System Documentation

PCS Shutter

8051 compatible micro controller system for mechanical shutter control /
DMX-512 / analogue in- output / keyboard and display units

1. First steps

Your ***PCS Shutter*** Firmware currently supports two modes of operation, namely **Manual Control** for controlling the shutter position via the attached keyboard and **Remote Control**. The device is equipped with a DMX-512 interface and an analogue input allowing the remote control of the shutter position via an analogue input line or two unique DMX-512 addresses[1]. The whole DMX-512 address space can be used, though it is advisable to use the lowest possible address permitted by your application.

For directly accessing the shutters use **Remote Control** the second operation mode of the device. In this mode sending the appropriate control sequence via the DMX-512 lines you can directly preset any shutter position.

The ***PCS Shutter*** is currently shipped with a back lighted 20 x 4 character LCD display for status messages and user notification, an ***Operation*** status led (green) and a ***DMX-512 Signal*** control led (red). The backlight facility provides the possibility to edit the device settings even in dark environment and the backlight automatically fades out after about 40s if no user interaction is detected by the system to avoid any distortions caused by the backlight in dark environments.

[1] For further information on setting the DMX address or controlling the slide position via DMX-512 standard check section 3.3 – The DMX-512 interface or the appropriate section regarding the ***PCS Shutter*** firmware.

2. Installation guidelines

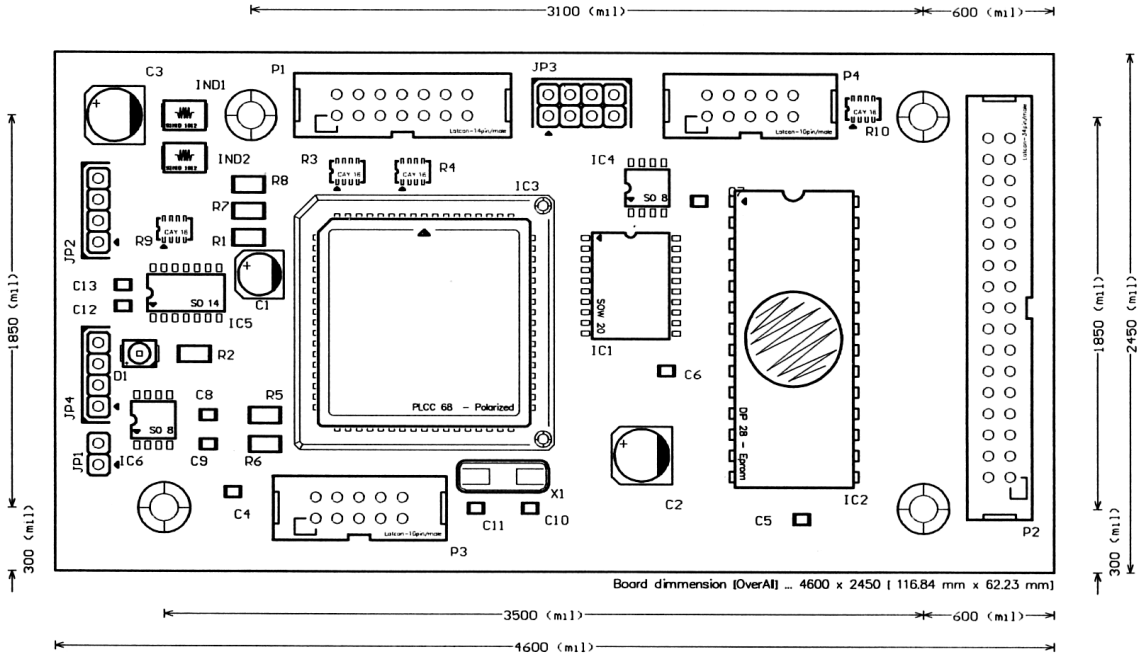
3. Assembly and Hardware

The following section is intended to make you familiar with the hardware components setting up the ***PCS Shutter*** electronics. Primarily, building the core of the control equipment, the main CPU module is build around an Intel 8051™ compatible processor controlling the display and keyboard module. Additionally handling all user interactions and generating the control sequences for the correct operation of the ***PCS Shutter***. Secondly there are the peripheral units, the galvanic de-coupled DMX-512 interface section, the analogue input and output section and the stepper control module build around a Microchip PIC 16C72A™ processor and featuring a SDxP-IIC[2] interface.

3.1. CPU core module - Motherboard

The CPU core module is built around an Infineon SAB C515™ processor taking full advantage of the built in serial communication feature and the ADC circuitry. The CPU core module additionally functions as a signal distribution matrix establishing all the links to the peripheral modules. A Dallas DS1232 supervisory unit monitors the supply lines and resets the system in case of power supply dropout or failure.

[2] SDxP-IIC ... Serial Data Exchange Protocol supports a serial data transmission via a two wire link and provides a transmission error checking on a checksum verification basis and is primarily intended for half duplex high speed data transmission between the CPU core and peripheral slaves.



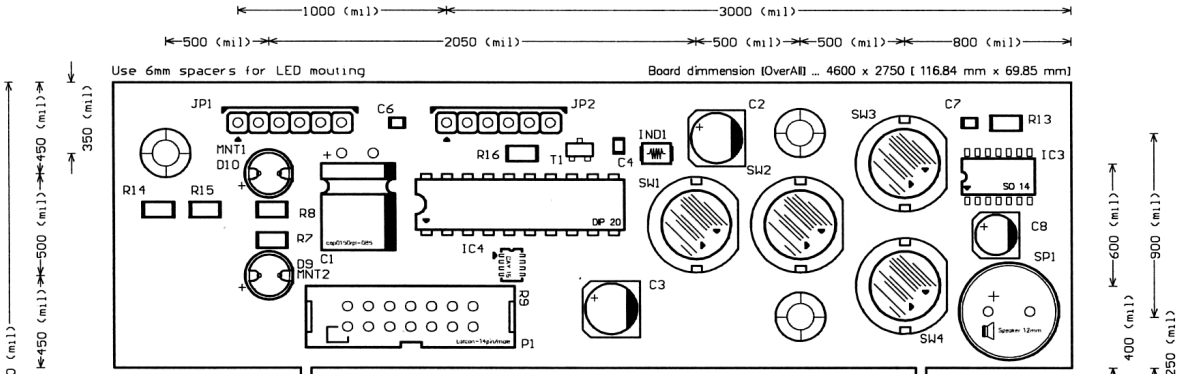
Connect the display module to connector ***P1***, the DMX-512 and analogue interface unit to connector ***P3***, the optional available expansion board for enhanced communication features including Ethernet networking to ***P2***. Connector ***P4*** is used to connect the analogue output board to ter system. ***JP1*** is provided for warm startup of the system and is intended for service purposes only. ***JP4*** features a serial communication interface based on the RS-232 communication standard but is not used throughout the ***PCS Shutter*** assembly. The stepper driver board featuring the power supply converters is connected to jumper ***JP3*** and the extension link to the synchronization sensor is connected to ***JP2***. By establishing all the above-mentioned links you are nearly done with all the setup work needed to get your system running.

All the setup data is stored in the non-volatile memory ***IC4*** and guarantees data retention for more the 15 years. In case of changing the firmware replace the ROM chip ***IC2***. Contact your firmware vendor for further details.

For mounting the board to your framework four drill holes with diameters fitted for M3 screws are provided near each corner of the board.

3.2. Display and keyboard

Any user interaction is done via the keyboard and display unit providing four buttons for controlling the system in manual mode and doing all the setup work, like selecting the appropriate DMX address of the unit or other elementary settings.



Above figure shows a section from the keyboard board including the buttons for user interaction. Speaker ***SP1*** for command confirmation and signaling alert conditions. Finally the 14-pin ribbon connector ***P1*** to the motherboard. All user relevant output is piped to a back lighted 20 x 4 character LCD display.

Remove jumpers ***JP1*** and ***JP2*** on the backside of the LCD display module in case of not needing the automatic back panel light facility. The backlight is automatically switched on in case of any user interaction and fades out after about 40s when no button is pressed.

Connection to the motherboard via 300mm 14pin ribbon cable AWG 28. Pin #1 marked red

For mounting the board to your framework four drill holes with diameters fitted for M3 screws are provided in conjunction with the LCD display module.

3.3. Analogue I/O module and DMX-512 interface

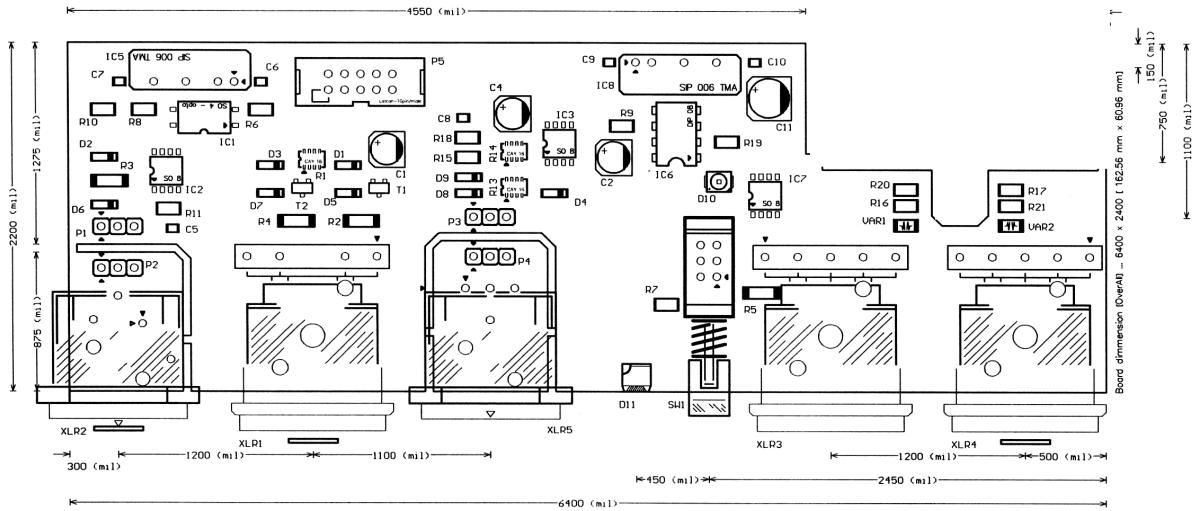
The DMX-512 interface is galvanic de-coupled and complies with the TIA/EIA-485 standard for multi-point bus communication and is conform to the USITT standard as pointed out in section 9.02 of the DMX-512 08/1990 standard. Internal circuitry features fail save termination and over-voltage protection. The Pin assignment of the **XLR3** and **XLR4** connector is summarized below.

Pin 1	***Signal common (shield)***
Pin 2	***Dimmer drive complement (data 1 negative)***
Pin 3	***Dimmer drive true (data 1 positive)***
Pin 4	***Second channel complement (data 2 negative)***
Pin 5	***Second channel true (data 2 positive)***

The RS-485 multi-point transceiver interface ***IC8*** is mounted via a socket so replacement in case of line failure is easily done. Depending on the position of the device within the DMX-512 transmission line[3] the interface has to be terminated to avoid signal distortion due to transmission line reflections[4].

[3] The RS-485 standard defines a maximum number of up to 32 devices per line segment to guarantee correct signal transmission within the driver specification.

[4] The correct termination resistor of 120Ω is assembled onto the DMX interface board, so termination is easily done by closing ***SW1***



Line termination status is flagged by led ***D16***. ***D16*** active red means line is terminated else line termination disabled. Termination status is changed via ***SW5***[5].

Connect your analog lines to **XLR5**. The analogue input section provides one analog input with a maximum range of 00 … +/− 10Vdc. Input protection is guaranteed up to voltage levels of about 150Vac and the input load is about 100k. The input features a full way rectifier so polarity of the input voltage is of no necessity. The Pin assignment of the **XLR5** connector is summarized below.

Pin 1	***Signal common (GND)***
Pin 2	***Analog input line (0 … +10V or 0 … -10V)***
Pin 3	***Signal common (GND)***

[5] Use a small screwdriver to alter the termination status by pushing the nozzle of ***SW1***.

The digital output lines can be accessed via **XLR1**. Output voltage swing is 00 … 15Vdc and the driver sources up to 100mA. The outputs are short circuit protected and clamped against a driving voltage of about 50V. The Pin assignment of the **XLR1** connector is summarized below. The output section is equipped with free wheeling diodes as protection against inductive loads.

Pin 1	***n.c.***
Pin 2	***Digital Out 1 – Puls Off***
Pin 3	***Digital Out 2 – Puls On***
Pin 4	***Signal common (GND)***

The galvanic decoupled analogue output line can be accessed via **XLR2**. Output voltage swing is 00 … 10Vdc and the driver sources up to 20mA. The outputs are short circuit protected and clamped against a driving voltage of about 50V. The Pin assignment of the **XLR2** connector is summarized below.

Pin 1	***n.c.***
Pin 2	***Signal common (GND)***
Pin 3	***Analogue Out***

A ribbon cable connected to P5 establishes the link to the motherboard.

Connection to the motherboard via a 200mm 10pin ribbon cable AWG 28. Pin #1 marked red

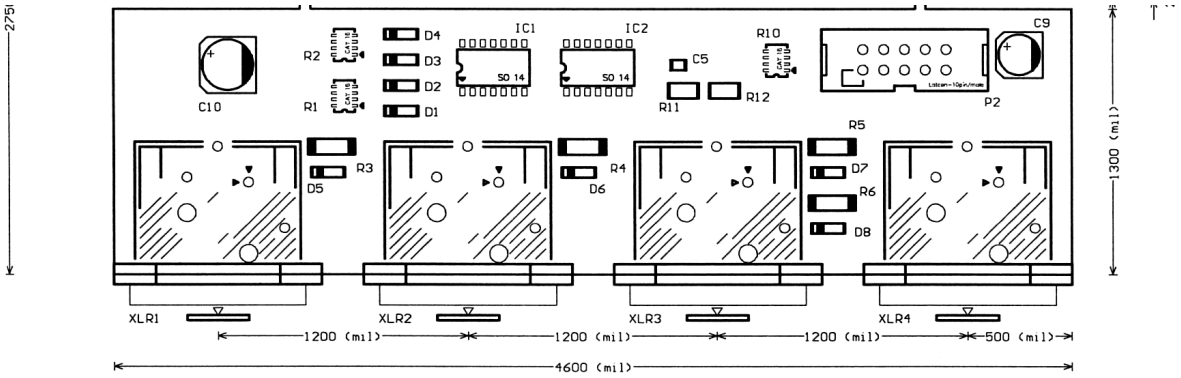
For mounting the board to your framework use drill holes with diameters fitted for M3 screws - partly provided by the XLR connectors.

3.4. Quad Analogue Output module

The four analogue output lines can be accessed via **XLR1** to **XLR4**. Output voltage swing is 00 … 10Vdc and the driver sources and sinks up to 20mA. The outputs are short circuit protected and clamped against a driving voltage of about 50V. The Pin assignment of the **XLR1** throughout **XLR4** connector is summarized below.

Pin 1	***n.c.***
Pin 2	***Signal common (GND)***
Pin 3	***Analogue Out 2***

Connect the external link cable to the motherboard connector ***P4*** and mount the board to the appropriate mechanical support unit.

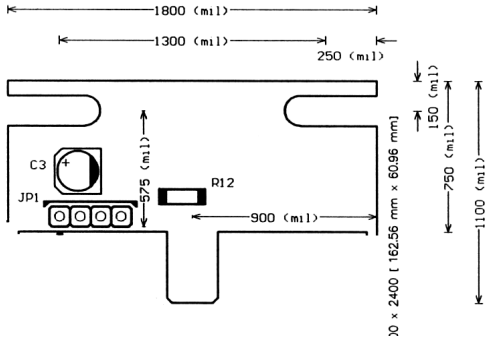


Connection to the motherboard via a 250mm 10pin ribbon cable AWG 28. Pin #1 marked red

For mounting the board to your framework use drill holes with diameters fitted for M3 screws - partly provided by the XLR connectors.

3.5. Synchronization sensor

Connect the external link cable to the motherboard jumper ***JP2*** and mount the sensor to the appropriate mechanical support unit. Adjust the sensor laterally for correct shutter position by shifting in belt direction until the **ZERO** position of the shutter is correct.



Use extra care when mounting the sensor to the mechanical framework. Observe the direction of the arrows at the sensor chip – **they have to point to the device**.

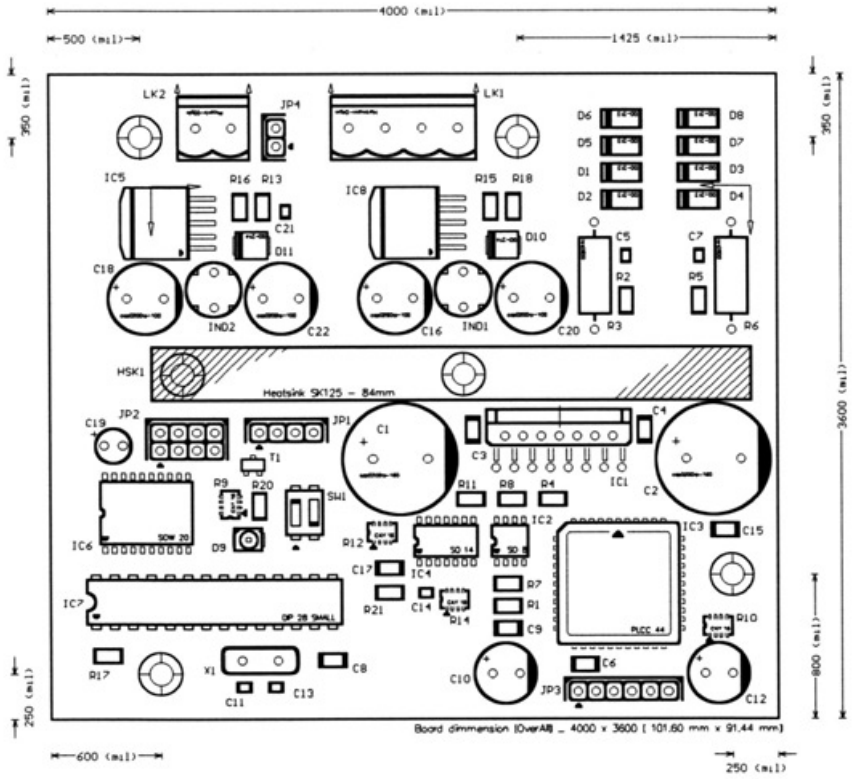
For mounting the board to your framework two drill holes with diameters fitted for M3 screws are provided near each end of the board.

3.6. Micro step Stepper driver

The micro step driver board handles the control of the 5 phase stepper. The board features an SDxP-IIC[6] serial communication facility, which is mastered by the main processor. Up to four boards can be connected to the same bus in daisy chain manner – so use extra care when changing the board address in case of driver replacement.

[6] The SDxP communication protocol handles checksum verification to avoid transmission errors due to noisy environment and provides data exchanges via a two wire interface.

The board is build around a Microchip PIC 16C72A™ RISC[7] processor, which entirely handles the controlling of the stepper motor and the data communication. In case of correct command transmission led ***D11*** flashes prior to command execution and as long as the stepper motor is rotating. Additionally, the board provides all the necessary voltage converters for the different locally power supply rails, including the logic supply. The voltage converter circuitry is based on Texas Instruments Simple Switcher™ technology.



[7] RISC stands for Reduced Instruction Set Computer. The basic idee of a RISC machine lies in a simpler core architecture of the processor.

The board is connected to a **+24V +/- 5%** power supply rail via connector ***LK2***. Connect the 2-phase stepper motor to ***LK1***. The motor is driven in bipolar mode; therefore observe correct wiring of the stepper coils to avoid damage of your hardware. The Connection to the motherboard is established via jumper ***JP2***, which also provides the power supply for the CPU core. Additional modules can be connected in a daisy chain manner to jumper ***JP1***. The external van (see for proper air flow within the case) can be connected to ***JP4***.

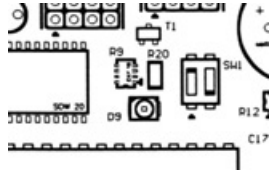
Pin 1	***+24Vdc (Maximum of 300mA)***
Pin 2	***Signal common (shield)***

Observe the current limitation of the van motor to avoid damage to your hardware. In case of uncertainty contact your hardware vendor.

The onboard CPLD (programmable logic device) can be updated and re-programmed in system via the JTAG interface connector ***JP3*** with features the necessary ISP pins. Contact your board vendor for further details.

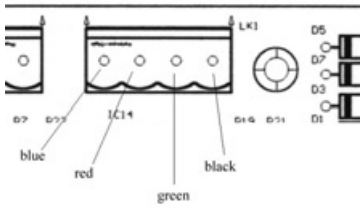
1. Setting the board address

A unique address has to be assigned to every board connected to the command daisy chain; the board address can be altered via ***SW1*** according to the binary system[8]. The address selection facilities of the board is not used throughout the ***PCS Shutter*** assembly.



2. Stepper connector

The stepper motor is connected to the microstep stepper driver via ***LK1*** a 10-pin Phoenix plug-in connector.



[8] Pin 1 marks the MSB switch. Within the PCS assembly only address 00 is used, therefore all other settings result in malfunction.

Connection to the motherboard via 7 x 200mm single lead cable AWG 24. Pin #1 marked green.

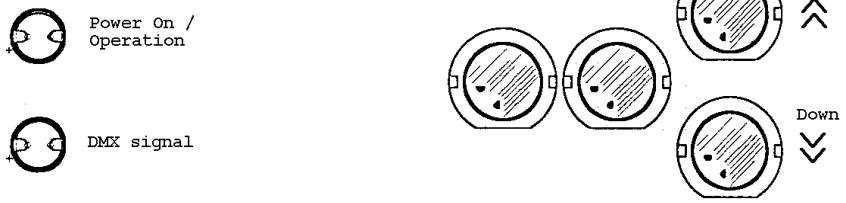
Connection to the power supply via a 2 x 150mm single lead cable AWG 20. Pin #1 marked red.

For mounting the board to your framework four drill holes with diameters fitted for M3 screws are provided near the edges of the board.

4. Firmware

The following section is intended to introduce you to the firmware of the ***PCS Shutter*** and explains the operation modes. Shows you how to alter different settings via the menu functions and get you working with the ***PCS Shutter***. Primarily the device can be operated in ***Remote Control*** mode controlling the Shutter position via the attached keyboard or remote commands. In ***Remote Control*** mode the device can be fully controlled via the DMX-512 interface. Two channels[9] must be reserved for controlling the shutter number. On the other hand you can simultaneously control the shutter number via the two analog input lines[10]. The device accepts an analog input voltage of *00 ... 10V* or the control via potential free *external contacts*.

Before going deeper into the details of the firmware the keyboard layout and the functionality of the keyboard buttons[11] should be illustrated briefly.



[9] Setting the DMX-512 base address to N for controlling the slide number, the device automatically reserves the next four addresses for controlling the internally available functions of the ***slide changer***. The base address can be set within the range of 001 ... 507, so the complete DMX-512 address space is available, but it is strongly recommended to use the lowest possibly base address for remote control.

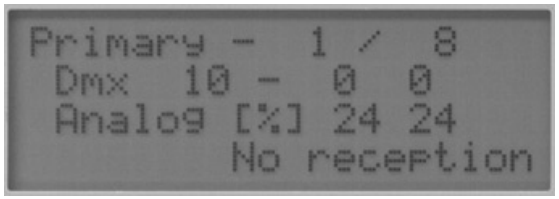
[10] The device strictly operates with a HTP (higher takes presidency) strategy. So whatever input signal (analog line, DMX command, keyboard event) triggers an operation the operation will be handled without any priority or time slot mapping. All available input sources are handled simultaneously.

[11] Some of the keyboard buttons exhibit second level functions depending on the operation status and the menu structure. The second level functions are cited in brackets.

Immediately after powering up, the ***PCS Shutter*** firmware performs a short power-on self check, reloads the last recent parameter settings and initializes the shutters to shutter **#1**. When the shutters are initialized the device is ready for operation and you can change the system settings if necessary.

4.1. Menu structure

Prior to discussing the different operation modes of the device, a brief note on the menu structure and the altering of the system settings will be helpful. Immediately after initializing the shutters, the device restores the operation mode, displaying the mode and mode relevant device information, like shutter number, DMX address, analog input voltage levels for both channels and the current DMX reception buffer info...



By pressing the ***Menu*** button the main menu pops up and you can scroll through the whole menu structure by pressing the ***Up*** and ***Down*** button. If you have done all your setup work just press the ***ESC*** button and the device resumes operation. During browsing the menu items and doing the setup work the device stalls all external operations.

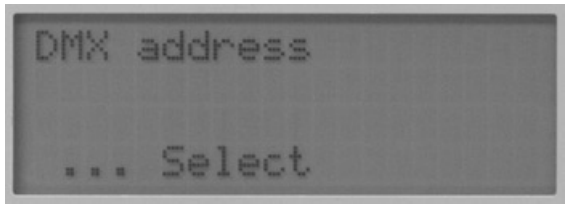
Operation mode	***Use to select one of the available operation modes – PRIMARY CONTROL operation, RANDOM ACCESS, AUTO TIMER or SCROLLING operation mode is available***
DMX address	***Use to change the DMX-512 base address of the PCS Shutter. Allows the changing of the DMX-512 base address and also changes the address space mapping of the DMX stack***
Shutter numbers	***Set the number of shutters your PCS Shutter is equipped with. For the ARC2-10 assembly a maximum number of 10 shutters can be assembled. You can set up any shutter number within the permitted range to be processed regardless of the actual number of shutters assembled. The BP-12 assembly supports up to 12 shutters.***

Exposure time	***Setup the time span your shutter is presented. This time defines the time span the actual shutter can be seen throughout your presentation.***
Fading time	***In case of using a shutter assembly in combination with your `PCS Shutter` the fading time defines the time span the actual shutter is faded out (or in) prior to be changed. The usage of a shutter must be enabled wit in the corresponding menu item.***
Shutter control	***Enables or disables the usage of a mechanical shutter. In case of enabling the shutter control the system creates a 10V … 00V voltage ramp at the analog output 1 prior to changing the shutter and vice versa when the next shutters fades in.*** ***The shutter control is only active in the AUTO TIMER operation mode.***
Auto timer mode	***In case of using the PCS Shutter as a stand alone device a variety of different auto timer modes can be selected. Starting with the `Single` mode, performing only a single cycle, `Uni-` and `Bi-directional` scrolling can be selected with different interleave factors and scrolling directions.***
Scrolling speed	***Set the scrolling speed for your presentation. Customize the speed of the shutter change to best fit your applications need. Altering the scrolling speed the process of changing the actual shutter may take from about 2s up to a minute and more.***
Scrolling direction	***Changes the direction for the `Scrolling` mode and also influences the scrolling direction for the `Auto timer` mode. Doesn't affect the operation in `Remote` or `Random Access` operation mode.***
Error code	***This menu entry permits the readout of the last recent error code. The device logs all operation errors leading to a restarting of the system. So in case of encountering any problems with your PCS Shutter report the error code to your system vendor it will be helpful for correct error diagnostics.*** ***The error code is intended for diagnostic purposes only and isn't used throughout the normal operation of the device.***
Acoustic Beep	***Use to toggle the acoustic confirmation flag. When enabled every keyboard action is confirmed by a beep. When disabled no acoustic signals are available – except during alert condition and in case of male editing by the user.***
Reload defaults	***Use this entry to reset the device to factory default settings[12] – use with extra caution all your previously done settings will be lost and the device restarts with the factory pre-settings. Mind that the calibrated settings for the shutter position are reset to***

[12] In case of having changed the settings in an unpredictable way and getting stucked on the way this is a very handy feature to void your current settings and getting started with the factory pre-settings. Except the DMX-512 address the factory pre-settings should match your needs for remotely controlling the ***`PCS Shutter`***.

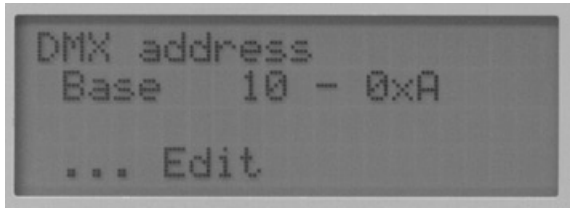
	factory settings too.
Calibration	***For high accuracy needs in this mode the shutter position can be shifted in single step mode. By pressing the UP button the shutter position can be shifted in high resolution mode for optimum fit to the desired position. The new calibrated shutter position is stored to the onboard EEPROM and is used throughout any following operation.***
Belt correction	***This option is only used throughout the initial calibration of the belt length due to mechanical tolerances of the driving belt. To calibrate the belt length select PRIMARY operation mode and scroll from shutter #1 … #6 … to #10(12). When overflowing from #10(12) to #1 the systems performs the fine calibration routine. A correct set belt correction offset results in a fine calibration movement ONLY in the direct of the current movement[13].*** ***By pressing the UP, DOWN button the belt correction offset can be altered to fit the desired offset. The newly calibrated offset is stored to the onboard EEPROM and is used throughout any following operation.*** ***The BELT CORRECTION OFFSET settings are not affected by the RELAOD DEFAULTS command.***

The above table gives you a summary on the available menu functions and a brief description of the entries and is primarily given for reference. In the following example the altering of the DMX-512 base address settings has been chosen to illustrate the way of browsing the menu structure. You can alter the settings to customize the device performance according to your needs.



[13] A wrong chosen belt correction offset result in a bi-directional fine calibration movement, for that case *reduce* the belt correction offset, e.g. from +3 to –1. The useable range for the belt correction offset ranges from –10 … +10 [1/10 mm].

If you like to do changes to the respective menu item just confirm your selection by pressing ***ENTER*** and the sub menu pops up giving you the opportunity of changing the relevant parameter settings. The figure below shows the numerical editing of the DMX-512 address, the address is given in decimal as well as in hexadecimal notation for eased binary to decimal conversion.



Now you either can change the numerical parameters by using the ***Up*** and ***Down*** buttons, toggle selections or just select one item out of a list of available items. The following deals with the numerical editing of the DMX-512 address.

By pressing the ***Up*** or ***Down*** button you can now change the numerical value of the DMX-512 address. The DMX-512 address is displayed in normal decimal as well as in hexadecimal notation, so addresses given in hexadecimal notation can be easily entered without complicated conversion from the hexadecimal to the decimal numbering system. The input routines automatically validates the entered address and limits it to the given range[14]. When you have finished your editing just press the ***ENTER*** button to make the changes permanent, save them to the onboard EEPROM and make the current address the default[15] DMX-512 address. Press the ***ESC***[16] button twice to resume.

Proceed with all other settings and parameters the same way as shown within the DMX-512 address settings example.

[14] An automatic roll-over functions provides a handy way to quickly change from lowest to highest DMX-512 addresses and vice versa. 000 – 511 and 511 – 000. The highest possible DMX-512 address of 511 is based on the fact, that the device reserves always two consecutive addresses and therefore a base address of 512 will cause male functioning of the device.

[15] The device will always start with the default settings after power up. So if you want your changes to be permanent you have to SAVE them to the onboard EEPROM and make them the default settings. If you do not save the changes to the EEPROM the device will operate with the current changes until the next power down and then reload the default settings from the EEPROM at power up.

[16] In case of getting stuck during editing of any settings or parameter pressing ***ESC*** always aborts the current editing and takes you up one menu level. Therefore pressing ***ESC*** twice gets you out of any editing and makes the device resumes normal operation.

In case of getting messed up within the menu structure pressing the ESC button twice always brings you back to the topmost menu and the device resumes operation immediately. Observe the green power led, whenever editing menu settings, this led fades out signalizing that the device is currently offline. Pressing the ESC button twice sets the device online[17].

IMPORTANT NOTE:

If you want to make your changes permanent you have to save them to the onboard EEPROM, otherwise they will be lost at the next power down.

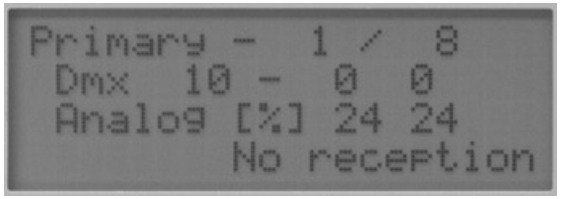
By pressing the ENTER and ESC button simultaneously the device performs a Soft-Reset and starts with initializing the shutter assembly.

4.2. Primary control operation mode

During ***Primary control*** mode operation all incoming signals via the DMX-512 lines, the analog input lines and the keyboard events will be processed simultaneously. Every valid incoming command forces the ***PCS Shutter*** to advance or reverse to the next shutter. In ***Primary control*** operation mode the changing of the shutter number is strictly limited to a step-by-step manner. It is not possible to address the shutters in a randomly way. If you like to scroll through all the available shutters just press to ***Up*** or ***Down*** button and the ***PCS Shutter*** will scroll through all shutters, but still in a step by step manner. To enable this quasi parallel processing of the input signals the device incorporates a HTP[18] (Higher takes presidency) strategy. As a base information the LCD display shows the actual shutter number, the maximum number of available shutters and an info string concerning the interface data.

[17] Under certain circumstance it is possible that the LCD display fades out. Under this circumstances please press the ***ESC*** button twice and wait for about 25s. The display resumes operation automatically. The fading of the display doesn't affect the operation of the ***PCS Shutter*** in any way.

[18] The device strictly operates with a HTP (higher takes presidency) strategy. So whatever input signal (analog line, DMX command, keyboard event) triggers an operation the operation will be handled without any priority or time slot mapping. All available input sources are handled simultaneously.



Additionally the DMX-512 base address and the DMX data along with the numerical data from the analog input lines is shown. The last row gives you an information update on the DMX reception buffer and status.

Press the ***Up*** or ***Down*** button to scroll from one shutter to the next. To get back to shutter #1 in the fastest possible way press both the ***Up*** and ***Down*** buttons simultaneously. To enter the ***Primary control*** mode press the ***Menu*** button, confirm the ***operation mode*** menu item by pressing ***ENTER*** again and scroll to the ***Primary control*** mode. Press ***ENTER*** if you want make your changes permanent and to save your changes to the onboard EEPROM. Finally press ***ESC*** twice to resume working.

The following table gives you a quick idea of the DMX-512 address assignment. The base address is set via the DMX address menu handler and is referred throughout the following as base address.

Primary mode operation		Random Access operation	
Base	Advance to next shutter Ø Shutter **N** to Shutter **N+1**	Base	Unlock command
Base + 1	Reverse to prior shutter Ø Shutter **N** to Shutter **N-1**	Base + 1	Address shutter number[19]
Base + 2	Analogue channel **01**	Base + 2	Analogue channel **01**
Base + 3	Analogue channel **02**	Base + 3	Analogue channel **02**
Base + 4	Program shutter scrolling speed[20]	Base + 4	Program shutter scrolling speed

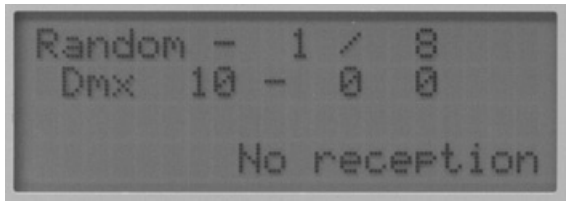
[19] For details check section on random access operation mode

4.3. Random Access operation mode

In case of engaging ***Random Access*** mode the device is entirely controlled via the DMX-512 interface lines (the keyboard is still active but allows only a shutter change in a step by step manner). The DMX-512 base address is used to trigger the shutter change. The next higher address is used as a pointer to address the selected shutter number. Observe the table below to correctly address your shutters.

Shutter number	1	2	3	4	5	6	7	8	9	10	11
DMX value [%]	< 8%	< 13%	< 18%	< 23%	< 28%	< 33%	< 38%	< 43%	< 48%	< 53%	< 58%
Shutter number	12	13	14	15	16	17	18	19			
DMX value [%]	< 63%	< 68%	< 73%	< 78%	< 83%	< 87%	< 93%	< 98%			

The first DMX-512 address is used to trigger the shutter changing. A numerical value > 80% triggers the command. When the command is processed reset the DMX value to < 20% to enable the next command processing. A constant DMX value > 20% keeps the command locking sequence in place. The numerical value of the next higher DMX address is mapped to specify the shutter number according to above table.



[20] The current firmware doesn't support the programming of the scrolling speed during the slide change via the DMX-512 interface. Set the speed via the corresponding menu item.

To enter the ***Random Access*** mode press the ***Menu*** button, confirm the ***operation mode*** menu item by pressing ***ENTER*** again and scroll to the ***Random access*** mode entry. Press ***ENTER*** if you want make your changes permanent and save your changes to the onboard EEPROM. Finally press ***ESC*** twice to resume working.

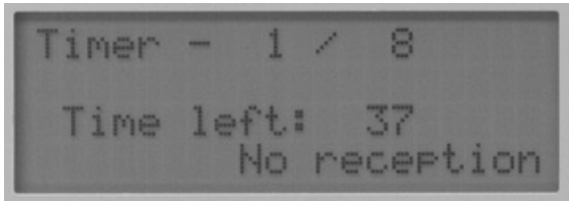
4.4. Auto timer mode

The ***Auto Timer*** operation mode is primarily intended for a stand-alone operation of the ***PCS Shutter***. In ***Auto Timer*** operation you can set the interval time between the shutter changes by customizing the ***exposure time*** according to you needs.

A variety of different modes easily allows you to fit the ***PCS Shutter*** operation you personal needs. The table below gives you a quick overlook on the available modes and their characteristics.

Single	***Performs a single cycle starting with shutter #1 to the last assembled shutter. When reaching the last shutter the device stalls any further movement.***
Uni- Directional	***Performs multiple cycles starting with shutter #1 to the last assembled shutter. When reaching the last shutter the device starts again with shutter #1 by performing an overflow from the last shutter to the first shutter. This timer mode performs infinite cycles***
Bi- Directional	***Performs multiple cycles starting with shutter #1 to the last assembled shutter. When reaching the last shutter the device changes the direction of movement and scrolls back to shutter #1 and starts the next cycle. This timer mode performs infinite cycles***
Uni- Directional Interleave	***Performs multiple cycles starting with shutter #1 to the last assembled shutter. When reaching the last shutter the device starts again with shutter #1 by performing an overflow from the last shutter to the first shutter. This timer mode addresses only every second shutter, e.g. 1 -> 3 -> 5 and so on..***
Bi- Directional Interleave	***Performs multiple cycles starting with shutter #1 to the last assembled shutter. When reaching the last shutter the device changes the direction of movement and scrolls back to shutter #1 and starts the next cycle. This timer mode addresses only every second shutter, e.g. 1 -> 3 -> 5 and so on..***

When programming the device for ***Auto Timer*** mode operation the ***PCS Shutter*** immediately resumes working after the power up sequence has been successfully performed. So no further user interaction is necessary to trigger operation. Additionally to the actual shutter number the time span to the next shutter change is displayed within the LCD display. Whenever the menu structure is entered the device stalls the ***Auto Timer*** operation as long as any settings are altered. This can be observed by the fading of the ***Power On*** led. After leaving the menu the device resumes operation immediately.



To enter the ***Auto Timer*** mode press the ***Menu*** button, confirm the ***operation mode*** menu item by pressing ***ENTER*** again and scroll to the ***Auto Timer*** mode. Press ***ENTER*** if you want to make your changes permanent and save your changes to the onboard EEPROM. Finally press ***ESC*** twice to resume operation.

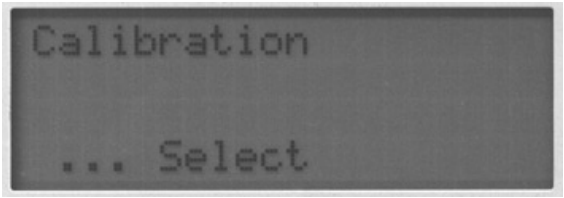
4.5. Menu handler and operation

1. Calibration

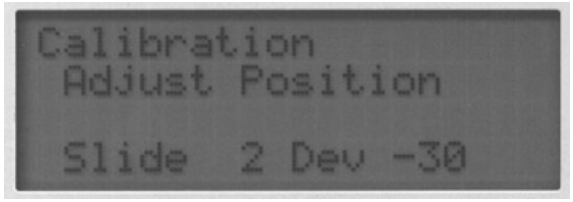
In case of needing a higher position accuracy than provided by the factory settings, the shutter position can be calibrated to match the shutter position for the projection with the target frame. By using the **calibration routine** you can alter the position settings for shutter number **2** throughout the last shutter. These new settings evaluated during the calibration routine will be stored within the ***onboard EEPROM***, and furthermore used as your new default settings. This means that the old settings will be replaced with the new calibration data.

So be extra careful when calibrating the device. In case of getting completely messed up with your calibration settings for the shutter positions use the ***Reload default settings*** menu to restore the factory settings.

To enter the calibration mode press the ***menu button*** and select the calibration menu[21] handler.



Confirm your selection again by pressing the ***ENTER*** button. For security purposes the system forces you to confirm your selection again. Do this by pressing the ***ENTER*** button one more time.



Now you are ready to calibrate the shutter position for **shutter #2**. The system always displays the shutter to be calibrated and the number of steps to the ***factory default position*** – the **deviation** from the factory settings. Mind that your calibration is always relative to the factory settings and the scrolling limits are **+/– 30 steps** relative to this position.

To alter the shutter position simple press the ***UP button*** and the shutter will scroll to the right. **Mind that you can only scroll the shutter to the right** – it is not possible to back up[22]. When the current position matches the targeted shutter position press the ***ENTER button***. The systems saves the current location and proceeds to the next shutter. Handle shutter **#3** throughout the last one in just the same way.

[21] Since the calibration menu is one of the last menu items within the menu structure, pressing the **UP** button is a good choice for speeding up the menu selection process.

After calibrating the last shutter the systems performs a warm start and is ready for operation. The newly calibrated settings will be used throughout normal operation as long as you do not reload the factory defaults or perform another calibration run.

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[22] Due to the deadlock of the gearbox it is not advisable to change the scrolling direction during a calibration run. So always have this fact in mind when deciding to move one step to the right.