

Valve Control Unit “ValDi”

General Description

Our valve control unit is a driver unit for solenoid valves for test purposes which comes with an especially developed software to control, visualize and configure the system via a GUI. Application of these valves is to control the fuel pressure and flow in an automotive combustion engine. The name of this driver unit is **ValDi**, which is the abbreviation for **Valve Driver**. ValDi hardware may be used to define load profiles and control the activation and stress of up to 8 solenoid valves in parallel and independently.

The basic functionality of ValDi is the following:

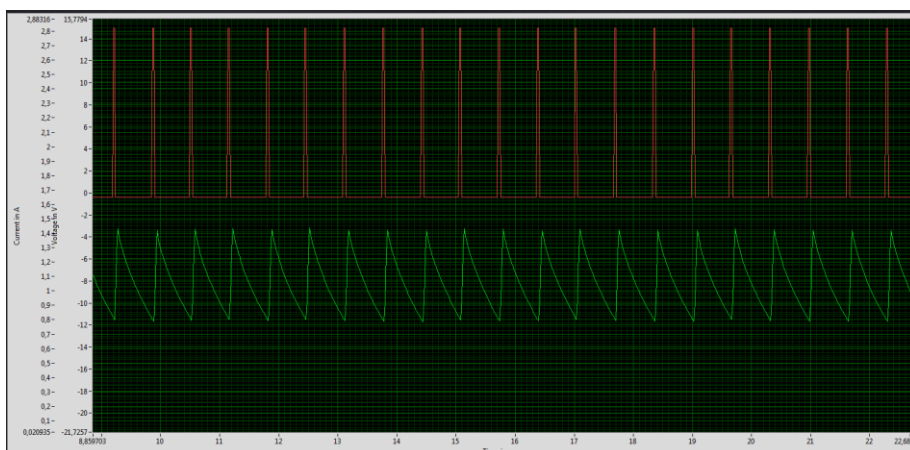
- Applying of currents to hydraulic solenoid valves
- Acquire data
- Processing control loops
- Signal valve status on debug outputs

The hardware may be applied in functional tests or endurance tests. For both, different operation modes may be applied.

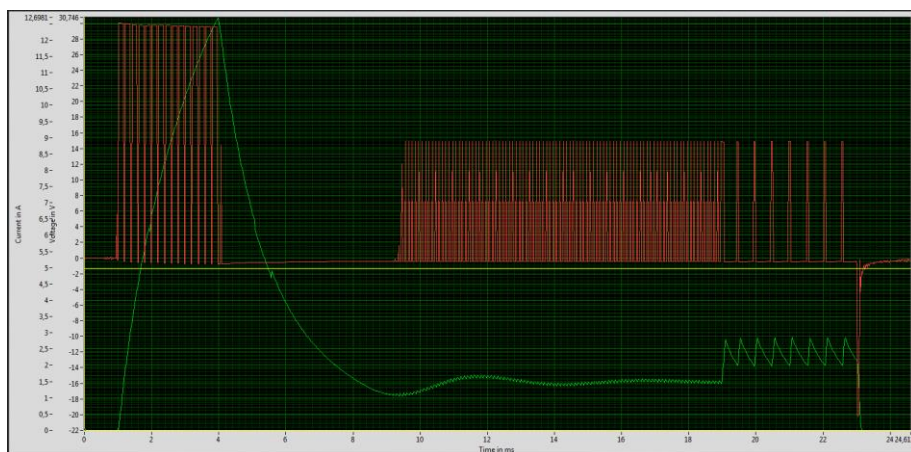
ValDi is the more intelligent Valve Control Unit that combines hardware and software in one solution. Please see ValDino for the standard hardware solution with reduced functions.

Functionality

The main purpose of ValDi is applying currents to solenoid valves. Generally, the applied current is defined by toggling the output at a specified duty cycle. A minimum inductance of the load is required. Depending on the valve type different current waveforms are used:



Static current control



Complex current profile

The current waveform (shot) may be divided into several time steps, called sections.

Section duration

The duration of every section may be defined. The section ends if one of the following conditions is valid:

- End after specified time
- End after specified angle (0...360°)
- End after current limit (greater than or less than)

If none of the section end conditions is specified, the section is regarded as endless, as it is the case in a static activation.

Section output status selection

During a section, the valve driver may be set into one of the following states:

- Off
- PWM: toggle output at specified
 - o frequency 10Hz ... 100kHz
 - o duty cycle 0...100%
- PWM-Ramp at specified
 - o frequency 10Hz ... 100kHz
 - o start duty cycle
 - o duty cycle increment per period
- Clamp -0 ... - 80V (feed energy from coil into clamp circuit)
- Constant current (adjust duty cycle for desired current using PID-control)
- Bang-Bang current control (output ON till upper limit is reached, OFF till lower limit)

Section voltage selection

For every section, one of two voltages is selectable in the range 0...80V depending on the power supply.

Acquire data

Acquiring of data is necessary for visualization, eventual data logging and synchronization to the entire test environment.

Valve voltage and current

Valve voltage and current are measured for visualization and eventual logging of the valve's behavior.

Valve current is measured in two measurement ranges

- 0...5 A for high resolution of low currents
- 5...40 A for measurement of high (peak) currents

The measurement range may be selected automatically, or may be set explicitly to the high range.

Valve voltage may be measured via sense lines directly at the valve or next to the valve driver. The type of sensing depends on the application.

Synchronization to the test environment

To capture data of the test environment, analog and digital values have to be measured or generated

- Analog inputs for measurement of pressure, flow, temperature, ...
- Digital inputs for speed, digital flow signals, ...
- Digital outputs for indication of running software.

Process control loops

Control loops have to be executed in real-time in the software.

- Lookup-tables with linear interpolation are implemented for numeric calculation.
- For control loops, up to eight PID-controllers are available.

Signal debug outputs

The current status of the valve may be signaled electrical and optical via

- Two-color-LED as optical indicator
- Electrical debug connectors, indicating
 - o Valve current (voltage 0...10V, proportional to momentary current)
 - o Averaged RMS valve current (voltage 0...10V, proportional to averaged current)
 - o Digital signal for valve output active

Operation modes

The valve control unit may run in different configurations:

- system is remote controlled by a user-PC
- system is remote controlled by a user PC and is integrated into a test stand including fluid at high pressure
- stand-alone running system, without PC, but including fluid at high pressure

When the valve control unit is integrated in a system with real fluid control at high pressure, the unit has to be synchronized to the complete system using analog and digital signals like fluid pressure, flow or simulated engine speed. This holds both for

- the stand-alone version,
- or the PC-controlled version.

In the stand-alone version the ValDi_PC_SW is not applied. In this case, the configuration has been created and downloaded into the real-time system (ValDi_RT_SW). ValDi_PC_SW is used for the configuration. The configuration is saved during power down and will be automatically reloaded and restarted. The user may stop the activation by a manual "disable" switch.

Software

ValDi GUI Software enables controlling, visualization and configuration of ValDi hardware. ValDi GUI Software is meant to run with Windows XP Service Pack 2 or later. Furthermore, .NET Framework 3.5 or higher must be installed on the computer.

Once you have successfully installed it the program provides among other things following functions:

Login

You can log in to the GUI with three different user types:

- Standard User (default, not logged in): Allows simple monitoring functionality.
- Advanced User: Permission to execute tests and monitor DUTs. Shot Editor and Analogue Editor are accessible. Permission to save is denied.
- Administrator: Is allowed to enter all menus and operate without any restrictions.

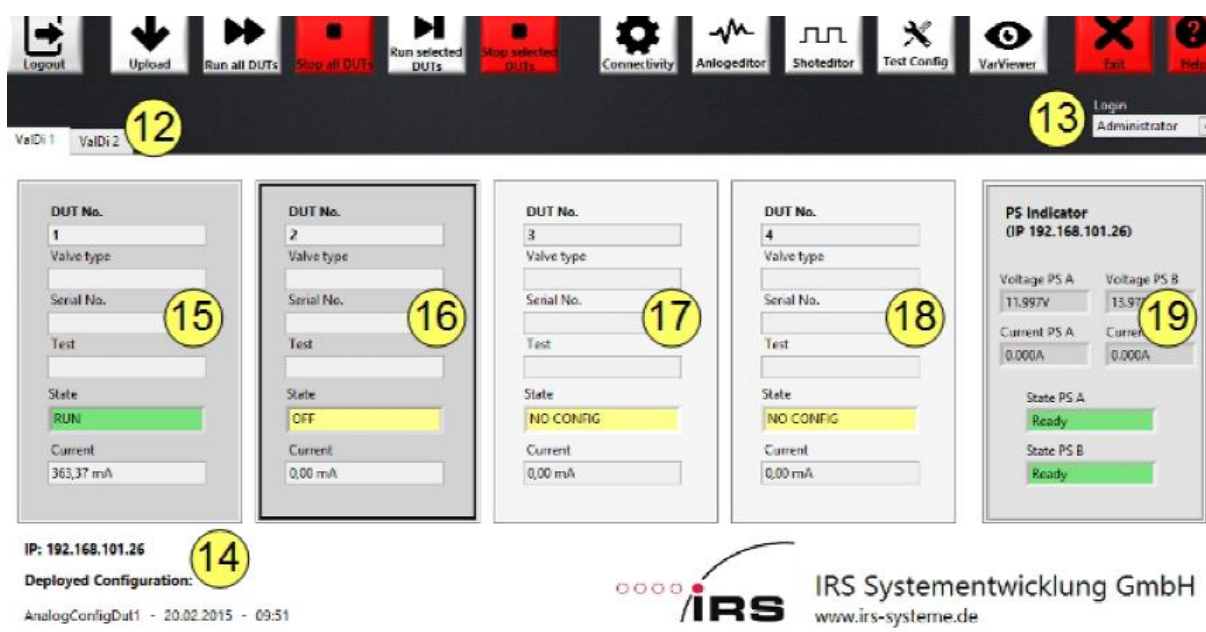
Running Tests

You need to be logged in and a valid test configuration must be deployed to ValDi.

One DUT indicator has to be active and in status "OFF". You can control the test with "Run all DUTs" and "Stop all DUTs" buttons.

Shot Editor

Basically shots are a set of so called sections. Sections can be of different types and describe specific current profiles. It is up to the user how to combine the sections to a more complex current profile. A shot configuration can be uploaded to ValDi (along with additional data) later. An uploaded shot configuration enables the Valve Driver to supply the DUT with the desired current profile. Typically shots are used to operate digital valves.



The screenshot displays the ValDi GUI interface. At the top, there is a toolbar with icons for Logout, Upload, Run all DUTs, Stop all DUTs, Run selected DUTs, Stop selected DUTs, Connectivity, Analogue Editor, Shot Editor, Test Config, Val Viewer, Fail, and Help. Below the toolbar, the main area is divided into several panels:

- Top Bar:** Shows 'ValDi 1' and 'ValDi 2' with a yellow circle '12' next to 'ValDi 2'. On the right, there is a 'Login' section with 'Administrator' and a yellow circle '13'.
- DUT Panels:** Four panels for DUTs 1, 2, 3, and 4. Each panel includes fields for DUT No., Valve type, Serial No., Test, State, and Current.
 - DUT 1: State is 'RUN' (green bar), Current is 363,37 mA. Yellow circle '15' is next to Serial No.
 - DUT 2: State is 'OFF' (yellow bar), Current is 0,00 mA. Yellow circle '16' is next to Serial No.
 - DUT 3: State is 'NO CONFIG' (yellow bar), Current is 0,00 mA. Yellow circle '17' is next to Serial No.
 - DUT 4: State is 'NO CONFIG' (yellow bar), Current is 0,00 mA. Yellow circle '18' is next to Serial No.
- PS Indicator Panel:** Shows 'PS Indicator (IP 192.168.101.26)'. It includes 'Voltage PS A' (11.897V), 'Voltage PS B' (13.97V), 'Current PS A' (0.000A), and 'Current PS B' (0.000A). State PS A and State PS B are both 'Ready' (green bars). Yellow circle '19' is next to the Current PS B value.
- System Information:** At the bottom left, it shows 'IP: 192.168.101.26' (yellow circle '14'), 'Deployed Configuration:', and 'AnalogConfigDut1 - 20.02.2015 - 09:51'.
- Footer:** The IRS logo and 'IRS Systementwicklung GmbH www.irs-systeme.de' are at the bottom right.

Test Configuration

A Test Configuration merges 'Shots' or 'Analogue Configs' with a 'Control Module' for valve control purposes. Test Configurations must be evolved with 'Test Configurator'. A Control Module is basically a set of so called 'Control Elements'. Control Elements could be PID-Controls, 2D- or 3D-Table (lookup table). 'Shots' or 'Analogue Configs' must be assigned to a DUT (physical slot). Link the current profiles by using the 'DUT Config' Panel. When you have assigned current profiles to DUTs you may derive 'Output Variables' from the DUT Config.

DUT Config

The most important feature of the DUT Config is to assign current profiles (shots) to DUT's. Besides, you can specify the number of shots ValDi will fire per revolution/ 360° (see 9) and set the PID Sampling Time (8) at which the FPGA PIDs run.

Variable Editor

There are three types of variables. While User Variables serve as set points and interconnecting variables, Output Variables directly influence the DUT. Fixed Variables are preset and cannot be changed, but are also used to create Control Modules.

Electrical Data

	Min	Max	Unit	
Voltage range	-80	80	V	
Current continuous(single channel)	0	25	A	Single channel active
Current continuous (per channel)	0	20	A	All 4 channel concurrently
Current peak	0	40	A	Limited by software. Shutdown after 20 μ s

For full technical data sheet please contact IRS Systementwicklung GmbH:
info@irs-systeme.de

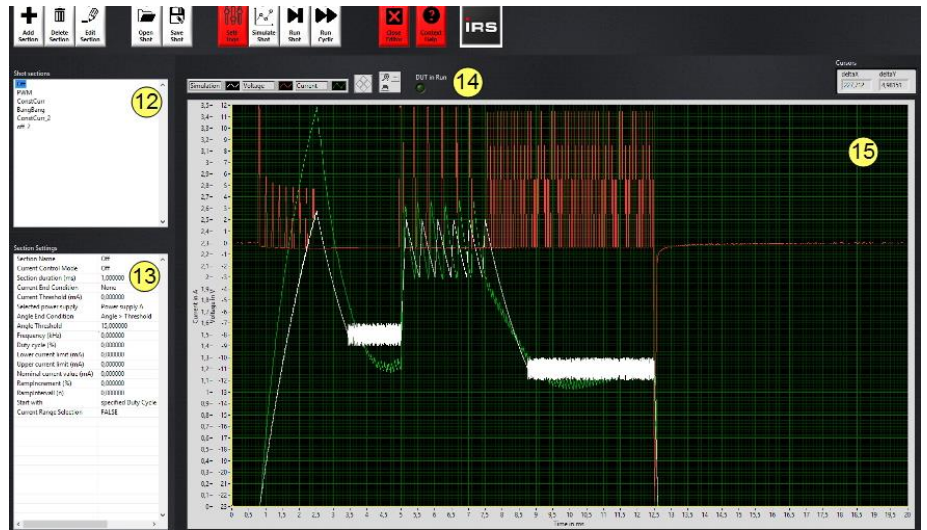
Product Pictures



1 Valve Driver ValDi



2 Single ValDi rack



3 Operating Shot Editor

Product Support

For further information contact IRS email support: info@irs-systeme.de