BLS1 Digital PID-Controller

for water hydraulic proportional control valves

Summary of Technical Data

- 4 analog 12-bit inputs 0-10V / 4-20mA (command values, feedback values)
- 8 digital inputs / 2 digital outputs (OC)
- 2 analog power outputs (pulse width modulated max. 3 A)
- 2 digital power outputs (max 3 A)- (in overlayed 3/3-Way Mode also PWM`s)
- sampling time 1.0 millisec.
- command value / feedback value range adjustable
- 2 ramp generators
- digital command Values
- ON-LINE programming of parameters via PC software
- 2 programmable analog outputs (optional)

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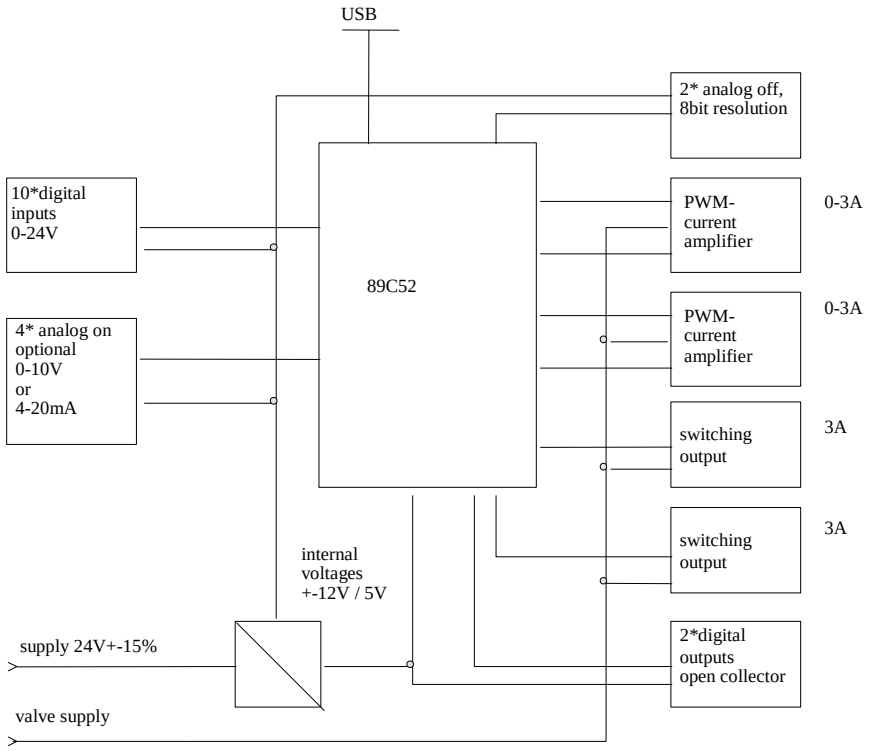


Fig. 1 : Block Diagram (Card Functions)

1. Introduction

The BLS1digital PID controller is designed for the control of proportional hydraulic pilot valves. The use of a 24 Mhz. – clocked microcontroller and assembler programming permits computing times that are adequate for controlling even highly dynamic hydraulic circuits.

Figure 1, above shows schematically how the card's hardware is arranged. In addition to the controller with its PID-characteristics and power amplifiers the card is also equipped with two power drivers for digital auxiliary functions. The digital inputs can also be used for various extra functions, such as direction control when the '**4/3-way Mode**' is used, or in the '**Overlayed 3/3-Way-Mode'** when these outputs are used to operate a second pair of proportional solenoids.

Setting the programming functions and the controller parameters is done using a PC program (user screen) via a USB connection to a PC or laptop. All such data is stored in a non-volatile memory (EEprom).

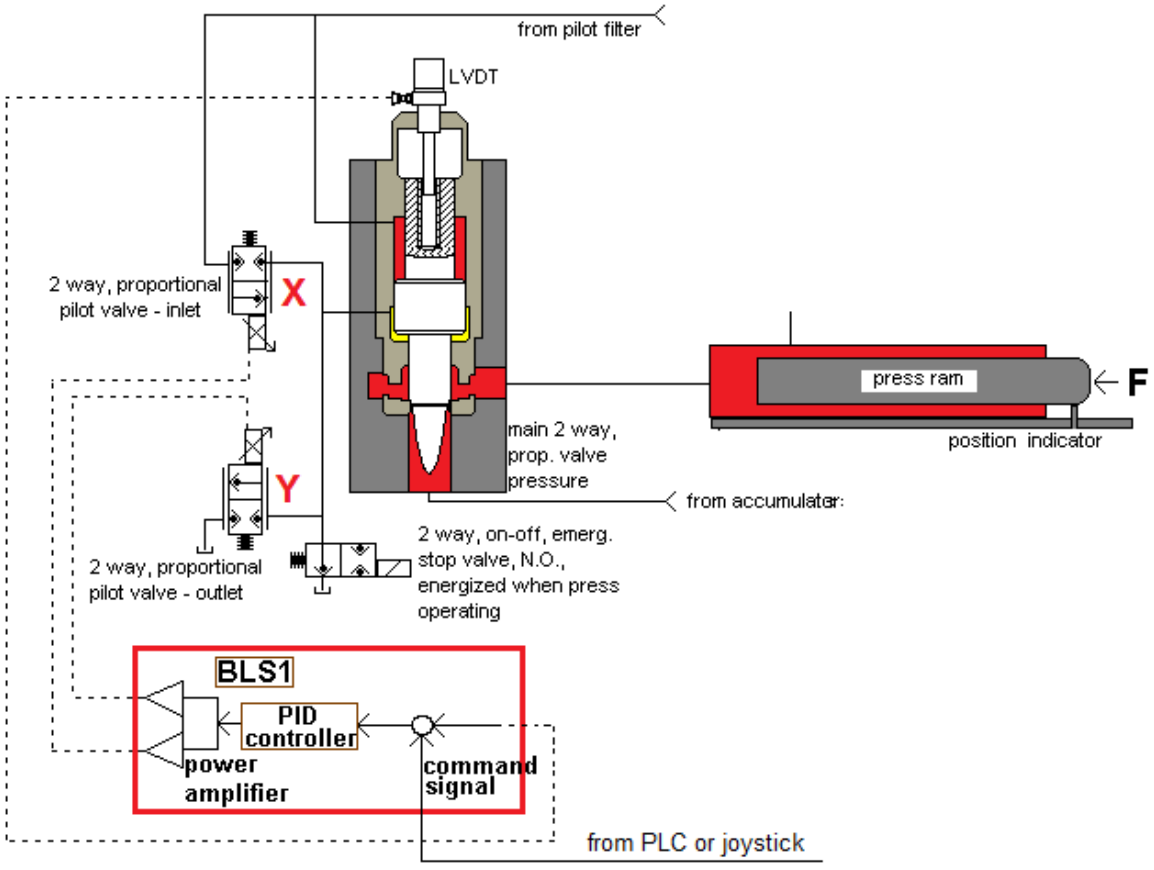


Fig. 2: Typical Control Circuit (Example A)

Figure 2 shows a typical control circuit where the card can be used. Figure 3 gives another example.

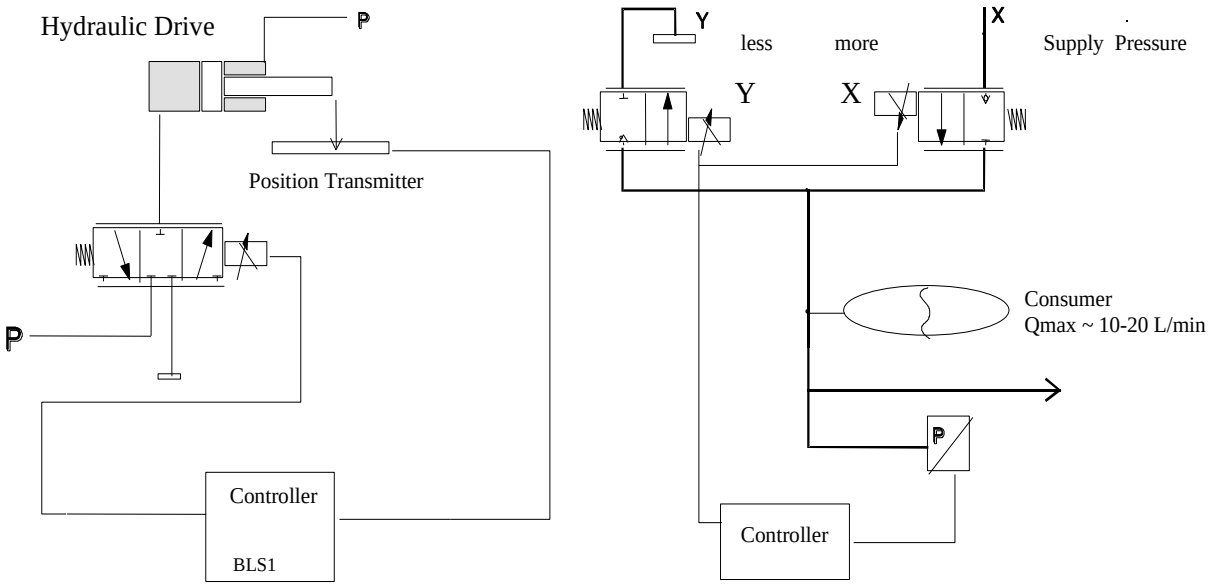


Fig. 3 : Typical Control Circuit (Example B)

2. Technical Data

The voltage supply lines are protected against reverse polarity and the power outputs are protected against short circuit and excessive temperature. The power drivers require a separate power supply, which should be connected to the power supply ground.

2.1 Electrical Data

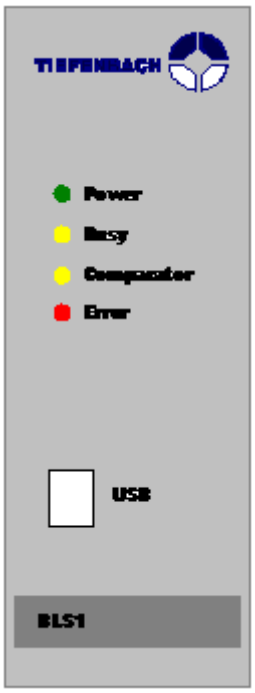
Supply Voltage U_V	18-28V (typically 24VDC)
Max. Intern. Current (not including solenoids):	100mA
Valve (sol.) Operating Voltage	U_W same as U_V
valve current	(max. 6A depending on solenoids)
Operating Temperature Range	-20 - +70 ^{O}C
Analog inputs:	
variables	(adjustable)
voltage	0-10V (internal resistance 20K□□
current	4-20mA (working resistance 500□□
Digital inputs:	
control inputs	0 or 24V max U_V
Analog outputs:	
voltage	0-10V (max. current-carrying capacity 100mA)
power (PWM)	0-3A
Digital outputs:	
open collector type	max. 100 mA
power outputs	0 or 24V (max 3A)
Controller sampling time	1.0 ms

2.2 Physical Dimensions

Printed circuit board	European standard (100 x 160mm)
Connector	48-pin to DIN 41612 types F
Width of front cover	8TE

2.3 Front Cover

Figure 4 shows the front cover. The LED's on the front cover indicate the operating state of the card. The USB interface connection is for programming card parameters via a PC or laptop.



2.3.1 'Power' LED

This LED glows when the operating voltage (Uv) is present. The **Power LED** is independent of the computer.

2.3.2 'Controller Busy' LED

This LED glows to indicate a deviation between the command and the feedback signals. In other words the controller is still busy, matching the two signals.

Fig. 4 Front Cover

The following error messages will be shown when you click on the read controller button.

1. Sollwert/Command Value < 4 mA
2. Istwert1/Feedback1-Value < 4 mA
3. Istwert2/Feedback 2-Value < 4 mA
4. Deviation Error (when feedback and command signal do not equalise within about 3 secs. this error LED glows)

2.4 Card Connection Details

Figure 4 shows the location of the various inputs and outputs on the card rack.

	z	b	d
2	+24V (Uv)	+24V	+24V
4	Ground SW	Command value 0-10 V	Command value 4-20mA
6	Ground IW1	Feedback value 1, 0-10V	Feedback value 1, 4-20mA
8	Ground IW2	Feedback value 2, 0-10V	Feedback value 2, 4-20mA
10	Dig.In 0/Direction 2	Dig.In 1/Direction 1	Dig. Command Value 2
12	Dig.In 8/ Valve interlock	Dig. Command Value 1	Dig. Command Value 0
14	Feedback value 1b, 0-10V	Feedback value 1b, 4-20mA	Dig.In 3/ 2. Pair of ramps
16	Dig.In 2/ ramps off	Dig.Out 1/ Iw-compar.	Dig.Out 2/ error
18	Prop solenoid X (-)	Analog 0 Out ([1]	Analog 1 Out ([1]
20	+12V	+12V	+12V
22	Ground	Ground	Ground
24	-12V	-12V	-12V
26		Ground SW-solenoid 1 (-)	SW-solenoid 1 (+)
28	+24V(Uw)	Ground SW-solenoid 2 (-)	Prop solenoid Y (-)
30	Prop solenoid Y (+)	Prop solenoid X (+)	SW-solenoid 2 (+)
32	Ground	Ground	Ground

Fig. 4 Card Connection Details

NOTE: Under most circumstances it is necessary to connect 2 to pin 28z externally. This powers the solenoids. This connection is not made internally and therefore permanent, because in some cases the solenoids are powered independently, or the emergency function is applied only to the solenoids.

3. Installing the Card into a Control Circuit

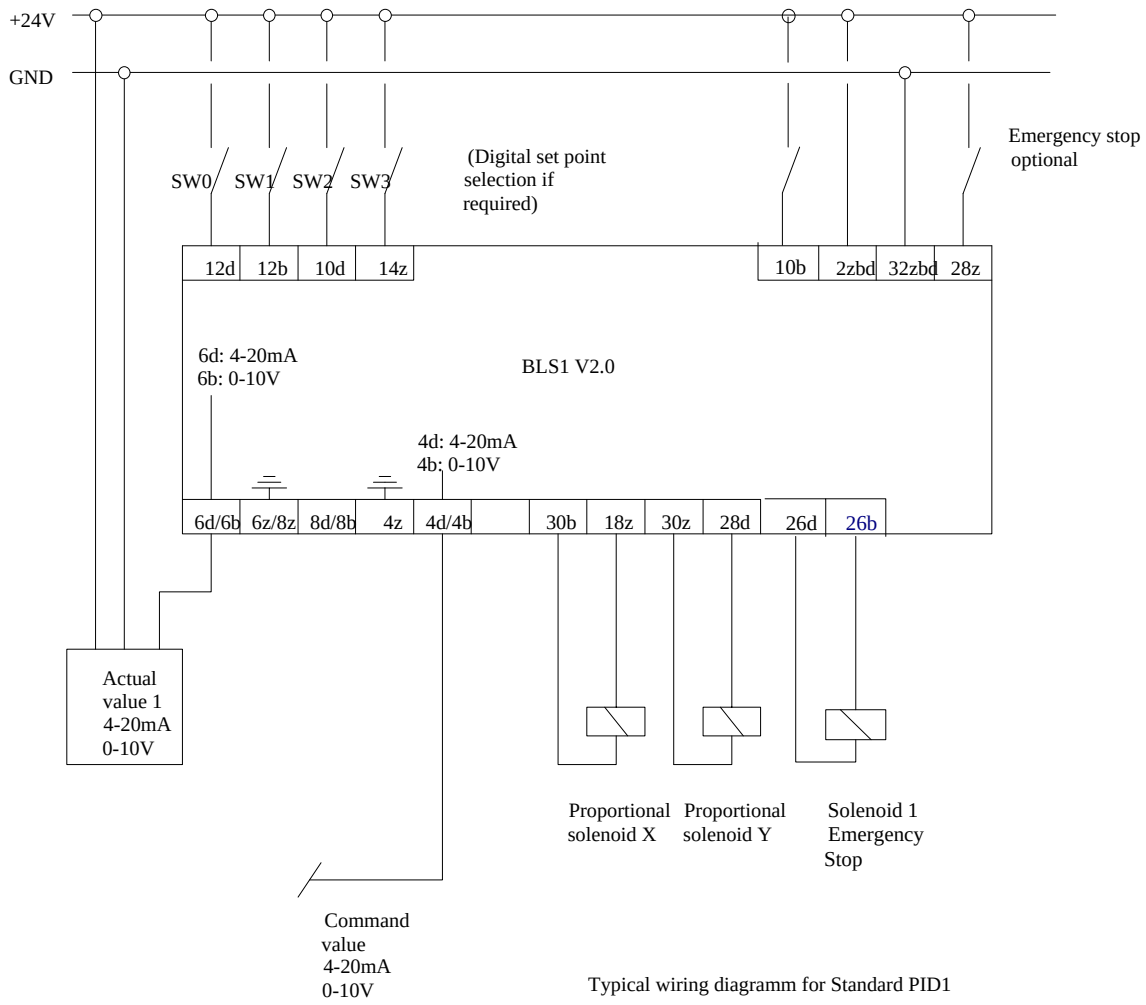
Safety information:
Only trained personnel should change the settings on the card. Incorrect settings may lead to damage or destruction of the components and/or equipment linked to the card.

For the function of the controller card in connection with a certain hydraulic configuration a guarantee will only be given after release.

Fig 5.0 through 5.3 on pages 8 through 10 give some examples of how the card can be hooked up. With these examples it has been assumed that both the command value (which generally comes from the PLC) and the feedback transducer have a value in the range of 4-20mA. However, 0 – 10VDc is also possible, as is the inverse of both current and voltage ranges.

([1] =optional

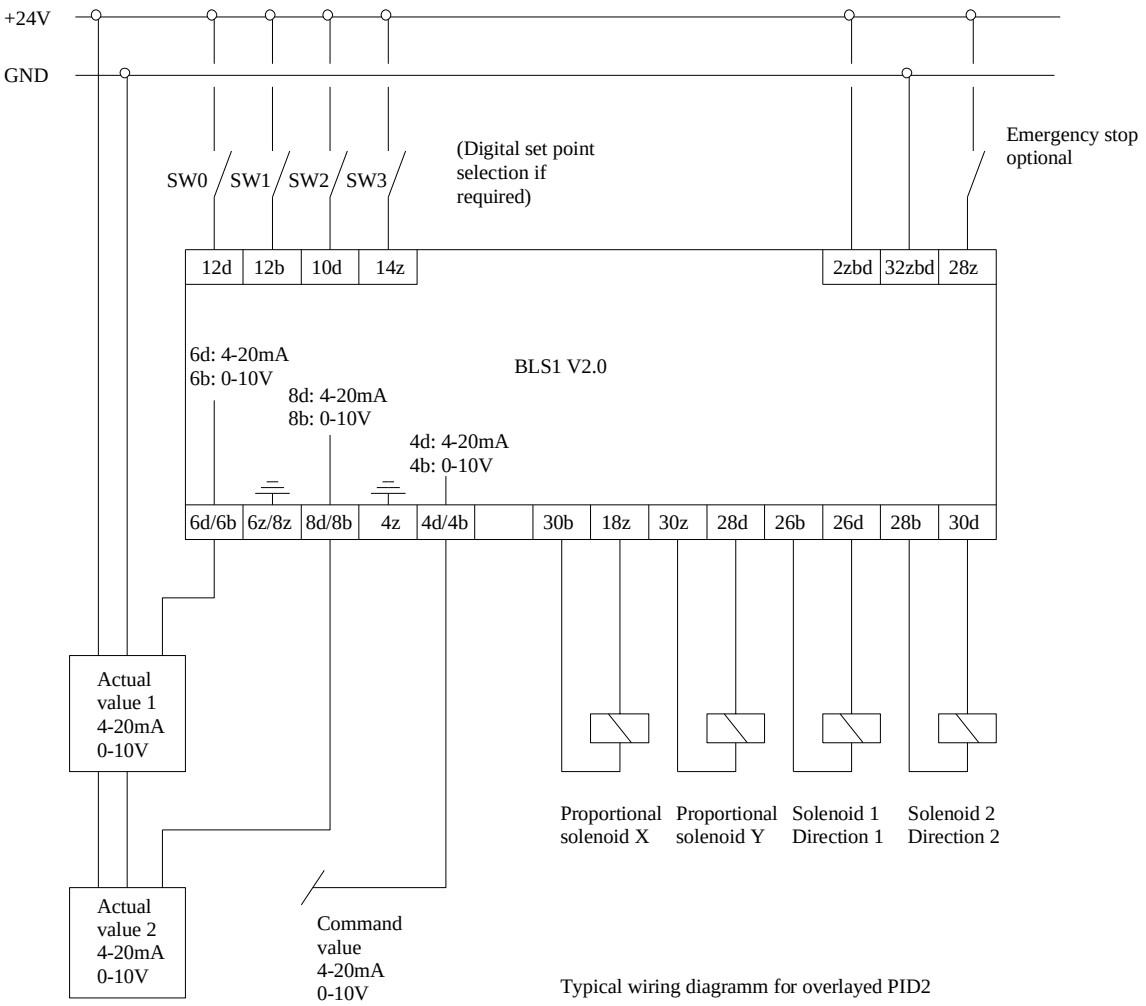
Fig.5.0 Card Connection Example (1)



Typical wiring diagramm for Standard PID1

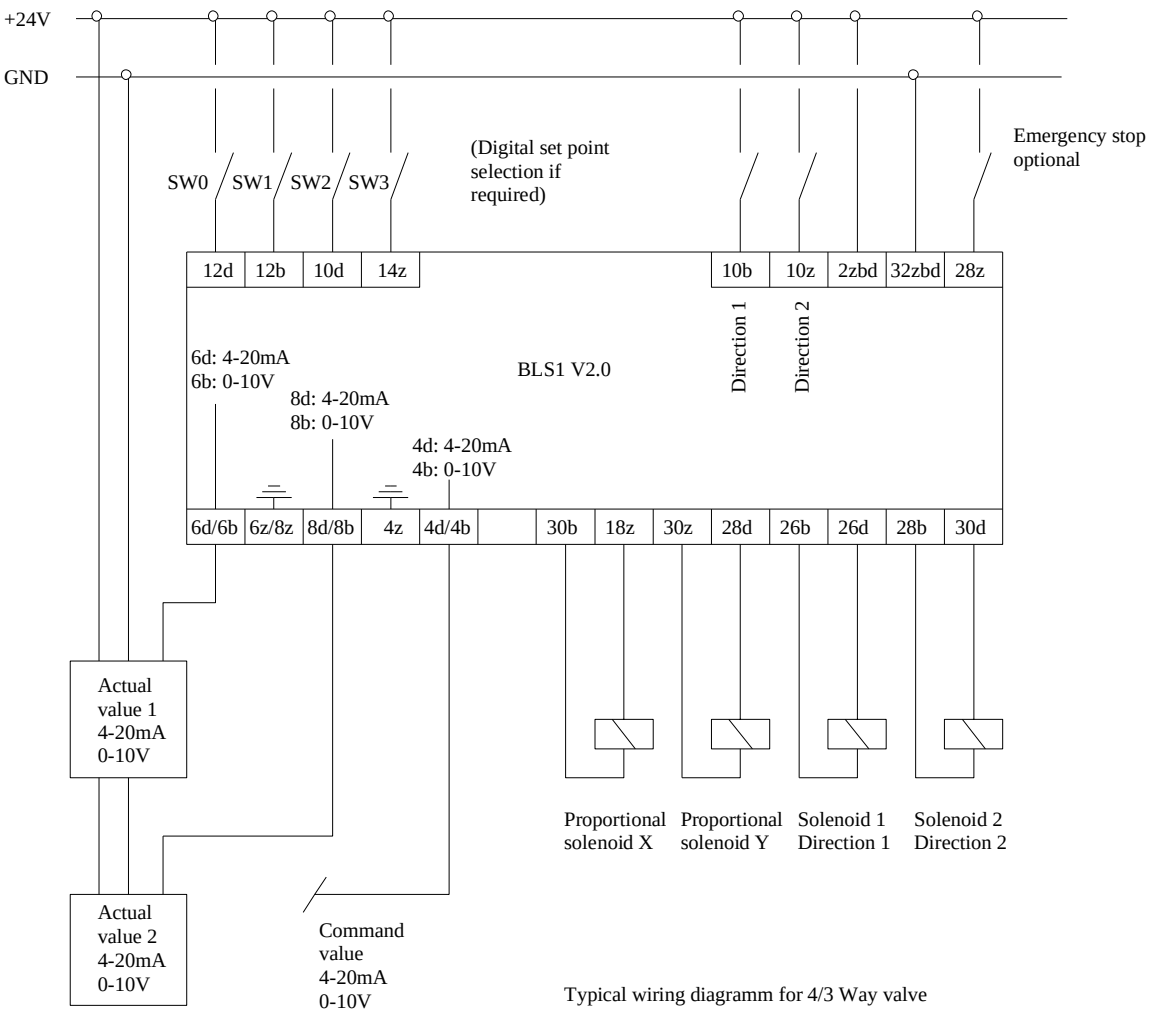
The emergency stop valve can only be used Standard PID mode. It connected as shown above, with 12 - 2VDC enable voltage applied to either Pin 28z or Pin Pin 10b. Generally Pin 28z will already have voltage applied to it, as this pin is usually connected to 2, the supply voltage (see page

Fig.5.1 Card Connection Example (2)



Typical wiring diagramm for overlayed PID2

Fig.5.2 Card Connection Example (3)



4. Card Set-Up

In order to program the controller parameters the card must be connected to a PC or laptop via a serial interface cable or a USB Adapter. Programming is menu-controlled. Parameter changes are accepted by the card in real time without delay, so the results can be checked immediately on whatever system the card is controlling. Caution is advised when doing this.

4.1 Connecting the Computer to the Card

Figure 6 below shows the connection between the computer and the card using a USB cable.

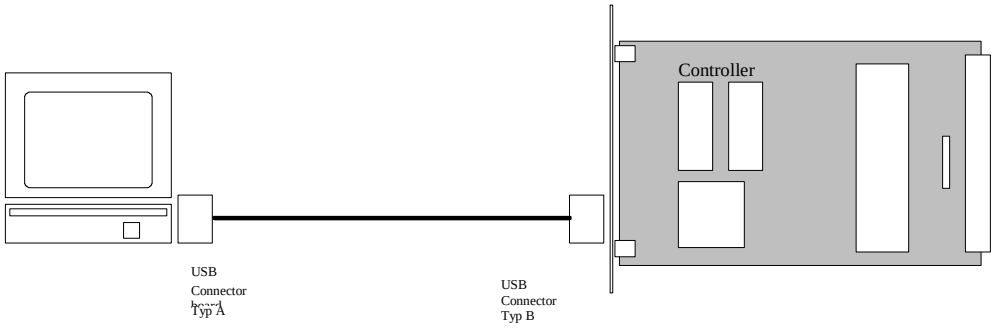


Fig. 5: Connection of the controller with a PC or a terminal

Using the PC program for the BLS1 Card you can select COM Port 1 to 16. However, you must first install the Virtual COM-PORT USB-Driver (included in the 'Software and Documentation Support Package').

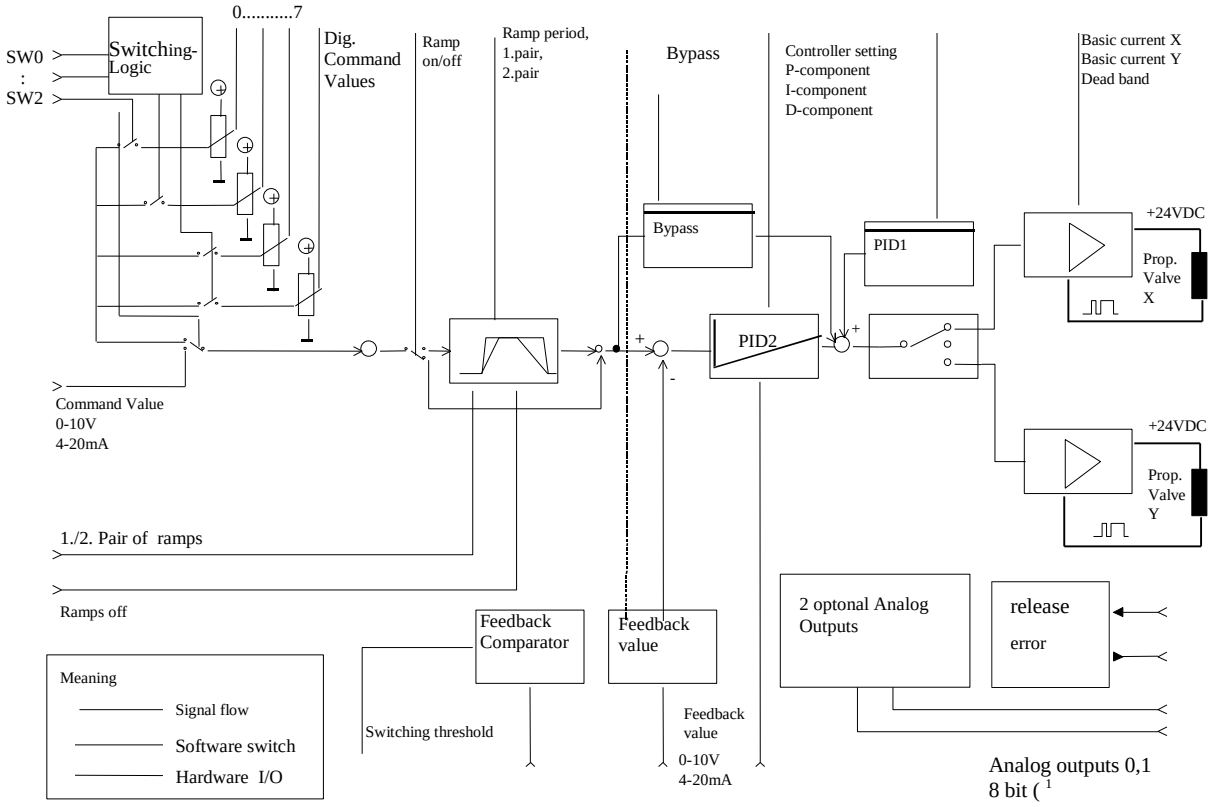


Fig. 6: Overview of Adjustable Parameters

4.1.1 Base Currents

A '**base current'** is supplied continuously to the proportional solenoids to ensure they react as quickly as possible when the PWM excitation signals changes. The range of adjustment is 0 - 100% of the maximum current depending on the solenoid connected. The slope of the solenoid excitation curve is adjusted via the proportional amplification (**P-amplification**). It is possible to choose different base currents for the two solenoids. Note however, that in the **'3/3 Way Overlayed Mode'**, the selected base current applies to both X and both Y solenoids.

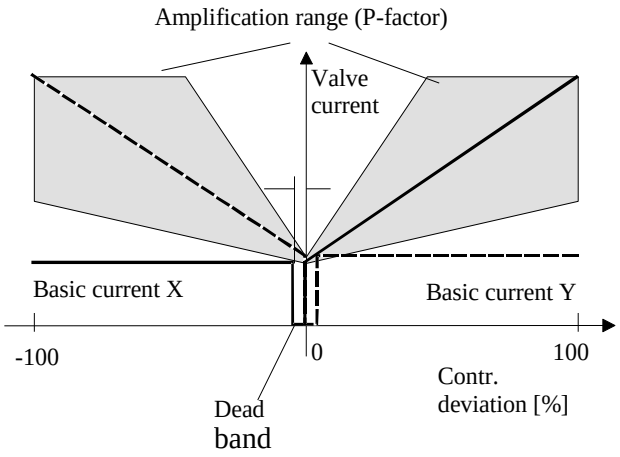


Fig. 7: Deviation v. output current

4.1.2 Programming the Feedback and / or Command Value Parameters

This is where the upper and lower limits for the analog inputs are assumed by the card (see Tiefenbach document, 'PC User Program for BLS1 Card' for a more detailed explanation of this). Each limit value is programmed by operating the valve manually and then confirmed at the user interface.

4.1.3 Dead Band

The dead band is a region defined by the user around the zero position in which the controller does not respond. If there is no dead band the controller will work constantly.

4.1.4 P-I-D Setting

Using the PID settings the effective amplification of the controller can be set. First set the proportional amplification at a level such that the hydraulic system controlled by card is just about to oscillate. Then set the I and D-components. These are only used for correction and our experience has shown that the type of high inertia hydraulic drive normally operated by these cards very rarely requires a high proportion of I and D component.

4.1.5 Ramp Generator

The card is equipped with an internal ramp generator. The ramp generator's signal pattern can be adjusted separately for positive and negative slopes. ([1] An optional external input also allows switch-over to 2 pairs of ramps, with different slopes.)

4.1.6 Digital Command values

The PC software allows the user to define internally generated command values. These are activated depending on the position of external inputs. It is possible to define 7 command values. Using the binary code shown in the table below (digital inputs SW0, SW1 and SW2) the respective constant command value can activated. The level of each internal command value can be set using slide buttons on the PC user interface.

	Dig. Command Value 0 (12d)	Dig. Command Value 1 (12b)	Dig. Command Value 2 (10d)
Command value 1	**1**	0	0
Command value 2	0	**1**	0
Command value 3	**1**	**1**	0
Command value 4	0	0	**1**
Command value 5	**1**	0	**1**
Command value 6	0	**1**	**1**
Command value 7	**1**	**1**	**1**

If none of these inputs is activated the controller defaults to the regular external analog command value signal.