OneLight Spectra

ONELIGHT SPECTRA

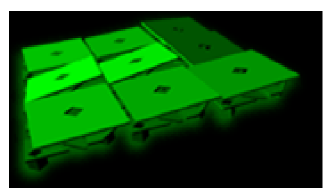
APPLICATION NOTE – TTL CONTROL AND SYNCHRONIZATION

The OneLight Spectra uses a MEMS based spatial light modulator manufactured by Texas Instruments as the heart of its light engine technology. This chip is commonly called a DLP (digital light processor) chip. The DLP chip provides many useful capabilities but to use it effectively in your application it is important to understand its characteristics and optical properties and to bear these in mind when designing your application. Because these mirrors can switch at high speeds, synchronization can be controlled quite precisely and so OneLight has built in a range of ways to synchronize illumination with other devices.

OneLight's spectrally programmable light engine uses the Texas Instruments digital light processor as a digital switch. This micro-electro-mechanical system (MEMS) chip can be programmed to control illumination with software, providing complete digital control over wavelength selection, intensity, exposure time, and timing sequences. This chip is a low-cost fully developed product widely used by many companies producing digital projectors and rear-projection televisions.

OneLight uses this array of tiny mirrors to control the distribution of color in light. Its light engine splits the white light from a bright lamp into its constituent colors – much like a prism projects a rainbow of color onto a wall on a sunny day – and then projects this rainbow onto the DLP chip. The microscopic computer-controlled mirrors can be switched on and off at high speed to select and change the color distribution of the light, enabling the technology to switch between or blend together multiple wavelengths of light at great speed.

This true platform technology replaces many complex mechanical systems for shaping and controlling illumination with a single high-performance device. Now, instead of engineering complex opto-mechanical light sources, OneLight customers can program the light distribution they need nearly instantly and then combine data about the light illuminating their subject with their image data.



DLP Chip with rainbow spectrum and close-up of microscopic mirrors

DLP Switching Characteristics - The chip consists of tiny mirrors that tilt through an angle of +12 or -12 degrees. They are bi-stable, having only two active positions, but are designed to switch rapidly between these two positions. Switching occurs as a result of electrostatic attraction between energized electrodes at the corners of the mirrors. The movement of the mirrors is along an axis between two opposing corners of the mirror. A third position can occur when the system is not powered. In this state the mirrors "float" in an approximately horizontal position. While the mirrors are too small to observe with the naked eye, their approximate dimensions relative to the active area pf the chip can be seen by walking close to a projection screen during a presentation using a well-focused DLP projector. Then the individual squares of each mirror can be seen on the projection screen.

The mirrors of the DLP can be switched in microseconds. From the time the electrodes are energized until the mirror flips from one state to the other is about 2 microseconds. All electrodes are energized simultaneously. After the mirrors switch there is a period of vibration or oscillation while they settle into their new position. This lasts up to 10 microseconds. If one monitors the energy delivered by the mirror to a detector at some distance from the mirror one will see a variation in the energy projected that is analogous to the “ringing” of a transistor switch.

Loading Data to the DLP – The data that defines the state of the mirrors is loaded into a memory register. The binary state of this register determines whether a mirror will be set to on or off. Once the data is loaded into this register a single signal then triggers the transfer of the new data to the mirrors. Data loading and transfer operations are separate processes. Data transfer speed is very fast (2-10 microseconds) and is the limiting factor for synchronization precision. Data loading speed is longer and determines the speed at which newly defined or calculated patterns can be loaded to the chip (about 250 microseconds). The chip also has the ability to store up to eight predefined patterns that can be loaded at higher speed.

Synchronization Modes - The FPGA controller of the OneLight Spectra light engine has a number of triggering modes built into it. These are all subject to the limitations of loading the pattern into the mirror array memory register. Once a pattern is loaded into the register, the user can program a number of automated timing functions that are independent of the host computer or system software. The two main modes are triggering on data received.

Data Synchronization - The FPGA controller of the OneLight Spectra light engine can trigger the setting and resetting of the mirrors of the DLP in several timing modes. After data is loaded into the mirror memory register, the mirrors can be set to switch to the new pattern when data transfer is complete, or in response to an external TTL trigger signal. The switch to the new pattern can occur immediately after these events or a programmed delay of up to sixteen seconds can be set by the FPGA. Once the new pattern is switched in it can be held indefinitely while waiting in response to external data and/or TTL triggering or can be set to expose for a fixed exposure time of up to 16 seconds. The programmed delay or the active illumination time can be set to a value in microseconds, but accuracy will be reduced as the time that is set approaches the switching time of the mirrors.

Command List – The following is a list of triggering related commands for the OneLight Spectra. For a detailed explanation of these commands and their parameters refer to the SDK manual.

Input Trigger

- int dmdGetInputTrgrStatus(HANDLE hDevice)
- int dmdGetInputTrgrMode(HANDLE hDevice)
- int dmdGetInputTrgrDelay(HANDLE hDevice)
- int dmdGetInputTrgrHold(HANDLE hDevice)
- int dmdSetInputTrgrMode(HANDLE hDevice, int nMode)
- int dmdSetInputTrgrDelay(HANDLE hDevice, int nDelay_us)
- int dmdSetInputTrgrHold(HANDLE hDevice, int nHold_us)

Output Trigger

- int dmdGetOutputTrgrStatus(HANDLE hDevice)
- int dmdGetOutputTrgrMode(HANDLE hDevice)

- int dmdGetOutputTrgrDelay(HANDLE hDevice)
- int dmdGetOutputTrgrHold(HANDLE hDevice)
- int dmdGetActiveOutMode(HANDLE hDevice)
- int dmdSetOutputTrgrMode(HANDLE hDevice, int nMode)
- int dmdSetOutputTrgrDelay(HANDLE hDevice, int nDelay_us)
- int dmdSetOutputTrgrHold(HANDLE hDevice, int nHold_us)
- int dmdSetActiveOutMode(int handle, int mode)

TIMING – The following is an excerpt form the programming guide describing some of the timing characteristics of the OneLight Spectra. For a detailed explanation of these commands and their parameters refer to the SDK manual.

The following descriptions explain the timing of the communications with the device with the various triggering options.

<u>dmdTrgrInOnDataReceived</u>

Once pattern data is received, the delay count begins immediately. After the delay count ends, the mirrors are updated. The hold count then begins. When the hold count ends, the mirrors are cleared. If you wish to keep the mirror pattern permanently, set the hold count to zero.

<u>dmdTrgrInOnRisingEdge</u>

<u>dmdTrgrInOnFallingEdge</u>

<u>dmdTrgrInOnEitherEdge</u>

When the edge trigger condition occurs, the delay count begins. After the delay count ends, the mirrors are updated. The hold count then begins. When the hold count ends, the mirrors are cleared. If you wish to keep the mirror pattern permanently, set the hold count to zero. After the mirrors are cleared the edge trigger may be issued again, and the delay then hold repeats. If a trigger occurs while a previous trigger is either delaying or holding, then that newer trigger is ignored.

<u>dmdTrgrInFollowActHi</u>

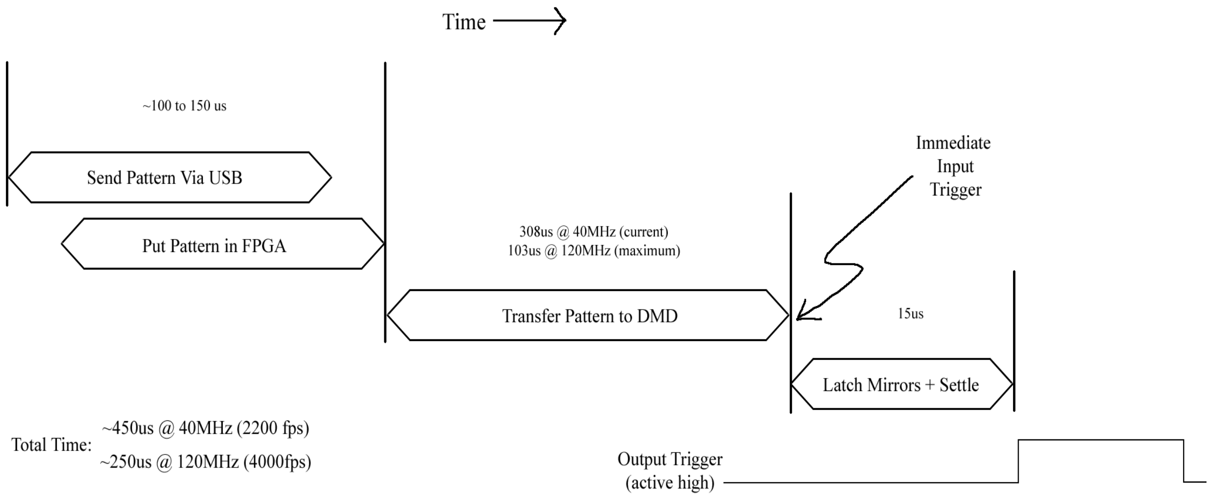
<u>dmdTrgrInFollowActLow</u>

The delay count and hold count are not used. The state of the mirrors simply follows the state of the trigger. When the trigger is active the pattern is loaded onto the mirrors. When the trigger is inactive the mirrors are cleared.

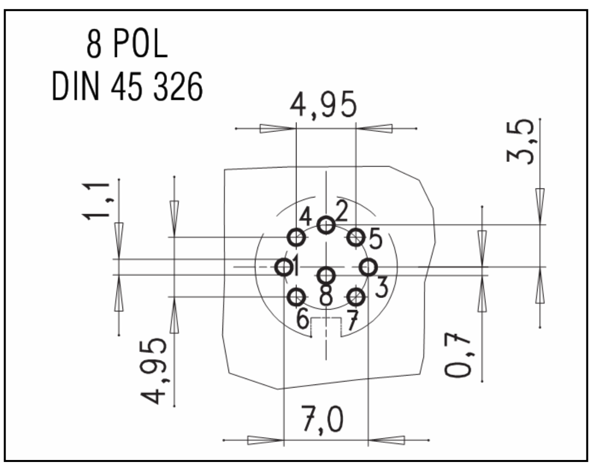
There is a short delay to load and clear the mirrors (~250 us).

Example Timing:

Figure below shows an example timing diagram for sending a new pattern to the DMD with an immediate input trigger. The current clock speed is 120 MHz, so the data transfer time is 103 microseconds.

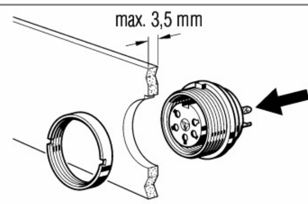


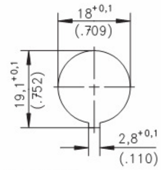
TTL Connector – The TTL connector is at the back of the OneLight Spectra and is a circular AMP connector mounted to the back panel board. This connector is polarized and selected excerpts from the manufacturer's specification sheets are provided below. The connector has 8 sockets. Because the inputs and outputs are optically isolated both power and ground must be supplied to the connector from the interfaced device. This can be either 5V for 5V TTL or 3.3 V or 3.3 V TTL. The system will automatically adapt to either supply. There are 3 positions that are for input signals and 3 positions for output signals. Currently these inputs and outputs are not individually addressed, but operate in common. There is provision for setting these up in future as separately triggered inputs or outputs for controlling multi-channel devices such as RGB cameras. These signals are routed via a connector to the FPGA controller where they are interpreted by the system firmware



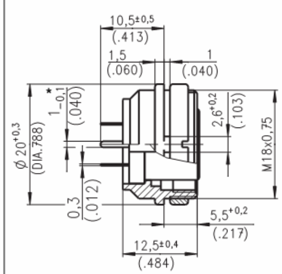
C 091 A

Female receptacle, screw locking, rear mounting





Panel cutout

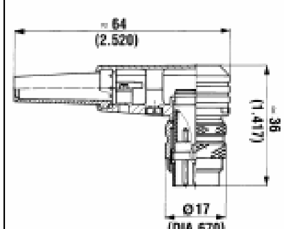


*Measure 12- and 14-pol. Ø 0,6

Female receptacle, termination: straight dip solder, pin length 10.5 mm from flange, panel mounting with ring nut, contact plating: silver or gold. solder area: tin plated	*Measure 12- and 14-pol. Ø 0,6	2	T 3203 400	–	–	–
		3 DIN	T 3263 400	–	–	–
		4 IEC	T 3303 400	–	–	–
		5	T 3363 400	–	–	–
		5 S DIN	T 3359 400	–	–	–
		6 DIN	T 3403 400	–	–	–
		7	T 3478 400	–	–	–
		7 DIN	T 3487 400	–	–	–
		8 DIN	T 3507 400	–	–	–
		12	–	–	T 3638 404	–
		14	–	–	T 3653 404	–

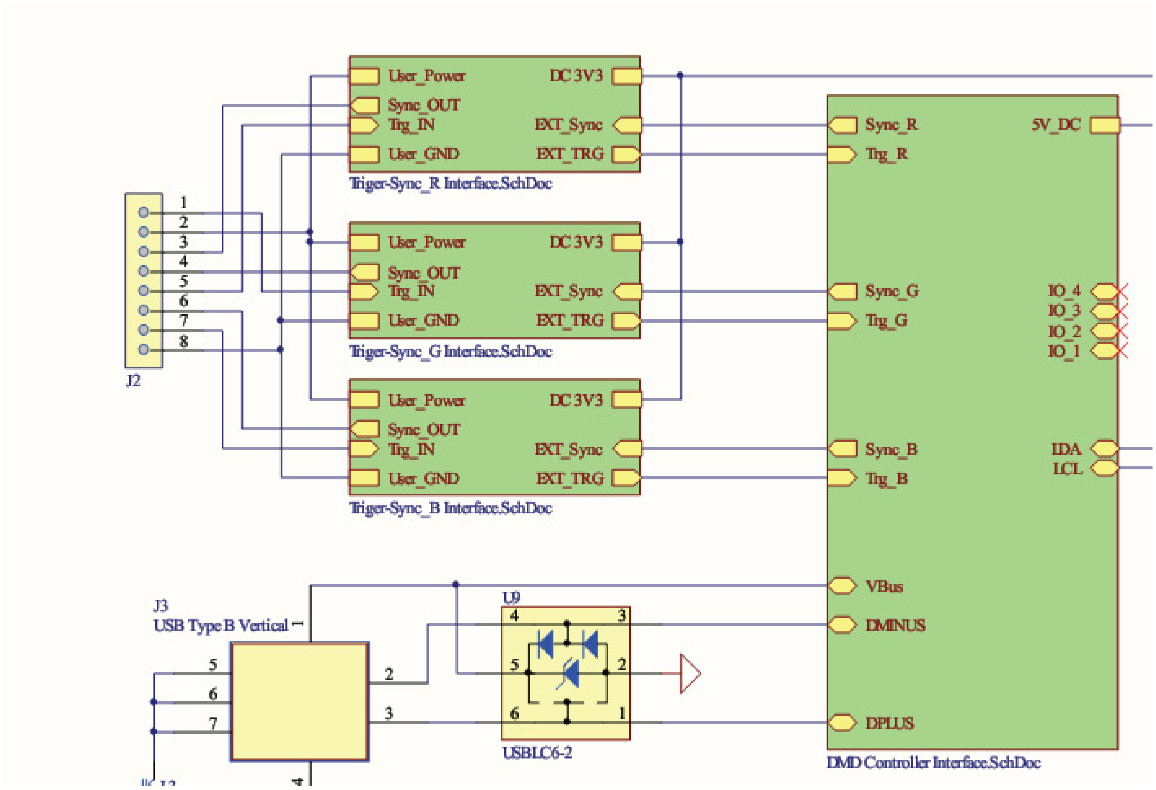
C 091 A

Male cable connector, screw locking, right-angled



Description	Drawing	No. of cont.	Part Number solder termination Contact plating silver	Contact plating gold [2]	Part Number Crimp termination[1]
Male cable connector, right-angled, max. cable outlet 6 mm, termination: solder or crimp, contact plating: silver or gold.		2	T3200 005	T3200 058 [4]	–
		3 DIN	T3260 005	T3260 058 [4]	T3260 055 [4]
		4 IEC	T3300 005	T3300 058 [4]	T3300 055 [4]
		5	T3360 005	T3360 058	T3360 055
		5 S DIN	T3356 005	T3356 058 [4]	T3356 055 [4]
		6 DIN	T3400 005	T3400 058	T3400 055
		7	T3475 005	T3475 058 [4]	T3475 055 [4]
		7 DIN	T3484 005	T3484 058 [4]	T3484 055 [4]
		8 DIN	T3504 005	T3504 058 [4]	T3504 055 [4]
		12	T3635 005	T3635 058	–
		14	T3650 005	T3650 058	–

[1] Please order crimp contacts separately, see page 46 [2] See remark page 9 [4] Available upon request. Min. order qty.100 pcs/type.



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