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Subject: **Using PWM Output Control**

Application Note

Applications:

PWM outputs are required for laser control applications. This application note defines the functions available:

- Programmable Mark/Space PWM outputs.
- Optional linking of PWM outputs to velocity profile speed of an interpolating axis group.
- Optional gating of the PWM signal from a series of encoder or stepper pulse positions. This is designed for laser engraving applications.

Controllers:

The PWM output functions are currently available on the EURO205X *Motion Coordinator* only. A special FPGA program is required for PWM operation. This FPGA program has to be fitted at the factory by Trio. The current implementation works with stepper axes 2 and 3 of the EURO205X. Software Version 1.6457 or higher is also required.

Axis Combinations:

- The PWM signal can be provided as an additional output on a stepper axis using the third differential output. This would use the "enable" output of the set of three (step/dir/enable). The axis gating functions are linked to the step/direction position of the axis. (ATYPE=35)
- The PWM signal can be provided as an additional output on a servo axis using the "Z" channel. The axis gating functions are linked to the encoder position of the axis.

Functions:

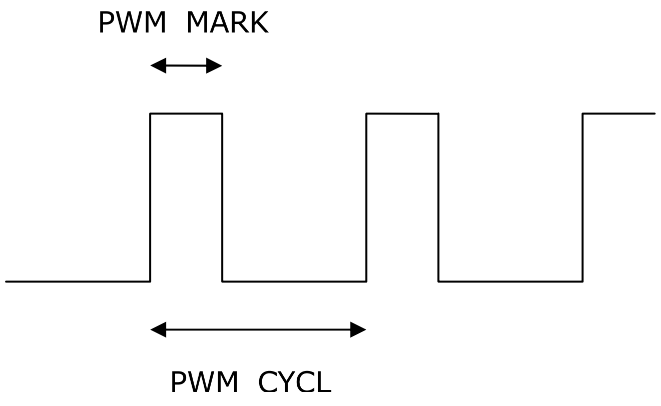
- The PWM output mark/space can be written to via software in a simple way
- The PWM signal can be gated by a sequence of axis positions
- The PWM mark size can be automatically set via the interpolated path speed
- The PWM signal is automatically set OFF when the axis enable WDOG is OFF

PWM generation:

The 20 Mhz clock is used as the base clock for the PWM generation.

PWM_CYCLE Axis parameter defines number of clocks in the combined mark+space period (Maximum value 65535)
PWM_MARK Axis parameter defines the number of ON clocks in the mark (Maximum value 65535)

For example: If PWM_CYCLE=1000 PWM will be generated at 20Khz frequency
If PWM_CYCLE=200 PWM will be generated at 100kHz frequency (but with lower resolution)



PWM Gating and Speed Linking:

The PWM signal can be controlled and optionally gated with a series of positions. A dedicated 29 bit encoder hardware register is used for the position of the axis. This register can be read using the keyword PWM_ENCODER. When the axis moves the PWM_ENCODER register will change with the MPOS register. The PWM_ENCODER register is independent of the position register. It can be reset separately and is not changed by the DEFPOS and OFFPOS commands.

PWM_CONTROL(0)

The PWM output is switched OFF using this axis function.

PWM_CONTROL(1)

PWM output is switched on. The PWM_MARK value comes from the PWM_MARK axis parameter.

PWM_CONTROL(2, multiplier,offset,limit value,link axis)

PWM output is calculated via VP_SPEED (path velocity of an axis) of an axis and multiplier and will be adjusted on each servo cycle. The value loaded into the PWM_MARK is given by VP_SPEED*multiplier/100000 + offset. If the calculated value exceeds the "limit value" the limit value is applied. The VP_SPEED value is the velocity profile speed for the link axis.

PWM_CONTROL(3, GT/LT, ON/OFF, table start, table end)

This axis function loads a sequence of positions into the gating FIFO. The GT/LT value should be set to 1 for a GT comparison, 0 for a LT comparison. The ON/OFF bit is toggled as the positions are loaded automatically by the function. The FIFO is up to 256 positions deep, and can be loaded with one or more PWM_CONTROL(3,… functions. Longer sequences of positions can be loaded as the position buffer becomes available.

PWM_CONTROL(4)

The FIFO can be emptied using the PWM_CONTROL(4) function.

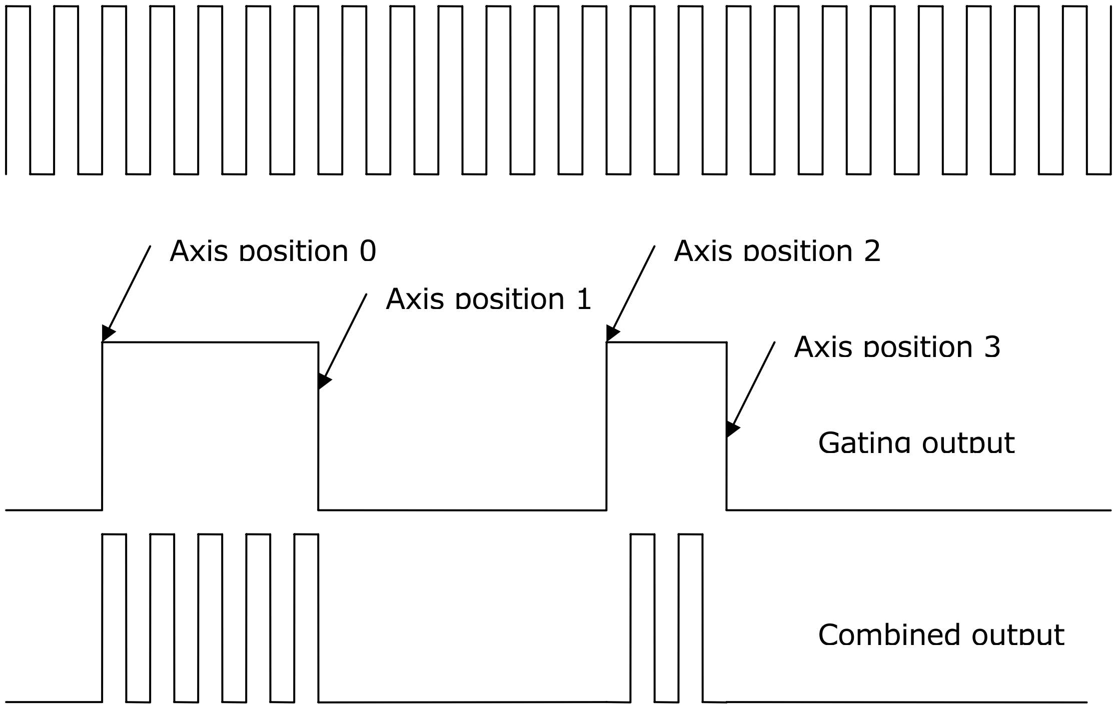
PWM_CONTROL(5)

The FIFO gating is switched on using the PWM_CONTROL(5) function.

PWM_CONTROL(6)

The PWM_ENCODER register can be cleared to zero using the PWM_CONTROL(6) function.

The PWM_CONTROL function is an axis function and can be directed to an axis using the AXIS() modifier or the BASE() function.



Axis Gating Example:

```
WDOG=OFF
BASE(3) ' only axes 2 and 3 have this feature
PWM_CONTROL(0)
ATYPE=35 ' atype for stepper output with PWM
SERVO=ON ' required to allow stepper pulses to generate "encoder" pulses
FE_LIMIT=500000000 ' dpos and mpos may not match
PWM_CYCLE=1000 ' 20Khz PWM output
PWM_MARK=0 ' switch off for now
UNITS=16 '
PWM_CONTROL(1)
DEFPOS(0)
PWM_CONTROL(6)
TABLE(1000,110,115,195,220)
TABLE(2000,220,195,115,110)
PWM_CONTROL(4)
PWM_CONTROL(5)' switch on gating function
PWM_MARK=400
WDOG=ON

REPEAT
    PWM_CONTROL(3,1,ON,1000,1003)' load positions to gate
    MOVEABS(300)
    WAIT IDLE
    PWM_CONTROL(3,0,ON,2000,2003)' same pattern in reverse
    MOVEABS(0)
    WAIT IDLE
UNTIL FALSE
```

The axis switch positions should be a sequence of axis positions.

For example, suppose the axis starts at position 100 and the laser should be switch ON at position 110 and OFF at 115, then ON at 195 and OFF at 220:

The positions are put into TABLE memory at locations 1000 to 1003:

```
TABLE(1000,110,115,195,220)
```

```
PWM_CONTROL(3,1,ON,1000,1003)
```

This command loads the 4 positions into the gating hardware and sets the comparison logic to GT. As the axis moves past the positions the gating output is toggled ON then OFF.

Note:

After changing the ATYPE to 35 the PWM_ENCODER register will often have a value. It can be cleared to zero using the PWM_CONTROL(6) function.

If the PWM_MARK value equals or exceeds PWM_CYCLE, the output will be continuously on.