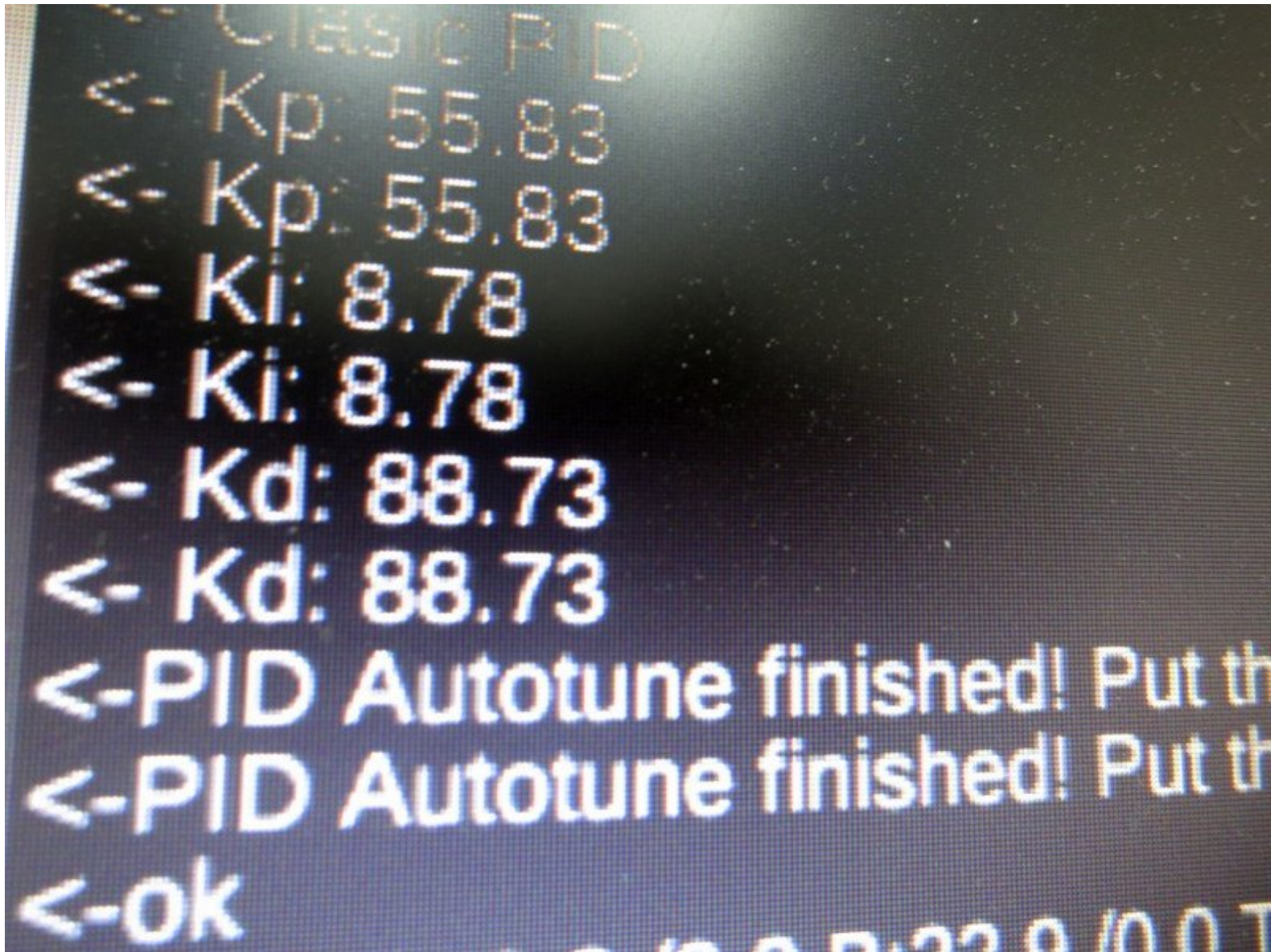


MatterHackers

PID Tuning

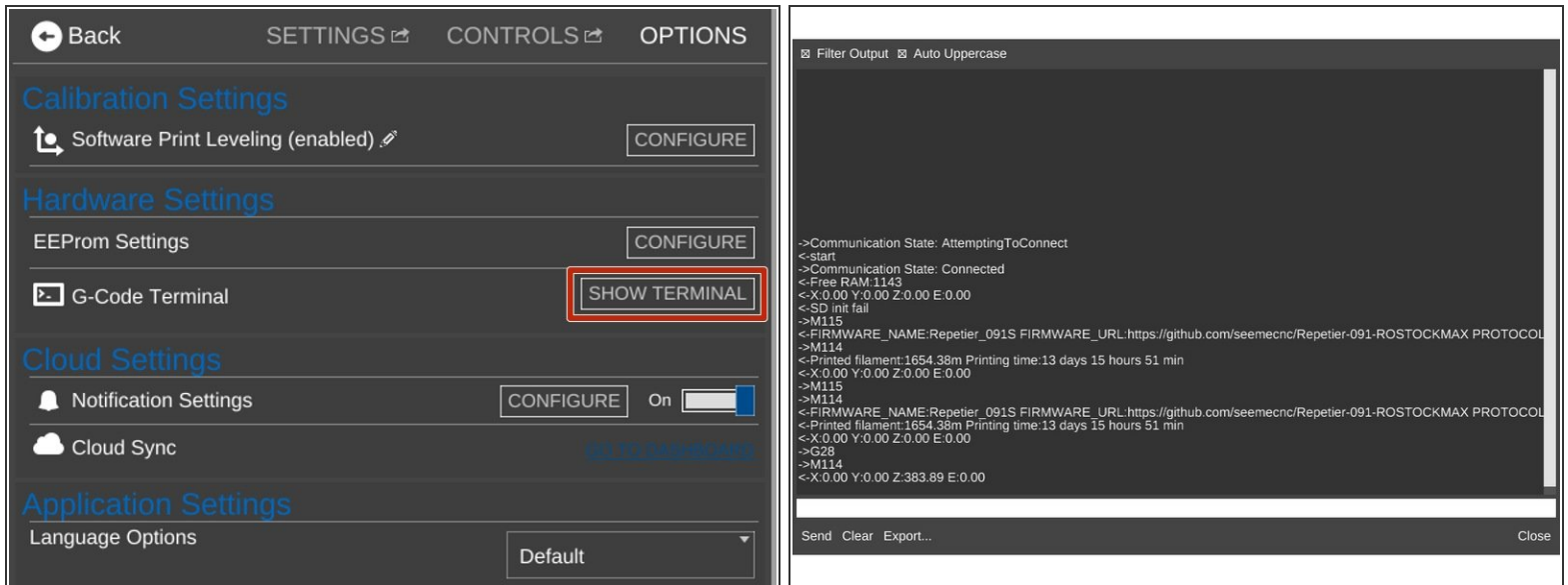
Written By: Tyler Anderson



INTRODUCTION

PID ([Proportional Integral Derivative](#)) is the control algorithm the printers use for holding temperature. The parameters for this algorithm control how fast the printer reaches the set temperature and how well it holds that temperature once it gets there. Fortunately, the printer has an automatic way of tuning these values.

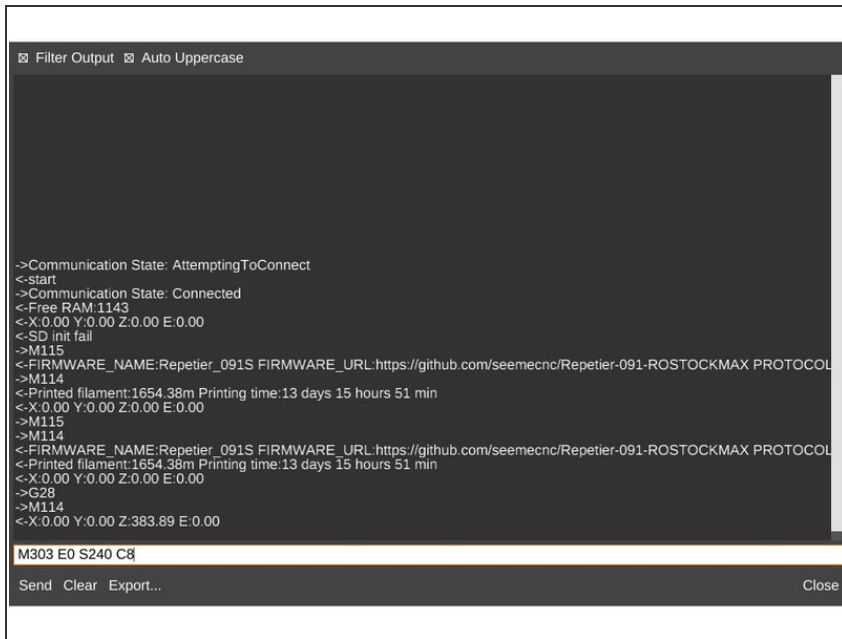
Step 1 — Open G-Code Terminal



The image shows two side-by-side screenshots from the MatterControl software. The left screenshot displays the 'SETTINGS' menu with a red box highlighting the 'SHOW TERMINAL' button under the 'G-Code Terminal' section. The right screenshot shows the G-Code terminal interface with a dark background and white text. The terminal output includes status messages such as '>-Communication State: AttemptingToConnect', '<-start', '<-Communication State: Connected', and '<-Free RAM:1143'. It also shows coordinates like '<-X:0.00 Y:0.00 Z:0.00 E:0.00' and '<-SD init fail'. The terminal interface includes a 'Filter Output' checkbox, an 'Auto Uppercase' checkbox, and buttons for 'Send', 'Clear', 'Export...', and 'Close'.

- Open the [G-Code Terminal](#) in MatterControl.

Step 2 — Run Auto-tuning



```

Filter Output Auto Uppercase

->Communication State: AttemptingToConnect
<-start
->Communication State: Connected
<-Free RAM:1143
<-X:0.00 Y:0.00 Z:0.00 E:0.00
<-SD init fail
->M115
<-FIRMWARE_NAME:Repetier_091S FIRMWARE_URL:https://github.com/seemecnc/Repetier-091-ROSTOCKMAX_PROTOCOL
->M114
<-Printed filament:1654.38m Printing time:13 days 15 hours 51 min
<-X:0.00 Y:0.00 Z:0.00 E:0.00
->M115
->M114
<-FIRMWARE_NAME:Repetier_091S FIRMWARE_URL:https://github.com/seemecnc/Repetier-091-ROSTOCKMAX_PROTOCOL
<-Printed filament:1654.38m Printing time:13 days 15 hours 51 min
<-X:0.00 Y:0.00 Z:0.00 E:0.00
->G28
->M114
<-X:0.00 Y:0.00 Z:383.89 E:0.00

M303 E0 S240 C8
Send Clear Export... Close

```

- The M303 command runs the PID tuning. It uses the following format:
 - M303 E<extruder>
S<temperature> C<cycles>
 - Example: M303 E0 S240 C3
- The E option is not required on single extruder machines (except Smoothie). To tune the heated bed, use P1 (Repetier), E-1 (Marlin, others), or E1 (Smoothie). On multi-extruder machines, use the number of the extruder you want to tune (starting with 0).
- S is the temperature you want to run the tuning at. This should be close to the temperature you will use for printing.
- C is the number of cycles of tuning to run. We recommend 3.
- Once you run this command the autotuning process will start. The printer will cycle the temperature up and down over the course of several minutes.
- ⓘ You can turn off the Filter Output option in the console to watch the temperatures change.

Step 3 — Set PID Values

```

-<-start
->Communication State: Connected
-<-Free RAM:1143
-<-X:0.00 Y:0.00 Z:0.00 E:0.00
-<-SD init fail
->M115
-<-FIRMWARE_NAME:Repetier_091S FIRMWARE_URL:https://github.com/seemecnc/Repetier-091-ROSTOCKMAX_PROTOCOL
->M114
-<-Printed filament:1654.38m Printing time:13 days 15 hours 51 min
-<-X:0.00 Y:0.00 Z:0.00 E:0.00
->M115
->M114
-<-FIRMWARE_NAME:Repetier_091S FIRMWARE_URL:https://github.com/seemecnc/Repetier-091-ROSTOCKMAX_PROTOCOL
-<-Printed filament:1654.38m Printing time:13 days 15 hours 51 min
-<-X:0.00 Y:0.00 Z:0.00 E:0.00
->G28
->M114
-<-X:0.00 Y:0.00 Z:383.89 E:0.00
->M303 E0 S240 C8
-<-Info:PID Autotune start
-<- bias: 149 d: 105 min: 237.50 max: 241.54
-<- bias: 155 d: 99 min: 237.81 max: 241.92
-<- bias: 152 d: 102 min: 238.75 max: 241.54
-<- Ku: 46.57 Tu: 15.65
-<- Classic PID
-<- Kp: 27.94
-<- Ki: 3.57
-<- Kd: 54.68
-<- bias: 147 d: 107 min: 238.75 max: 241.54
-<- Ku: 48.86 Tu: 15.12
-<- Classic PID
-<- Kp: 29.31
-<- Ki: 3.88
-<- Kd: 55.41
-<- bias: 147 d: 107 min: 238.75 max: 241.54
-<- Ku: 48.86 Tu: 15.13
-<- Classic PID
-<- Kp: 29.31
-<- Ki: 3.88
-<- Kd: 55.42
-<-Info:PID Autotune finished ! Place the Kp, Ki and Kd constants in the Configuration.h or EEPROM
M301 P29.31 I3.88 D55.42

```

Description	Value
Extr.1 acceleration [mm/s ²]	2500
Extr.1 heat manager [0-3]	1
Extr.1 PID drive max	205
Extr.1 PID drive min	60
Extr.1 PID P-gain/dead-time	29.31
Extr.1 PID I-gain	3.88
Extr.1 PID D-gain	55.42
Extr.1 PID max value [0-255]	255
Extr.1 X-offset [steps]	0
Extr.1 Y-offset [steps]	0
Extr.1 temp. stabilize time [s]	3
Extr.1 temp. for retraction when heating [C]	150
Extr.1 distance to retract when heating [mm]	0
Extr.1 extruder cooler speed [0-255]	255

Save To EEPROM Cancel



Each firmware has different requirements for saving PID values. Consult your firmware's documentation to determine the correct method.

- As the tuning runs, the printer will calculate values for Kp, Ki, and Kd. When it is done, take the last three values provided and set these using the M301 command. For this example:
 - M301 P29.31 I3.88 D55.42
 - In the case of multiple extruders, these settings will be applied to all of them.
 - For the bed, use M304 instead.
- ⓘ You can also save the values through the [EEPROM settings](#) in MatterControl.

Step 4 — Save settings to EEPROM

```
->Communication State: Connected
<-Free RAM:1143
<-X:0.00 Y:0.00 Z:0.00 E:0.00
<-SD init fail
->M115
<-FIRMWARE_NAME:Repetier_091S FIRMWARE_URL:https://github.com/seemecnc/Repetier-091-ROSTOCKMAX_PROTOCOL
->M114
<-Printed filament:1654.38m Printing time:13 days 15 hours 51 min
<-X:0.00 Y:0.00 Z:0.00 E:0.00
->M115
->M114
<-FIRMWARE_NAME:Repetier_091S FIRMWARE_URL:https://github.com/seemecnc/Repetier-091-ROSTOCKMAX_PROTOCOL
<-Printed filament:1654.38m Printing time:13 days 15 hours 51 min
<-X:0.00 Y:0.00 Z:0.00 E:0.00
->G28
->M114
<-X:0.00 Y:0.00 Z:383.89 E:0.00
->M303 E0 S240 C8
<-Info:PID Autotune start
<- bias: 149 d: 105 min: 237.50 max: 241.54
<- bias: 155 d: 99 min: 237.81 max: 241.92
<- bias: 152 d: 102 min: 238.75 max: 241.54
<- Ku: 46.57 Tu: 15.65
<- Classic PID
<- Kp: 27.94
<- Ki: 3.57
<- Kd: 54.68
<- bias: 147 d: 107 min: 238.75 max: 241.54
<- Ku: 48.86 Tu: 15.12
<- Classic PID
<- Kp: 29.31
<- Ki: 3.88
<- Kd: 55.41
<- bias: 147 d: 107 min: 238.75 max: 241.54
<- Ku: 48.86 Tu: 15.13
<- Classic PID
<- Kp: 29.31
<- Ki: 3.88
<- Kd: 55.42
<-Info:PID Autotune finished ! Place the Kp, Ki and Kd constants in the Configuration.h or EEPROM
->M301 P29.31 I3.88 D55.42
M500
```

- When you are done, make everything permanent with M500.

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