PIDmareike

Functionality

vastly enhanced PID-Thijs

Control Overview

- It has two input SMA connectors and one Sub D9 input connector. The first SMA connector CONN1 is the setpoint signal input. The second SMA connector CONN2 is the input of the signal that has to be controlled. In case of a current stabilization, the second SMA input can be exchanged with a Sub D9 connector CONN7 by a jumper J9. The Sub D9 connector can be connected to a hall sensor. It gives a voltage supply and receives a current signal from the sensor that is transduced into a voltage on board. The pin configuration is suited for a LEM IT 200-S Ultrastab current transducer.
- The three input connectors are followed by a jumper pair which can be used to optionally invert the signals at the following instrumentation amplifiers. In order to obtain an error signal, the input signals have to be of opposing sign. At the operational amplifier U4, the input signals are summed. Here, a dipswitch S1 should be used to adjust the voltage level of the error signal. The resistors R11 to R15 are connected in parallel (Remember: 1/Rges=1/R1+…1/Rn). In order to choose an order of magnitude for the amplification, only enable one resistor at a time. The amplification factors for the following dipswitch configurations are: (0000)=1M/10k=100, (x000)=50, (0x00)=10, (00×0)=1, (000x)=0.1.
- The next part is the actual PID controller with P-, I- and D-parts connected in parallel.
- The P-part has a fixed amplification factor of 1.
- The I-part has an adjustable amplification factor. It is adjusted by two dipswitches S2 and S3. The amplification at an integrating operational amplifier is given by -1/(R*C). Dipswitch S3 switches capacitors that are connected in parallel. This dipswitch gives the order of magnitude with (0000)=1/1n=10^9
- Additionally, there are up to three TTL input connectors. The first TTL signal is for discharging the capacitor in the integrator part, the second one quickly turns off the controller and the third one, if enabled, gives the setpoint signal to the output.
- As well as the Thijs-PID, there is a optional voltage offset that has to be enabled with a jumper. It can be adjusted with a potentiometer.
- Instead of using potis for the adjustment of the amplification, this controller uses dipswitches for the resistors and capacitors such that the amplification can easily be read out.
- The controller has four monitor outputs for the input signal, the internal error signal, the internal control signal and the output control signal.
- The are two optional filters that can be enabled behind the PID part.
- In the end there is an optional ideal diode that gives only positive control signals as they are needed for AOM drivers.

Choice of operational amplifiers: * the integrator has a OP27 which has a very low input voltage offset.

Detailed Control Options

Connectors

Connector	Purpose	Description
CONN1	SMA signal input	
CONN2	SUB D9 signal input	It is supposed to be connected to a current transducer. The pin configuration fits a LEM IT 200-S Ultrastab.
CONN3	SMA setpoint signal	
CONN4	SMA monitor signal	gives the input signal or the input to the current transduver
CONN5	-	
CONN6	SMA monitor internal error signal	It gives the error signal that is given to the PID controller. The input signal is substracted from the setpoint signal.
CONN7	JAE 5V voltage supply	has to be connected to the front panel's coaxial power connector
CONN8	SMA monitor internal control signal	gives the output of the PID part before any other operation (e.g. filtering) is performed
CONN9	SMA TTL input fast shut down	if signal is high, controller is shut down fast
CONN10	SMA TTL input discharge integral part	if signal is high, short cuts the integral part in order to discharge the integral capacity
CONN11	SMA output signal	output of the controller signal
CONN12	SMA monitor output signal	
CONN13	SMA TTL input pick off setpoint signal	if signal is high, picks off the setpoint signal and gives it to the output signal
CONN14	JAE 5 Pin	
CONN15	XLR power plug	voltage supply

Jumper

Jumper	Purpose	Description	Default Position
J1	ground connection for CONN2 housing	solder pads	open
J2	ground connection for housing	solder pads	open
1J1	sign of the setpoint input at the instrumentation amplifier at 1U1	pins (2×2)	left to right, inverts signal
1J2	sign of the input signal at the instrumentation amplifier at 1U3	pins (2×2)	left to right, inverts signal
1J3	sign of the current transducer signal at the instrumentation amplifier at 1U4	pins (2×2)	open
1J4	chooses input signal either from CONN1 or CONN2	pins (3×1)	middle and right pin (CONN1)
1J5	enables/disables an input offset	pins (2×1)	open
3J1	enables/disables optional low-pass filters	pins (3×1)	left and middle (disabled)
3J2	enables/disables optional high-pass filter	pins (3×1)	left and middle (disabled)
3J3	enables/disables an output offset	pins (2×1)	closed

3J4	enables/disables optional ideal diode	pins (3×1)	left and middle (disabled)
3J5	choose which TTL signal to use to shut down the controller (CONN10 or CONN9)	pins (3×1)	middle and right (CONN9)
4J1	if enabled, sets supply voltage to +12V instead of +15V	4J1 and 4J2 should always be both enabled or disabled	open
4J2	if enabled, sets supply voltage to -12V instead of -15V	solder pads (as is 4J1)	open

Dipswitches

- For all possible settings, see:

1st amp

,

I-part

,

D-part

,

final amp

.

First amplification

- Dipswitch 1S1
- compared to 10k resistor

setting	amplification	resistor
0000	100	1M
x000	50	1M
0x00	10	100k
00×0	1	10k
000x	0.1	1k

Integral amplification

- amplification is calculated by -1/(R*C)
- use Dipswitch 2S2 to adjust the order of magnitude and 2S1 for a fine adjustment of the amplification
- Dipswitch 2S1 resistors

setting	amplification (*10	**5)**	resistor
0000	1	100k	
x000	8.7	13k	
0x00	6	20k	
00×0	4	33k	
000x	2	100k	

- Dipswitch 2S2 capacities

setting	amplification (*10	**6)**	capacity
0000	10000	100p	
x000	1000	1n	
0x00	100	10n	
00×0	10	100n	
000x	1	1u	

Differential amplification

- amplification is calculated by -(R*C)
- use Dipswitch 2S3 to adjust the order of magnitude and 2S4 for a fine adjustment of the amplification
- Dipswitch 2S3 capacities

setting	amplification (*10	**9)**	capacity
0000	1	1n	
x000	1000	1u	
0x00	100	100n	
00×0	10	10n	
000x	2	1n	

* Dipswitch 2S4 resistors

setting	amplification (*10	**9)**	resistor
0000	1	10k	
x000	8	40k	
0x00	6	15k	
00×0	4	6.8k	
000x	2	2.4k	

Final amplification

- the output stage has a fixed amplification of 21 but in front of the output stage is a voltage divider, that can be used to amplify or attenuate the signal
- amplification is calculated by R2/(R1+R2)
- use Dipswitch 3S6 to adjust the order of magnitude and 3S11 for a fine adjustment of the amplification
- Dipswitch 3S6 resistors

setting	amplification	resistor
0000	0.0001	1M
x000	0.1	1k
0x00	0.01	10k
00×0	0.001	100k
000x	0.0002	1M

- Dipswitch 3S11 resistors

- the exact amplification varies with the chosen resistor at dipswitch 3S6
- the total maximum amplification at the output stage is 12.6 (given by 21*0.6 when all resistors are activated and 1k is chosen at 3S6)

setting	amplification (with 1k @3S6)	resistor
0000	0.1	100
x000	0.44	680
0x00	0.33	390
00x0	0.23	200
000x	0.17	100

* in this case, the amplification can be chosen more precisely by combining several resistors

Switches

Date

V2.1: July 2021

Status

In Use

Reproduction Effort: Fix Me!

Developer

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Users

Various Experiments in Group Klempt

Files

- All files can be found in the git project here: https://git.iqo.uni-hannover.de/elektroniq/PIDmareike
- The schematic as PDF
- Fix Me! The

layout

as pdf

Layout

- Abmessungen der Leiterplatte: Fix Me!
- Versorgung: Fix Me!
- Eingang: Fix Me!
- Ausgang: Fix Me!
- Anzeigen: Fix Me!
- Der Bestückungsdruck: start_layout.pdf
- Die Bestückungsliste: start_bom.pdf, start_bom.xls
- Die gezippten Gerberdaten für die Bestellung der Platine
- Die Source des Layouts im pcb-Format liegt auf der Download-Seite des Wiki.

Fix Me!

Casing

Fix Me!

Test Protocol

- Ensure all switches are down, and no jumpers are set
- Ground is measured from pads 1, 2 and 3, and not from the front plate (unless J2 is closed to explicitly ground the front plate)

Voltage supply

- supply voltage: give a supply voltage of +/-18V. Check if the voltage regulators 4U1 and 4U4 receive +/-18V and give +/-15V at pin 2.
- reference voltage: check that 4U2 pin 6 gives +10V and 4U3 pin 6 gives -10V (which it will not do until you fix the following mistakes):
- first possible mistake: 4U2 is probably not connected to an input voltage of +18V. It can be solved by adding a cable
- second possible mistake: 4U2, 4U3 do not have a ground connection, 4U3 is not properly connected to the voltage supply

- check if jumpers 4J1 and 4J2 are set, the supply voltage is set to +/-12V. Do not use these jumpers in the following.

Input signals

- give an triangle input signal at CONN1.
- set 1J4 (middle and right pin) and check if the Monitor signal input at CONN4 gives the (inverted) input signal with the same amplitude (the sign depends on the jumper setting at 1J2)
- check if 1U5 pin 6 gives the inverted monitor input signal.
- set 1S1 pin 3 and test input offset at error signal CONN6: set jumper 1J5 and turn the potentiometer 1R14. The signal should go up and down.
- test first amplification stage: (0000, x000, 0x00, 00×0, 000x) should correspond to amplification factors (100, 50, 10, 1, 0.1).
- the red, green and red LEDs 1D1, 1D3 and 1D2 should alternatingly glow.

PID controller

- enable the P part by setting 2S5 to the up position. The I- and D-part remain disabled with 2S6 and 2S7 down.
- the internal control monitor signal at CONN8 should give the non-inverted signal with the same amplitude
- disable 2S5 and enable the I-part with switch 2S6. Signal either saturates or a sinusoidal signal is arising. Use dipswitch configuration 2S2 (x000), 2S1 (0000) to get an amplification of ca 1.
- press 2S8 to check if the discharging of the integrator works. The signal should vanish for the time the button is pressed.
- disable 2S6 and enable the D-part with switch 2S7. It should give a square-wave signal. Use dipswitch configuration 2S3 (0x00), 2S4 (000x) to get an amplification of ca 1.
- Re-enable the P part fort the following tests

Low-pass filter

- set jumper 3J1 to the middle and right pin so that the low-pass filter is enabled.
- give a triangle signal of about 1kHz. Look at signal of 3U1 and 3U2 at pin 6. The triangle should have rounded edges and a significant phase shift compared to the input signal.
- disable the filter by setting the jumper to the left and middle pin

High-pass filter

- set jumper 3J2 to the left and middle pin (this disables the filter, it is not populated by default).

Ideal diode

- set jumper 3J4 to the middle and right pin so that the ideal diode is enabled.
- measure at 3J4. Only the positive part of the triangle signal should be left.
- disable the ideal diode by setting the jumper to the left and middle pin

Final amplification

- choose at dipswitch 3S6 configuration (0x00) and at 3S11 (x000) to get an amplification of ca 1.
- the output stage has an additional amplification factor of 21.
- check the signal at 3U7 pin 6.

TTL signals

- connect 5V supply and measure at CONN12
- I-part: enable the integrator at switch 2S6 and connect a TTL signal (+3.3-5V pulse) to CONN10
- when the TTL is enabled, the integrator signal should vanish (similar to the discharge button 2S8). Several seconds after the TTL is disabled, the integrator signal should reappear.
- Fast shut down: generate a control output signal with P- I- and/or D-part. Set 3J5 to connect middle and right. Connect a TTL signal to CONN9. When the TTL signal is enabled, the controller output should vanish. Several seconds after disabling the TTL signal, the output should return.
- pickoff setpoint signal: give a setpoint signal (CONN3) that looks different to the control signal (this is usually the case when the integrator is enabled, as it smoothes out edges). Connect a TTL signal to CONN13. When the ttl signal is enabled, the controller output should give the setpoint signal. Make sure it is not the control signal that you still see (e.g. it does not change when you change control parameters in P, I and D.).
- or: turn off P-, I- and D-part. When TTL is disabled, there should not be an output signal, when enabled, it should give the setpoint signal.
- discharge I part feature+

Output offset

- enable jumper 3J3.
- by turning 3R10, the signal at CONN12 should go up and down.

Pictures

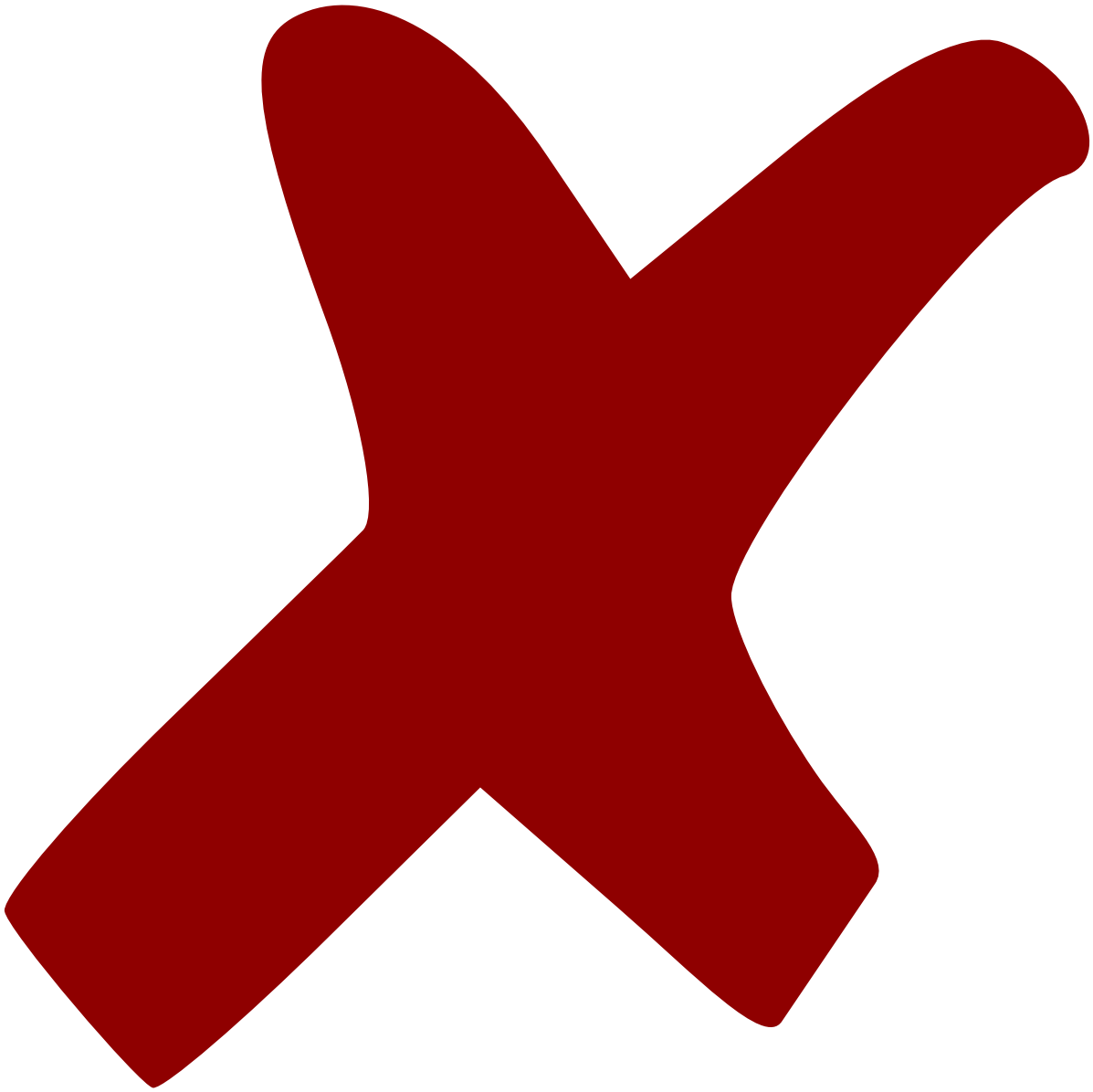
Calculation

was	wieviel	E-Preis	Preis	Anmerkung
Leiterplatte	1x	??.?? €	€	1/n von XXX EUR
Gehäuse	1x	??.?? €	€	
*	?x	??.?? €	€	...
R,C	??x	0.02 €	€	Bauform 0805
Bestückung			??.00 €	bei SRM
Verschnitt			?.?? €	

was	wieviel	E-Preis	Preis	Anmerkung
		Summe	€	

Improvements

What the next version should do better: (



:

abandoned,

: WIP,

: in the Schematic, but not the Layout,

: done)

Version 2.1

- Footprints for 3C1 and 3C2 are larger than the size of the required components
- The access holes for the trimmers 1R14 and 3R10 are located slightly too low in the front plate
- Switches 2S5, 2S6 and 2S7 are recessed more than is optimal, shortening the accessible length of their arms.
- The chosen two-part plug design for CONN15 has two screws with corresponding nuts for attaching part of it to the front plate. One of these screws is roughly at the height of the board, meaning that the board bends down at this point if it is not modified to fit properly (ie a small portion is cut away).
- The SMA connectors (CONN1, CONN3, CONN4, CONN6, CONN8,CONN9, CONN10, CONN11, CONN12, CONN13) should be positioned further back in order to leave enough space to prevent unwanted connections between ground and the front plate.
- The hole for 2S8 is located slightly too low in the front plate