Differences between PCL-240MK and PCL-240MS

1. General

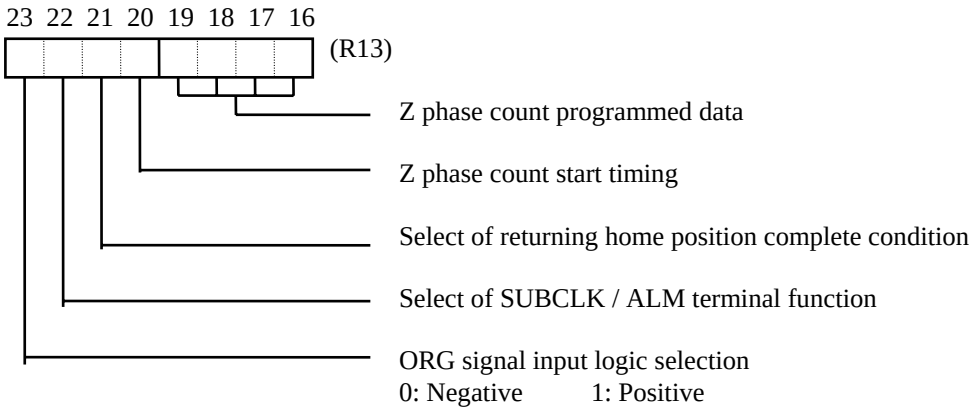
PCL-240MS, which replaces PCL-240MK, can offer S curve acceleration/deceleration control. There are no board or software changes required for S curve acceleration/deceleration.
Here are lists of changes and additions between the two chips.

1. R4 register (acceleration rate register) bit length is expanded from 14 to 16
2. R5 register (deceleration rate register) bit length is expanded from 14 to 16
3. R6 register (slow down point register) bit length is expanded from 20 to 24
4. Bit 23 of R13 register is added
5. R14 resister (accelerate S curve duration setting register) is added
6. R15 resister (decelerate S curve duration setting register) is added
7. Bit 20 ~ 16 of R17 register are added

2. Detailed information

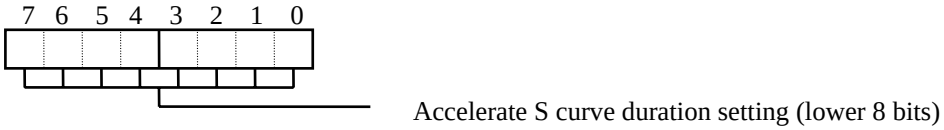
2-1. Bit 23 of R13 register

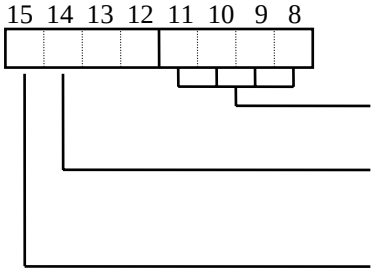
Bit 23 on PCL-240MK is fixed as “0”. However, this bit can be valid on PCL-240MS for selecting ORG signal input logic. Bit 23 = “0” (default value) is Negative and “1” is Positive.



2-2. R14 register

R14 is a 16 bit register. Its function is separated into Upper 4 bits and Lower 12 bits. The default value is 0000H.





Accelerate S curve duration setting (upper 4 bits)

Acceleration/Deceleration characteristics
0: S curve acceleration/deceleration
1: Liner acceleration/deceleration

FH corrective function
0: ON 1: OFF

Accelerate S curve duration setting (12 bits)

S curve duration of acceleration is set by step of speed (same unit of R1, R2, & R3).
Please refer to “3 Speed pattern setting”.

Acceleration/Deceleration characteristics

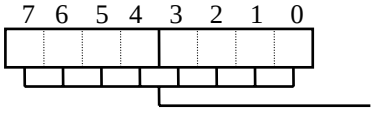
Acceleration/Deceleration characteristics are selected. If the liner acceleration/deceleration is selected, the acceleration/deceleration time is same as that of S curve with no intermediate liner duration.

FH corrective function

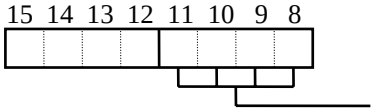
At pre-set (programmable) operation with acceleration/deceleration, PCL automatically makes FH speed lower to avoid a triangle motion profile if there does not have enough pulses. (No parameter of R2 and R3 register is changed)
If the triangle motion profile is OK, select “1” for bit 15. It makes that the corrective function is OFF.
Please refer to “3 Speed pattern setting”.

2-3. R15 register

R15 is a 12 bit register and its default value is 0000H.



Decelerate S curve duration setting (lower 8 bits)



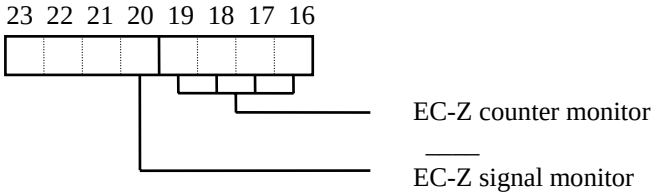
Decelerate S curve duration setting (upper 4 bits)

Decelerate S curve duration setting (12 bits)

S curve duration of deceleration is set by step of speed (same unit of R1, R2, & R3).
Please refer to “3 Speed pattern setting”.

2-4. Bit 20~ 16 of R17 register

EZ signal and EZ counter can be monitored.



EC-Z counter monitor

EC-Z counter value used for returning a home position can be monitored.
At normal operation, the counting value is set by bit 19 ~ 16 of R13. During the returning home position operation, PCL counts down by receiving every EC-Z signal, once the selected count timing at bit 20 of R13 is executed. It will count down until the counting value = 0 and then EC-Z signal is inputted. Afterward, the counting value automatically is back to whatever set by bit 19 ~ 16 of R13.

EC-Z signal monitor

According to a logic selection by bit 12 of R12, $\overline{\text{EC-Z}}$ signal can be read as ON/OFF

3. Pulse output pattern setting

There are 2 acceleration/deceleration modes available.

S curve Acceleration/Deceleration Mode **with no** intermediate linear acceleration/deceleration

Either R14 or R15 parameters are “0” or a value is higher than “([R2 or R3] parameter - R1 parameter) ÷ 2”, this chip accelerates and decelerates the pulse output while constantly varying the rate.

S curve Acceleration/Deceleration Mode **with** intermediate linear acceleration/deceleration

Either R14 or R15 parameters are not “0” or a value is lower than “([R2 or R3] parameter - R1 parameter) ÷ 2”, this chip performs S curve acceleration and deceleration with intermediate linear acceleration/deceleration.

([R2 or R3]) means that either one is selected by Start Command.

Pulse output pattern setting is controlled by R1~R7, R14, and R15 registers.
If the moving amount (pulses) is small in the pre-set (programmable) operation mode, “FH corrective function” - the maximum rate is automatically lowered and smooth acceleration/deceleration is made - is available. In such case, the lower the moving amount, the shorter the linear acceleration/deceleration duration becomes and the S curve duration is not decreased unless the linear duration is reduced to “0”.
(The smaller moving amount makes the linear acceleration/deceleration duration disappeared although mode is selected). FH corrective function can be set as invalid if it were requested.

Differences between PCL-240MK and PCL-240MS

Output pulse pattern with Acceleration/Deceleration
FH corrective function

Automatic correction of max rate based on moving amount

3-1. R14 Accelerate S curve duration setting register (12 bits)

Write the S curve acceleration duration for S curve varied-speed operation in this register. The setting range is 1 ~ 4,095 (FFFH). S curve acceleration is applied between the FL pulse rate and the rate written in R14 register and between the FH pulse rate (the rate written in R14 register) and the operating FH rate, while linear acceleration is applied to the intermediate duration.
If "0 (default)" is written in this register, a value of "([R2 or R3] parameter - R1 parameter) ÷ 2" is used for S curve acceleration and no linear acceleration is applied. To accommodate an intermediate linear acceleration, write a value in a range of 1 ~ lower than "[R2 or R3] parameter - R1 parameter) ÷ 2" in this register.
Relations between the R14 parameter and S curve accelerating rate S [pps] are as follows:

R14 parameter = S[pps] / Multiplication factor

Setting example: If 1,000 is written in the R14 under the following conditions, the S curve acceleration rate becomes 10,000 (= S). Thus, S curve acceleration is applied between 100 [pps] ~ 10,100 [pps] and between 40,000 [pps] ~ 50,000 [pps].
Conditions
Multiplication factor is x 10
FL pulse rate of 100 pps (R1 =10)
FH pulse rate 50,000 pps (R2 = 5000)

3-2. R15 Decelerate S curve duration setting register (12 bits)

Write the decelerate S curve duration for S curve varied-speed operation in this register. The setting range is 1 ~ 4,095 (FFFH). S curve deceleration is applied between the FH pulse rate to (the FH pulse rate - the rate written in R15 register) and between the rates written in R15 register to the operating FL rate, while linear deceleration is applied to the intermediate duration.
If "0 (default)" is written in this register, a value of "([R2 or R3] parameter - R1 parameter) ÷ 2" is automatically used for S curve deceleration and no linear deceleration is applied. To accommodate an intermediate linear deceleration, write a value in a range of 1~ lower than "([R2 or R3] parameter - R1 parameter) ÷ 2" in this register.
Relations between the R15 parameter and S curve decelerating rate S [pps] are as follows:

R15 parameter = S[pps] / Multiplication factor

Setting example: If 1,000 is written in the R15 under the following conditions, the S curve deceleration rate becomes 20,000 (= S). Thus, S curve deceleration is applied between 500 [pps] ~ 20,500 [pps] and between 80,000 [pps] ~ 1000,000 [pps].
Conditions
Multiplication factor is x 20
FL pulse rate of 500 pps (R1 =25)
FH pulse rate 100,000 pps (R2 = 5000)

3-3. Acceleration/Deceleration time

Acceleration/Deceleration time is determined by parameters written in registers R1, R2, R3, R4, R5, R14, & R15.
Here are equations. (Note - we herein use R2 for FH pulse rate but R3 can be used for FH pulse rate as well)
In case an automatic ramp-down point function is ON, the R4 register is picked instead of R5 for deceleration. Please use R4 on the equations to obtain the deceleration time.

S curve acceleration/deceleration mode with no intermediate linear acceleration/deceleration

Acceleration time Tsu [sec] = [(R2 - R1) x R4] / reference clock [Hz]
Deceleration time Tsd [sec] = [(R2 - R1) x R5] / reference clock [Hz]

S curve acceleration/deceleration mode with intermediate linear acceleration/deceleration

Acceleration time Tsu [sec] = [(R2 - R1 + R14 x 2) x R4] / (reference clock [Hz] x 2)
Deceleration time Tsd [sec] = [(R2 - R1 + R15 x 2) x R5] / (reference clock [Hz] x 2)

3-4. R6 Ramping down point setting register (24 bits)

The ramping down point is used for the varied-speed operation in the preset mode. Write the ramping down point in this register in a range from 0 ~ 16,777,215 (FFFFFFH).
This chip has an automatic ramp-down point setting function which can be ON and OFF by setting bit 4 of the Control mode command.
When it is ON, the R6 parameter is offset from the automatic setting value. If its value is a positive, the ramping down starts earlier and if its value is a negative, it starts slower. Since R6 parameter is automatically reset by the Reset command, a parameter setting should be done after writing the reset command. Its setting range is from - 8,388,608 (800000H) ~ + 8,388,607 (7FFFFFH).
When the automatic ramp-down point function is OFF, R6 parameter becomes the ramping down point.
A condition that the automatic ramp-down point function works properly is as follows:

(Time [Tsdb] from FL speed to the start of acceleration ~ the start of deceleration) ≥ (Deceleration time [Tsd])

Typically, there is (R14 parameter) ≥ (R15 parameter).
Please refer to “3 Speed pattern setting”.

Here are procedures to obtain R6 parameter in case the automatic ramp-down point function is OFF.
(Note - we herein use R2 for FH pulse rate but R3 can be used for FH pulse rate as well)
Automatic FH corrective function becomes OFF when automatic ramp-down point function is OFF.

3-4.1. S curve acceleration/deceleration with no intermediate linear acceleration/deceleration

Confirmation of trapezoidal profile

If the moving amount is too small, acceleration is not available to the FH pulse rate determined by R2, therefore, it results a triangle profile. It is confirmed by the following equation.

(Minimum number of pulses required for trapezoidal profile)
= $[(R2^2 - R1^2) \times (R4 + R5)] / (R7 \times 16384)$

Revision of R2 parameter

If (R0) ≤ (Minimum number of pulses required for trapezoidal profile), the profile would be a triangle. Please revise R2 by using the following equation.

Revised R2 ≤ $\sqrt{(R0 \times R7 \times 16834) / (R4 + R5) + R1^2}$

Write R6 (ramp down point) parameter

$R6 = [(R2^2 - R1^2) \times R5] / (R7 \times 16384)$

3-4.2. S curve acceleration/deceleration with intermediate linear acceleration/deceleration

Confirmation of trapezoidal profile

If the moving amount is too small, acceleration is not available to the FH pulse rate determined by R2, therefore, it results a triangle profile. It is confirmed by the following equation.
(Minimum number of pulses required for trapezoidal profile)
= $\{(R1 + R2) \times [(R2 - R1) \times (R4 + R5) + 2 \times (R4 \times R14 + R5 \times R15)]\} / (R7 \times 32768)$

Confirmation of intermediate linear acceleration/deceleration existence

If (R0) ≤ (Minimum number of pulses required for trapezoidal profile), check whether there is the intermediate linear acceleration/deceleration.

[In case, R14 = R15]

(Minimum number of pulses required for the intermediate linear duration)
= $[(R1 + R14) \times R14 \times (R4 + R5)] / (R7 \times 4096)$

[In case, R14 > R15]

(Minimum number of pulses required for the intermediate linear duration)
= $\{(R1 + R14) \times [R5 \times (R14 + R15) + 2 \times R4 \times R14]\} / (R7 \times 8192)$

[In case, R14<R15]

(Minimum number of pulses required for the intermediate linear duration)
= $\{(R1 + R15) \times [R4 \times (R14 + R15) + 2 \times R5 \times R15]\} / (R7 \times 8192)$

Revision of R2 parameter

If (Minimum number of pulses required for the intermediate linear duration) < (R0) ≤ (Minimum number of pulses required for trapezoidal profile), please revise R2 by using the following equation to avoid a triangle profile.

[In case, R14 = R15]

Revised R2 $\leq$ - R14 + $\sqrt{}$ (R14 - R1) ^{2} - (R0 x R7 x 32768) / (R4 + R5)

[In case, R14 $\neq$ R15]

Revised R2 $\leq$ [- A + $\sqrt{}$ (A - B x R1) ^{2} + (B x R0 x R7 x 32768)] / B

Where A = R4 x R14 + R5 x R15
B = R4 + R5

Write R6 (ramp down point) parameter

R6 = [(R1 + R2) x (R2 - R1 + R15 x 2) x R5] / (R7 x 32768)

3-5. Changing output pulse pattern during operation

Speed rate and acceleration rate can be changed by revising parameters written in registers R2, R3, R4, R5, R14, & R15 during operation.
However, do not revise parameters of R1, R4, R5, R14, and R15 under the pre-set mode and the automatic ramp-down point setting function is ON (Control mode Command bit 4 = 1). The automatic ramp-down point function is disabled to follow.