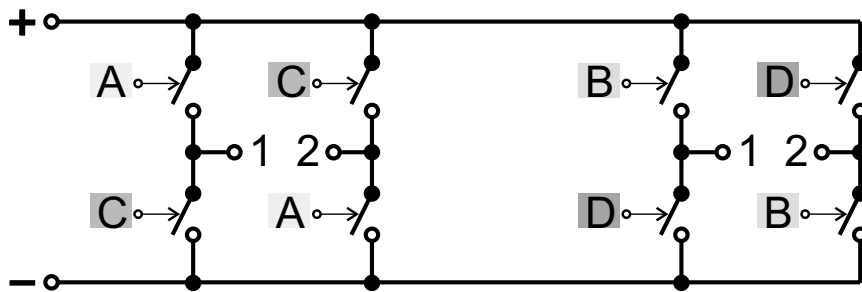


Figure 2. . Full-step unipolar drive of a 2-phase motor.

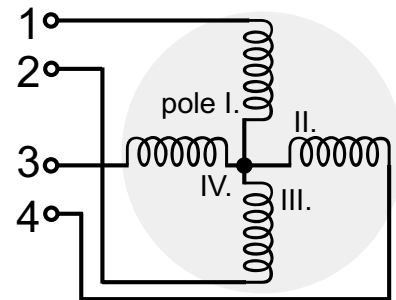
Function Description



motor bridge model



motor model



rotor stepping

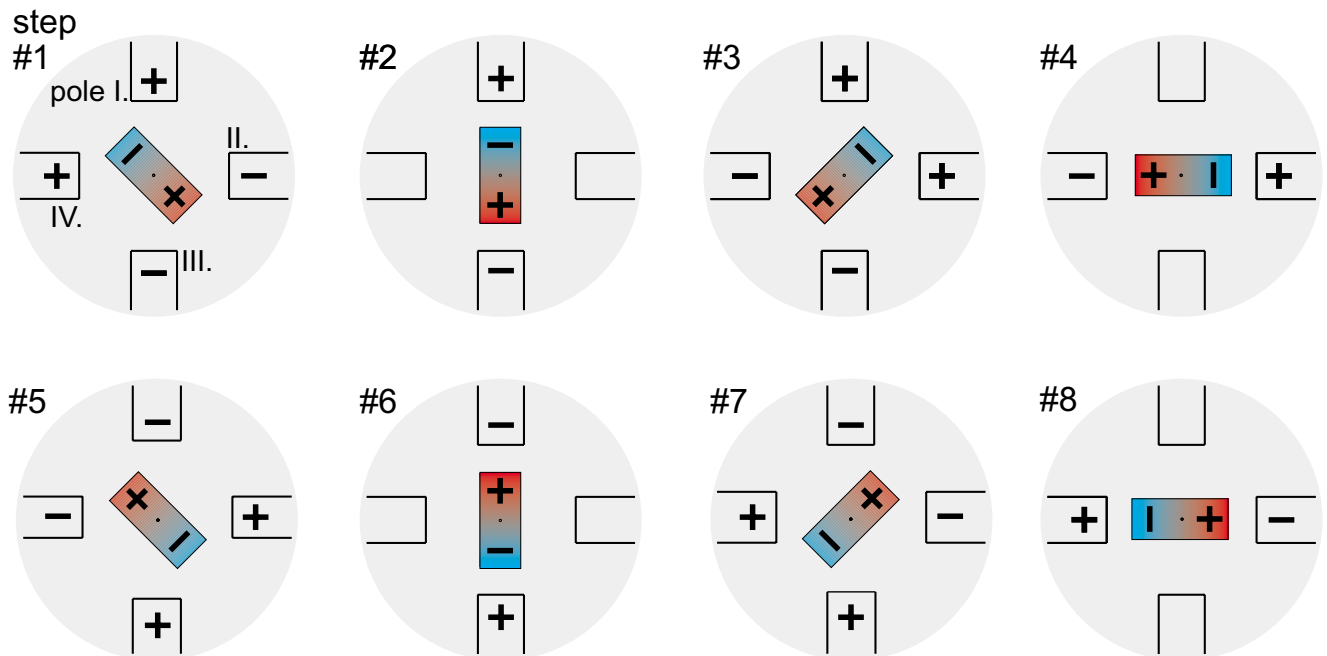
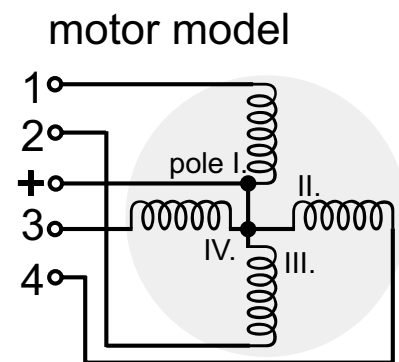
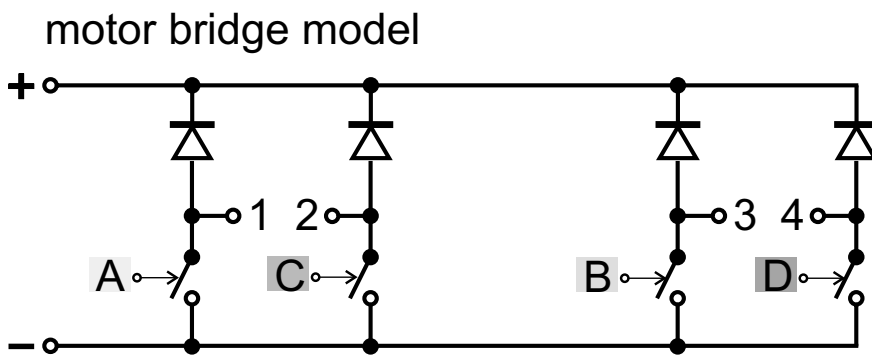
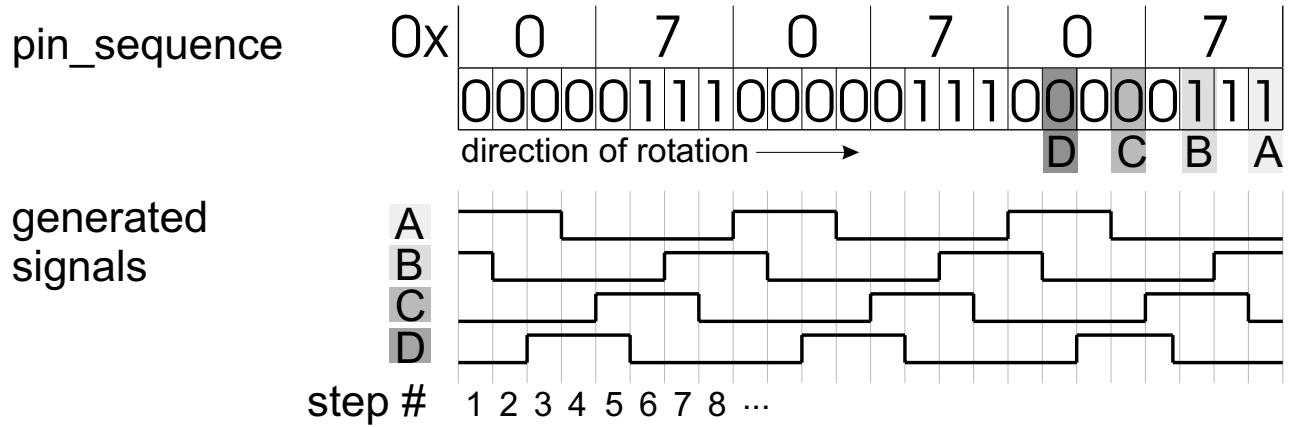


Figure 3. . Half-step bipolar drive of a 2-phase motor.



rotor stepping

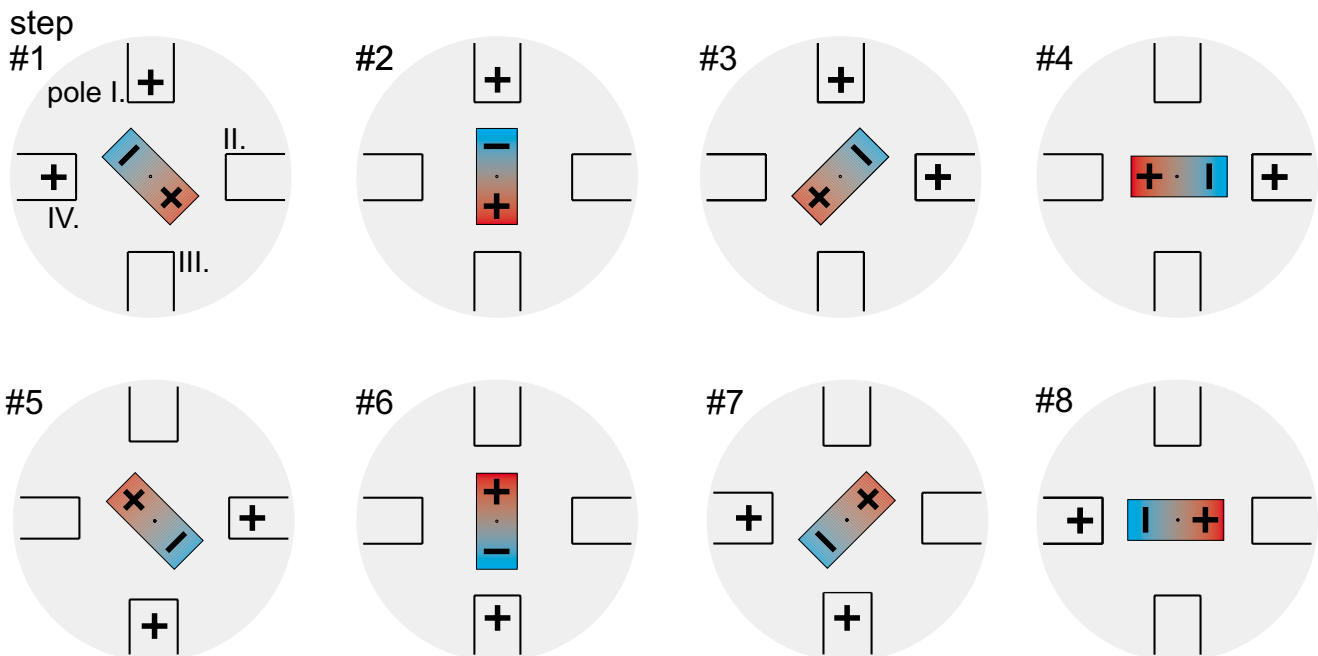


Figure 4. . Half-step unipolar drive of a 2-phase motor.

Function Description

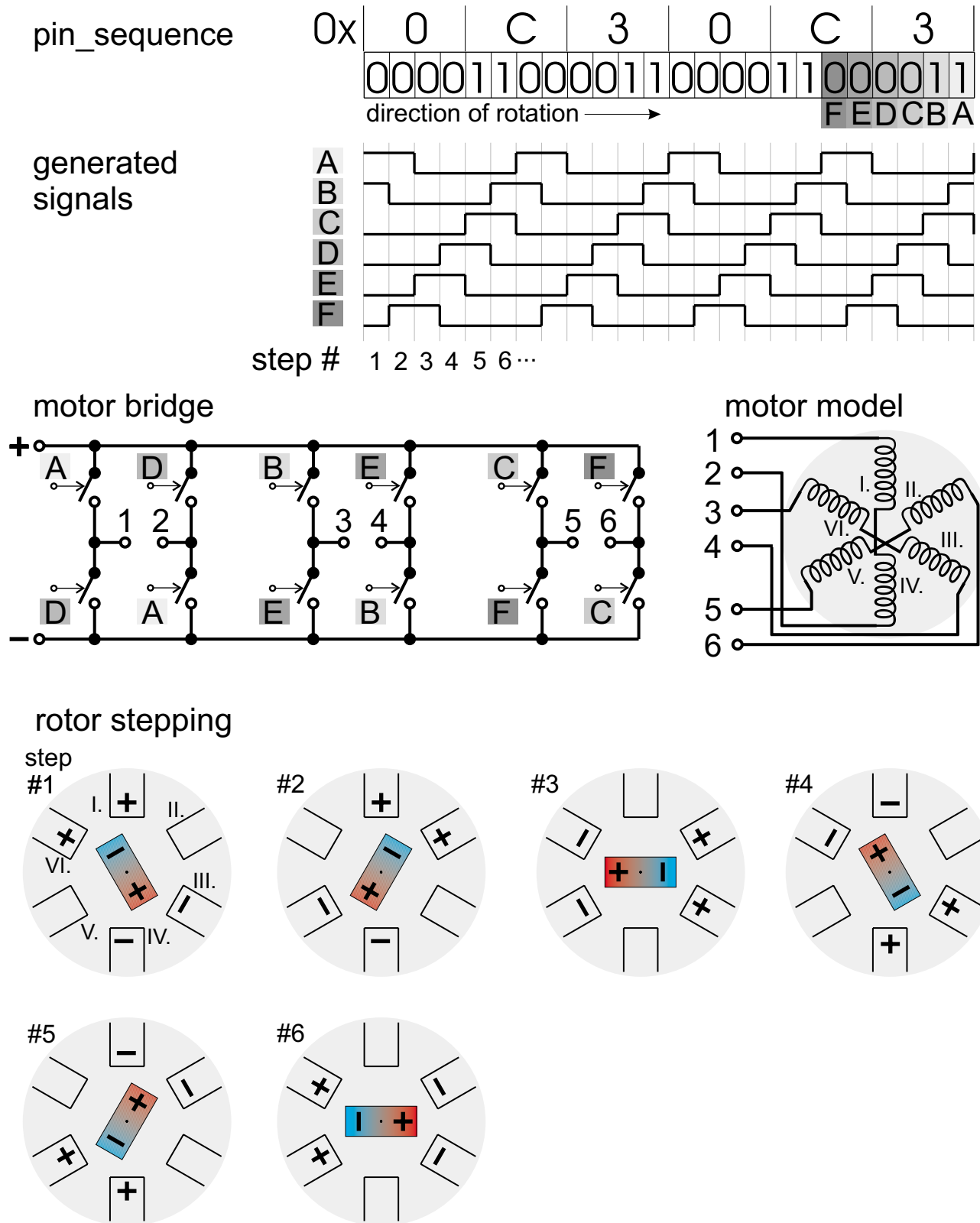
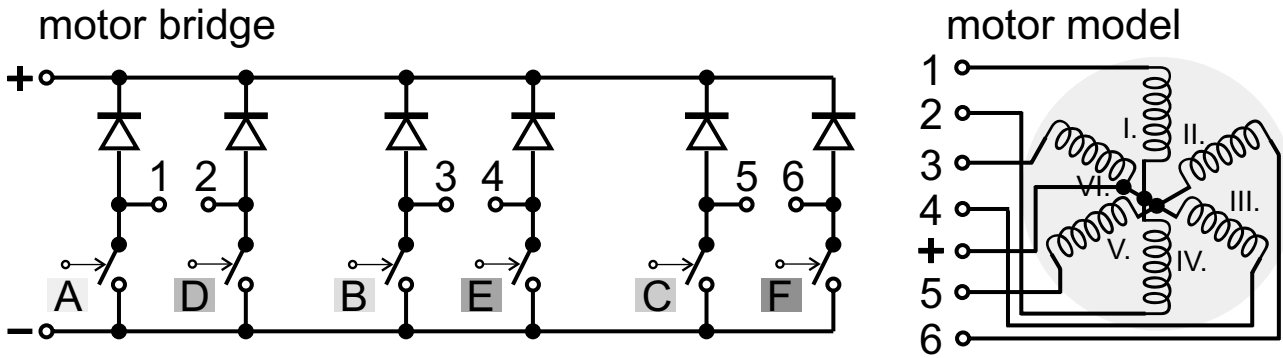
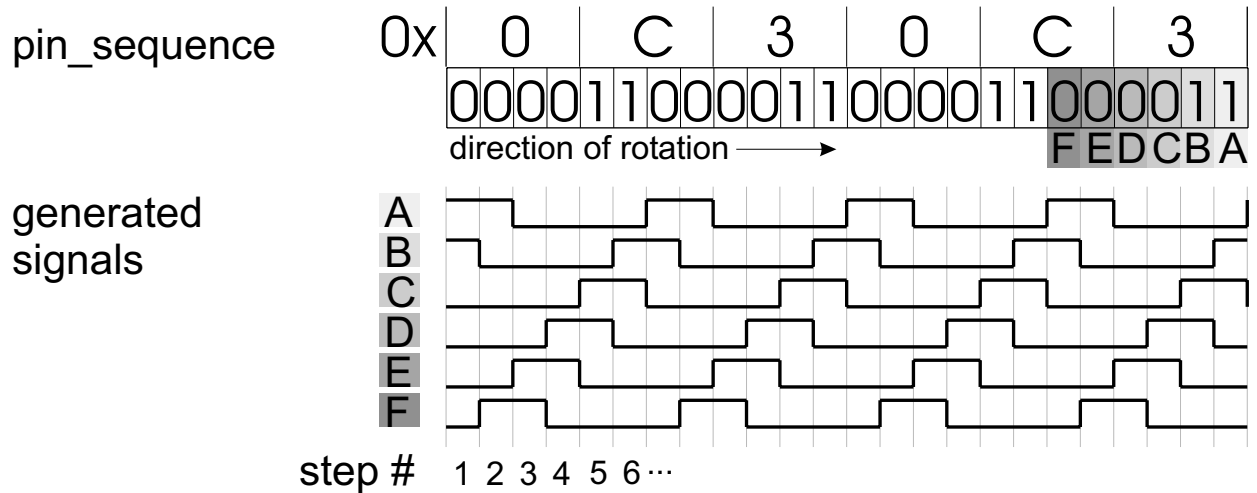


Figure 5. . Full-step bipolar drive of a 3-phase motor.



rotor stepping

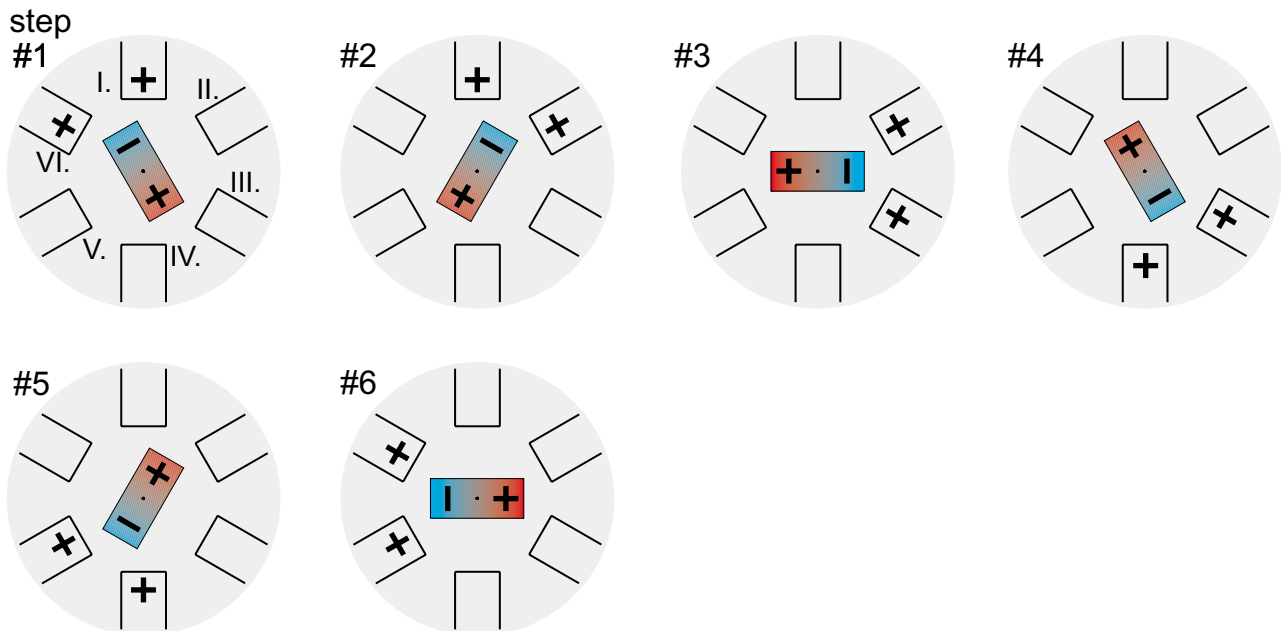


Figure 6. . Full-step unipolar drive of a 3-phase motor.

Function Description

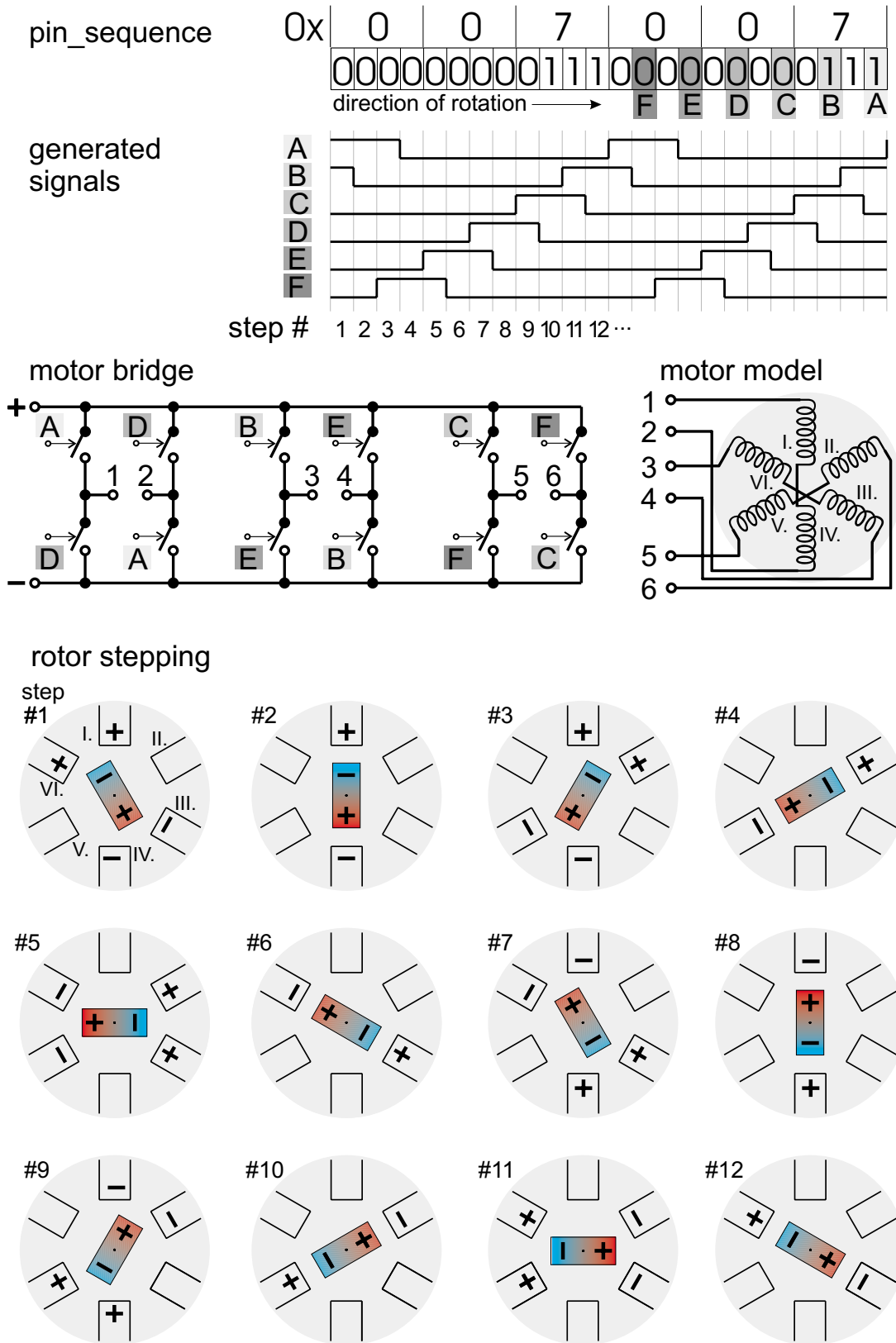


Figure 7. . Half-step bipolar drive of a 3-phase motor.

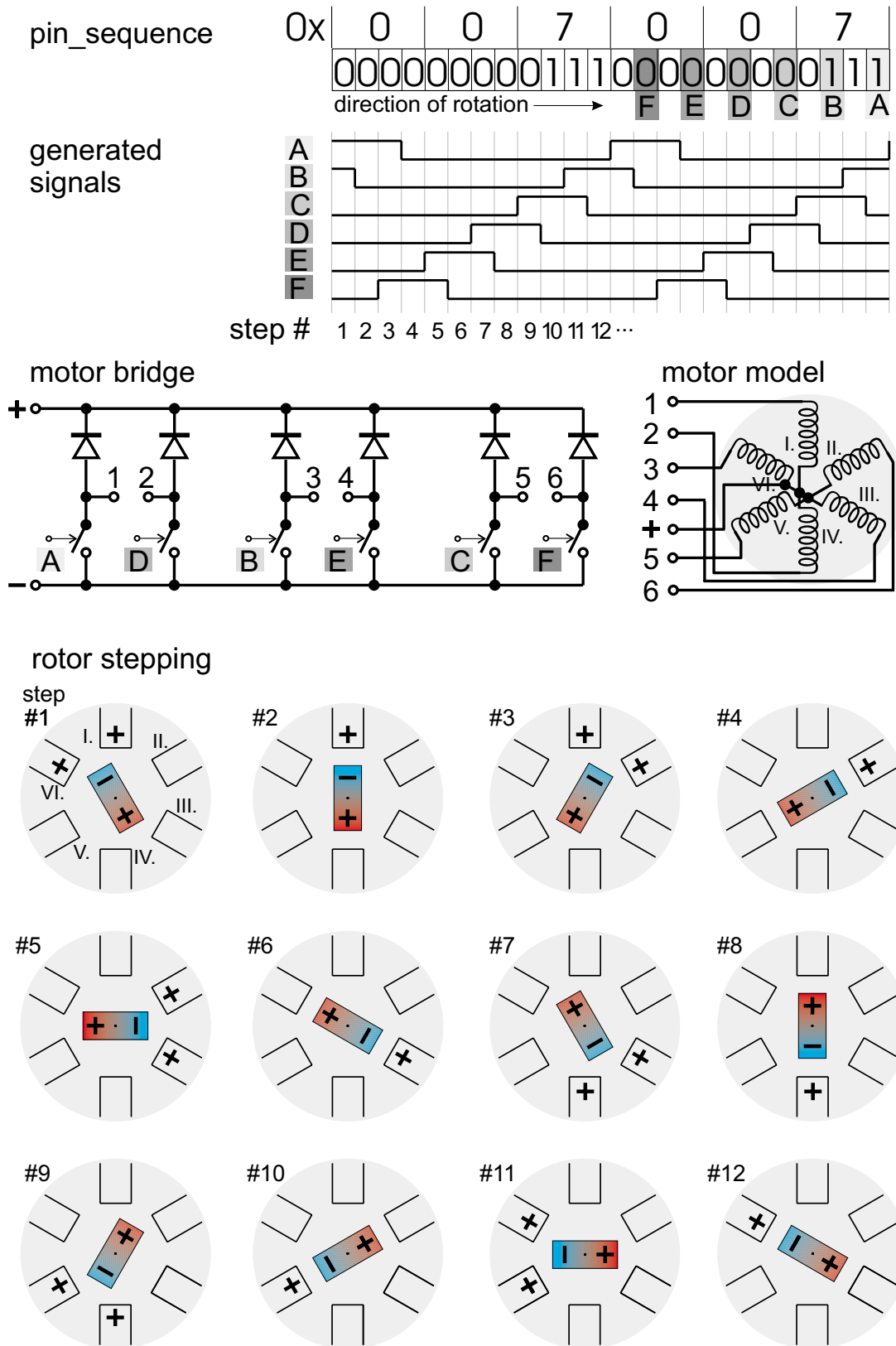


Figure 8. . Half-step unipolar drive of a 3-phase motor.

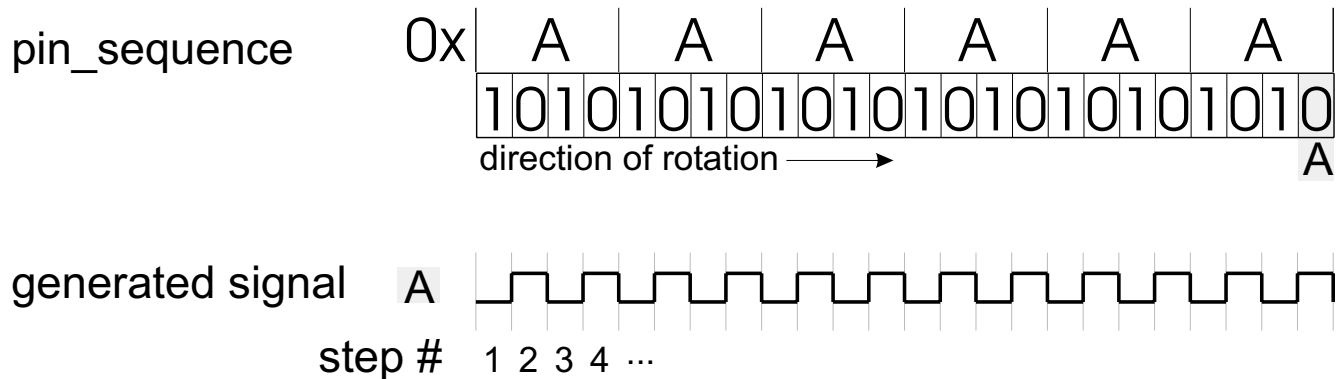


Figure 9. . General drive of a stepper motor using an external driver clocked by the eTPU.

3.2 Performance

Like all eTPU functions, the SM function performance in an application is, to some extent, dependent upon the service time (latency) of other active eTPU channels. This is due to the operational nature of the scheduler. When a single SM function is in use and no other eTPU channels are active, the minimum time between any two steps must be greater than 210 eTPU instruction cycles. For the MPC5554 with a system frequency of 128 MHz, the maximum step frequency is 304,700 steps per second. For the MCF5235 with a system frequency of 150 MHz, the maximum step frequency is 178,500 steps per second.

When more eTPU channels are active, performance decreases. In order to ensure the correct functionality of the SM, make sure that the slew period is longer or equal to the worst case latency of the SM master channel.

Maximum step-frequency is influenced by compiler efficiency. The above numbers are given for guidance only and are subject to change. For up to date information refer to the information provided in the eTPU SM software release available from Freescale.

4 C Level API for Function

The following routines provide easy access to the SM function for the application developer. Use of these functions eliminate the need to directly control the eTPU registers. There are six functions added to the application programming interface (API). The routines can be found in the `etpu_sm.h` and `etpu_sm.c` files, which should be included in the link file along with the top level development file(s). These routines use standard eTPU utilities, that are located in the `etpu_util.h` and `etpu_util.c` files. The routines will be described in order and are listed below:

- Initialization Function:

```
int32_t fs_etpu_sm_init( uint8_t  channel,
                        uint8_t  configuration,
                        int24_t  start_position,
                        int24_t  start_period,
                        int24_t  slew_period,
```

```
const uint16_t *p_accel_tbl,
      uint16_t accel_tbl_size )
```

- **Change Operation Functions:**

```
void fs_etpu_sm_enable( uint8_t channel, uint8_t priority)
void fs_etpu_sm_disable( uint8_t channel, uint8_t polarity)
void fs_etpu_sm_set_dp( uint8_t channel, int24_t desired_position)
void fs_etpu_sm_set_sp( uint8_t channel, int24_t slew_period)
```

- **Value Return Functions:**

```
int24_t fs_etpu_sm_get_dp( uint8_t channel)
int24_t fs_etpu_sm_get_cp( uint8_t channel)
uint8_t fs_etpu_sm_get_flags( uint8_t channel)
```

4.1 Initialization Function

4.1.1 int32_t fs_etpu_sm_init(...)

This routine is used to initialize the eTPU channels for the SM function. The SM eTPU channels must be initialized once, and then can be repeatedly enabled and disabled by `fs_etpu_sm_enable()` and `fs_etpu_sm_disable()` functions. This function has the following parameters:

- **channel (uint8_t):** This is the SM master channel number. This parameter should be assigned a value of 0-31 for ETPU_A, and 64-95 for ETPU_B, with respect to the number of following slave channels. The slave channels are defined immediately after the master, in numeric order.
- **configuration (uint8_t):** This is the pre-defined configuration parameter. This parameter should be assigned a value of:
 - FS_ETPU_SM_2PHASE_FULL_STEP
 - FS_ETPU_SM_2PHASE_HALF_STEP
 - FS_ETPU_SM_3PHASE_FULL_STEP
 - FS_ETPU_SM_3PHASE_HALF_STEP
 - FS_ETPU_SM_EXT_DRIVER

The pre-defined configurations correspond to the examples described in [Section 3.1, “Example Configurations”](#), and pre-define the number of channels used, the pin sequences, and the mode (full-step/half-step). If an application requires a change to a configuration, edit the pre-defined values in the file `etpu_sm.h`.

- **start_position (int24_t):** This is the starting current_position value.
- **start_period (int24_t):** This is the start period as a number of TCR1 ticks. The start period is the first and last step period of a movement. If an application uses frequencies in Hz, instead of periods in TCR1 cycles, one of the following expressions can be used instead of `start_period`:

```
etpu_a_tcr1_freq/start_frequency;
```

```
etpu_b_tcr1_freq/start_frequency;
```

- **slew_period (int24_t)**: This is the slew period as a number of TCR1 ticks. The slew period is the step period when the motor rotates at max speed. The slew period is the shortest period of a movement. If an application uses frequencies in Hz, instead of periods in TCR1 cycles, one of the following expressions can be used instead of `slew_period`:

```
etpu_a_tcr1_freq/slew_frequency;
```

```
etpu_b_tcr1_freq/slew_frequency;
```

- **accel_tbl (const uint16_t*)**: This parameter is the pointer to the acceleration table. The acceleration table is an array of unsigned fract16. The n^{th} step period results from the fractional multiplication of the start_period and `accel_tbl[n]`.
- **accel_tbl_size (uint16_t)**: This parameter is the acceleration table size as a number of 16-bit acceleration steps.

4.2 Change Operation Functions

4.2.1 void fs_etpu_sm_enable(...)

This routine is used to enable the SM eTPU channels. This function has the following parameters:

- **channel (uint8_t)**: This is the SM master channel number. This parameter should be assigned a value of 0-31 for ETPU_A, and 64-95 for ETPU_B, with respect to the number of following slave channels. The slave channels are defined immediately after the master, in numeric order.
- **priority (uint8_t)**: This is the priority to assign to the SM function. The eTPU priority definitions are defined in `etpu_utils.h`:
 - FS_ETPU_PRIORITY_HIGH
 - FS_ETPU_PRIORITY_MIDDLE
 - FS_ETPU_PRIORITY_LOW
 - FS_ETPU_PRIORITY_DISABLED

4.2.2 void fs_etpu_sm_disable(...)

This routine is used to disable the SM eTPU channels. This function has the following parameters:

- **channel (uint8_t)**: This is the SM master channel number. This parameter should be assigned a value of 0-31 for ETPU_A, and 64-95 for ETPU_B, with respect to the number of following slave channels. The slave channels are defined immediately after the master, in numeric order.
- **polarity (uint8_t)**: This is the polarity of the generated signals. This parameter can be assigned a value of:
 - FS_ETPU_SM_ACTIVE_HIGH
 - FS_ETPU_SM_ACTIVE_LOW

4.2.3 void fs_etpu_sm_set_dp(uint8_t channel, int24_t desired_position)

This function sets where to move the stepper motor, and the command for movement. This function has the following parameters:

- **channel (uint8_t):** This is the SM master channel number. This parameter must be assigned the same value that is assigned to the channel parameter in the initialization routine. If there are more SMs running simultaneously on the eTPU(s), the channel parameter distinguishes which SM function is accessed.
- **desired_position (int24_t):** This is the desired position that the motor should move to.

After `etpu_sm_set_dp(...)` is called, the motor moves until there is a match between the `current_position` and the `desired_position`. Also, the `etpu_sm_set_dp` function can be called at any time, even when the motor is stepping towards another value. The SM function will automatically take care of slowing the motor, reversing the direction (if necessary), and accelerating towards the new `desired_position` as needed.

4.2.4 void fs_etpu_sm_set_sp(uint8_t channel, int24_t slew_period)

The `slew_period` parameter specifies the minimum step period of the motor (and therefore its maximum speed).

- **channel (uint8_t):** This is the SM master channel number. This parameter must be assigned the same value as was assigned to the channel parameter in the initialization routine. If there are more SMs running simultaneously on the eTPU(s), the channel parameter distinguishes which SM function is accessed.
- **slew_period (int24_t):** Slew period as a number of TCR1 ticks. If the application uses frequencies in Hz, instead of periods in TCR1 cycles, one of the following expressions can be used instead of `slew_period`:

```
etpu_a_tcr1_freq/slew_frequency;
```

```
etpu_b_tcr1_freq/slew_frequency;
```

The `slew_period` parameter is used under two circumstances:

1. The end of the acceleration table is reached.
2. The period value, obtained from the fractional multiplication of the `start_period` value by an acceleration parameter (from the table), is less than `slew_period`. This allows the `slew_period` to be used to limit the maximum speed of a particular motor when multiple motors are sharing a common acceleration table.

The `slew_period` also allows a motor to make moves of the same length at different speeds, without requiring a reprogramming of the acceleration table.

NOTE

slew_period should only be changed between moves and not while the motor is running.

4.3 Value Return Functions

4.3.1 int24_t fs_etpu_sm_get_dp(uint8_t channel)

This function reads the desired_position and contains the following parameter:

- **channel (uint8_t)**: This is the SM master channel number. This parameter must be assigned the same value as was assigned to the channel parameter in the initialization routine. If there are more SMs running simultaneously on the eTPU(s), the channel parameter distinguishes which SM function is accessed.

The value of the **desired_position** is returned as an int24_t.

4.3.2 int24_t fs_etpu_sm_get_cp(uint8_t channel)

This function reads the current_position of the SM that can be used for program control when compared against the desired_position or some other value. This function has the following parameter:

- **channel (uint8_t)**: This is the SM master channel number. This parameter must be assigned the same value as was assigned to the channel parameter in the initialization routine. If there are more SMs running simultaneously on the eTPU(s), the channel parameter distinguishes which SM function is accessed.

The value of the **current_position** is returned as an int24_t.

4.3.3 uint8_t fs_etpu_sm_get_flags(uint8_t channel)

This function reads the status flags of the SM. There are the following flags:

- STEPPING - indicates if the motor is currently stepping or not
- DIRECTION - distinguishes if the motor is going in a decremental (left) direction or an incremental (right) direction
- SLEW - indicates if the motor is currently in a slew rate

This function has the following parameter:

- **channel (uint8_t)**: This is the SM master channel number. This parameter must be assigned the same value as was assigned to the channel parameter in the initialization routine. If there are more SMs running simultaneously on the eTPU(s), the channel parameter distinguishes which SM function is accessed.

The **flags** are returned as an int8_t.

The following examples show how the returned flags value can be used for program control. The flag masks and flag values defined in `etpu_sm.h` are used:


```

if ((flags & FS_ETPU_SM_STEPPING) == FS_ETPU_SM_STEPPING_ON) {...}
if ((flags & FS_ETPU_SM_STEPPING) == FS_ETPU_SM_STEPPING_OF) {...}

if ((flags & FS_ETPU_SM_DIRECTION) == FS_ETPU_SM_DIRECTION_DEC) {...}
if ((flags & FS_ETPU_SM_DIRECTION) == FS_ETPU_SM_DIRECTION_INC) {...}

if ((flags & FS_ETPU_SM_SLEW) == FS_ETPU_SM_SLEW_ON) {...}
if ((flags & FS_ETPU_SM_SLEW) == FS_ETPU_SM_SLEW_OFF) {...}

```

5 TPU-Compatible C Level API

The TPU-compatible API provides backward-compatibility from eTPU to TPU. The following functions allow control of the eTPU SM function using the TPU TSM API function calls:

- Initialization Function:

```

void tpu_tsm_init( struct TPU3_tag *tpu,
                  UINT8 channel,
                  UINT8 priority,
                  INT16 start_position,
                  UINT16 table_size_index,
                  UINT16 slew_period,
                  UINT16 start_period,
                  UINT16 pin_sequence,
                  UINT8 number_channels,
                  UINT16 *table,
                  UINT8 table_size)

```

- Change Operation Functions:

```

void tpu_tsm_mov(struct TPU3_tag *tpu, UINT8 channel, UINT16 position)

```

- Value Return Functions:

```

UINT16 tpu_tsm_rd_dp(struct TPU3_tag *tpu, UINT8 channel);

```

```

UINT16 tpu_tsm_rd_cp(struct TPU3_tag *tpu, UINT8 channel);

```

5.1 Initialization Function

5.1.1 void tpu_tsm_init

This routine will initialize the channels of the eTPU for the SM function, in the same way as for the TPU TSM function. This function has the following parameters:

- *tpu—Not used.
- channel—The channel number of the SM master channel.
- priority—The priority level which is assigned to all channels used for this SM function. This parameter should be assigned a value of: `FS_ETPU_PRIORITY_HIGH`, `FS_ETPU_PRIORITY_MIDDLE`, or `FS_ETPU_PRIORITY_LOW`.

- `start_position`—A 16-bit integer which establishes the initial value for both the desired position and the current position. This is efficient, since both values need to be set to the same value when the SM function is initialized.
- `table_size_index`—Combines the table size and the table index values into a single 16-bit input. The first 8 bits, the table size, is the number of steps defined in the acceleration table. The table index is set in the last 8 bits of this parameter and must be set to the value of zero.
- `slew_period`—Combines the slew period with the 1-bit "S" value. The slew period value must be shifted left by 1 bit, after encoding into a hex value. For example, an original value of \$2000 will be encoded as \$4000. The least significant bit is an "S" bit and must always be written as zero (and only at initialization).
- `start_period`—Combines the start period with the 1-bit "A" value. The start period value must be shifted left by 1 bit after encoding into a hex value. For example, an original value of \$6800 will be encoded as \$D000. The least significant bit is an "A" bit. A value of 0 will initialize a two-channel TSM function, and a value of 1 will initialize a four-channel function. This value must not be changed after initialization.
- `pin_sequence`—Determines the step patterns that are output on two or four TPU pins. Two channel and four channel example values are \$3333, and \$E0E0 respectively.
- `number_channels`—Used with the master channel designation to determine which channels will be the parameter table channels for the TSM function. Either a two- or four-channel designation is valid. The master channel is included in this number.
- `*table`—The pointer to the acceleration table.
- `table_size`—Not used.

5.2 Change Operation Functions

5.2.1 `void tpu_tsm_mov(struct TPU3_tag *tpu, UINT8 channel, UINT16 position)`

This function will designate where to move the stepper motor. This is accomplished by the following input parameters:

- `*tpu`—Not used.
- `channel`—The channel number of the SM master channel.
- `position`—The value of the new desired position.

5.3 Value Return Functions

5.3.1 UINT16 tpu_tsm_rd_dp(struct TPU3_tag *tpu, UINT8 channel)

This routine will read the value of the desired position, which is used for program control when compared against some other value.

- *tpu—Not used.
- channel—The channel number of the SM master channel.

The value of the desired position is returned as an UINT16 function.

5.3.2 UINT16 tpu_tsm_rd_cp(struct TPU3_tag *tpu, UINT8 channel)

This routine will read the value of the current position, which is used for program control when compared against some other value.

- *tpu—Not used.
- channel—The channel number of the SM master channel.

The value of the current position is returned as an UINT16 function.

6 Example Use of Function

6.1 Demo Application

This section describes an example application, which is created using Metrowerks CodeWarrior 4.0 and runs on MCF523x Evaluation Board (MCF523xEVB). Even if no stepper motor is connected, the stepping pattern is clearly visible on six LEDs that are connected to eTPU channels 8 to 13.

Example Use of Function

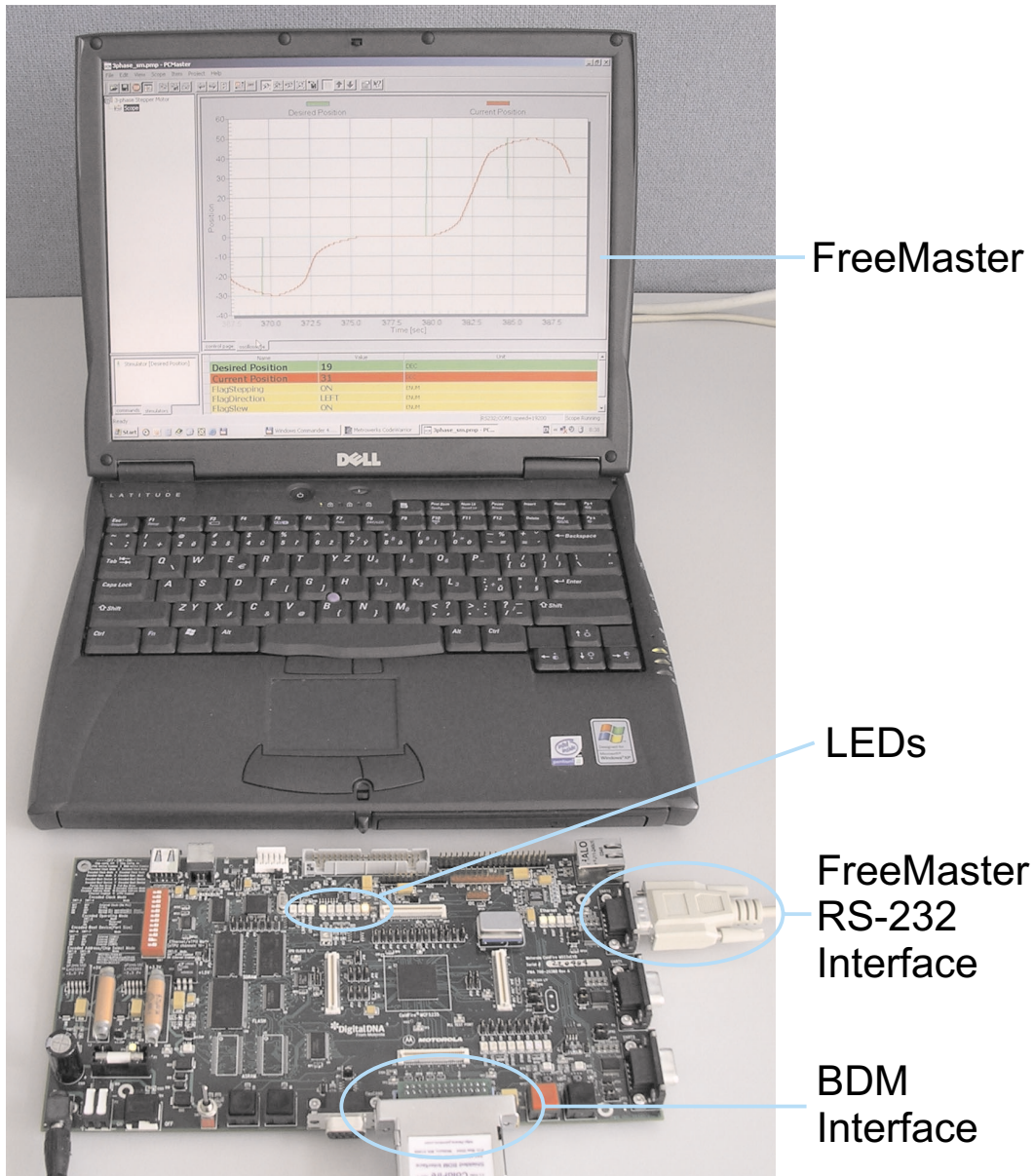


Figure 10. . SM demo application on MCF523xEVB.

The application demonstrates how to initialize the eTPU module and assign the SM function to eTPU channels. After initialization, an application state machine is started. Within the state machine, the SM function is enabled and disabled based on ON/OFF switch moves. When the application is in APP_STATE_ON the SM function can be commanded to move to a desired position.

The application state machine consists of the following states and is illustrated in Figure 11:

- **APP_STATE_OFF**—SM eTPU channels are disabled. If the ON/OFF switch is moved to the ON position, go to the APP_STATE_ENABLE.
- **APP_STATE_ENABLE**—Enable the SM eTPU channels and go to APP_STATE_ON.

- **APP_STATE_ON**—The SM eTPU channels are enabled. The SM function can be commanded to move to a given position. If the ON/OFF switch is moved to the OFF position, go to the APP_STATE_DISABLE.
- **APP_STATE_DISABLE**—Disable the SM eTPU channels and go to APP_STATE_OFF.
- **APP_STATE_FAULT**—Disable the SM eTPU channels. If the ON/OFF switch is moved to the OFF position, go to APP_STATE_OFF.
This state is entered if the ON/OFF switch is in the ON position at the time when the application is started.

Out of the application state machine, the current position and the SM flags are read.

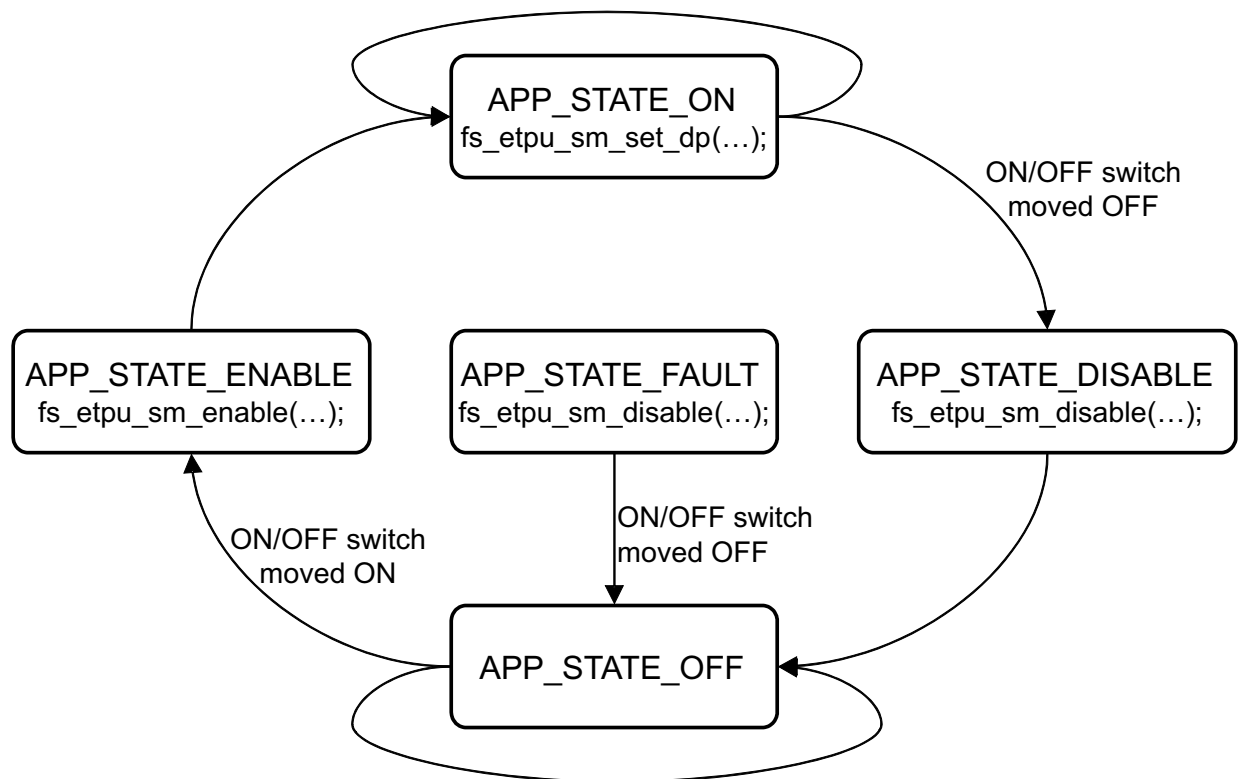


Figure 11. . Demo application state machine.

The user interface is made using the ON/OFF switch on MCF523xEVB and FreeMaster application on PC. FreeMaster communicates with the MCF523xEVB through the RS-232 serial line. FreeMaster enables to set the desired position and displays the current position and SM flags. Moreover, FreeMaster depicts the desired and the current positions in a time chart.

Example Use of Function

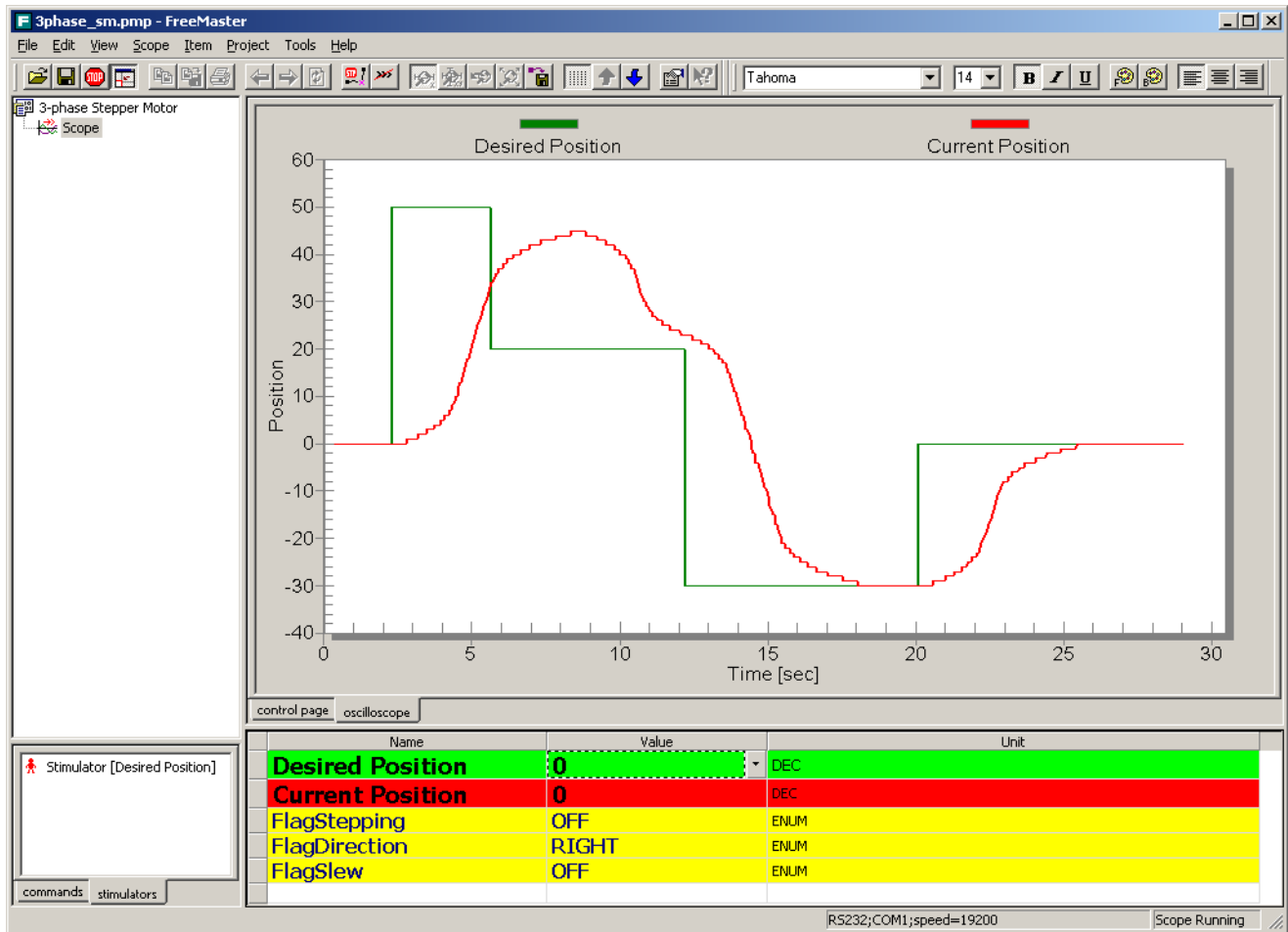


Figure 12. . FreeMaster application window.

For download and more information about FreeMaster visit <http://www.freescale.com>.

6.2 Application Code

The demo application consists of the following files and folders:

- 3phase_sm.mcp—The Metrowerks project file.
- 3phase_sm.pmp—The FreeMaster project file.
- src—This folder contains the application source code:
 - etpu - This folder contains the eTPU files.
 - etpu_set1.h - This file contains the standard eTPU function set (set1) code image.
 - etpu_sm.c/.h - These files contains the SM API functions.
 - etpu_sm_auto.h - This file was automatically generated by the eTPU code compiler.
 - 3phase_sm_etpu_gct.c/.h - These files contain initialization of eTPU for this

application. They were originally generated by the eTPU Graphical Configuration Tool.

- `etpu_util.c/.h` - These files contain useful macros and prototypes for using the eTPU.
- `typedefs.h` - This file contains type definitions.
- `pcmaster` - This folder contains FreeMaster routines for MCF523x.
- `init` - This folder contains MCF523x header files, etc.
- `main.c/.h` - This is the main application file and its header file.
- `vectors.s` - This file contains the vector table.
- `int_handlers.c` - This file contains the general interrupt handlers.
- `pcmaster` - This folder contains FreeMaster HTML page source.
- `lcf` - This folder contains the Metrowerks linker command files, MCF523xEVB configuration, etc.

The eTPU initialization consists of two function calls. First, the `my_system_etpu_init()` function is called, and second, after initialization of all other peripherals, the eTPU is started by `my_system_etpu_start()`. Both `my_system_etpu_init()` and `my_system_etpu_start()` functions are generated by eTPU Graphical Configuration Tool and are included in `3phase_sm_etpu_gct.c` file. Graphical Configuration Tool can be downloaded from <http://www.freescale.com>.

6.2.1 Function Calls

```
fs_etpu_sm_init(
    /* channel          */ SM0_A_MASTER,
    /* configuration    */ FS_ETPU_SM_3PHASE_HALF_STEP,
    /* start_position   */ 0,
    /* start_period     */ etpu_a_tcr1_freq/StartFrequency,
    /* start_period     */ etpu_a_tcr1_freq/StartFrequency,
    /* slew_period      */ etpu_a_tcr1_freq/SlewFrequency,
    /* p_accel_tbl      */ accel_tbl,
    /* accel_tbl_size   */ SM_ACCEL_TABLE_SIZE
);
```

```
fs_etpu_sm_enable(
    /* channel          */ SM0_A_MASTER,
    /* priority         */ FS_ETPU_PRIORITY_MIDDLE,
    /* configuration    */ FS_ETPU_SM_3PHASE_HALF_STEP
```

Summary and Conclusions

```
);

fs_etpu_sm_disable(
    /* channel          */ /* SM0_A_MASTER,
    /* configuration    */ /* FS_ETPU_SM_3PHASE_HALF_STEP
    /* polarity         */ /* FS_ETPU_SM_ACTIVE_HIGH
);

fs_etpu_sm_set_dp(
    /* channel          */ /* SM0_A_MASTER,
    /* desired_position */ /* DesiredPosition
);

CurrentPosition = fs_etpu_sm_get_cp(
    /* channel          */ /* SM0_A_MASTER,
);

Flags = fs_etpu_sm_get_flags(
    /* channel          */ /* SM0_A_MASTER,
);
```

7 Summary and Conclusions

This application note provides the user with a description of the stepper motor (SM) eTPU function usage and examples. The simple C interface routines to the SM eTPU function enable easy implementation of the SM in applications. The demo application is targeted at the MCF523x family of devices, but it could be easily reused with any device that has an eTPU.

References:

1. MCF5235 Reference Manual, MCF5235RM/D
2. M523xEVB User's Manual, M5235EVBUM/D
3. FreeMaster web page, <http://www.freescale.com>, search keyword "FreeMaster"
4. Enhanced Time Processing Unit Reference Manual, ETPURM/D
5. eTPU Graphical Configuration Tool, <http://www.freescale.com>, search keyword "ETPUGCT"

8 Revision History

Table 1 provides a revision history of this document.

Table 1. Revision History

Rev Number	Date of Release	Substantive Changes
0.1	04/2006	In section 3.2, changed 304.700 and 178.500 steps to 304,700 and 178,500 steps.
0	10/2004	Initial customer-release version.

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Freescale Semiconductor
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Schatzbogen 7
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+44 1296 380 456 (English)
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support@freescale.com

Japan:

Freescale Semiconductor Japan Ltd.
Technical Information Center
3-20-1, Minami-Azabu, Minato-ku
Tokyo 106-0047, Japan
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