DIRECTIONS FOR USE OF PLATO SPECTACLES

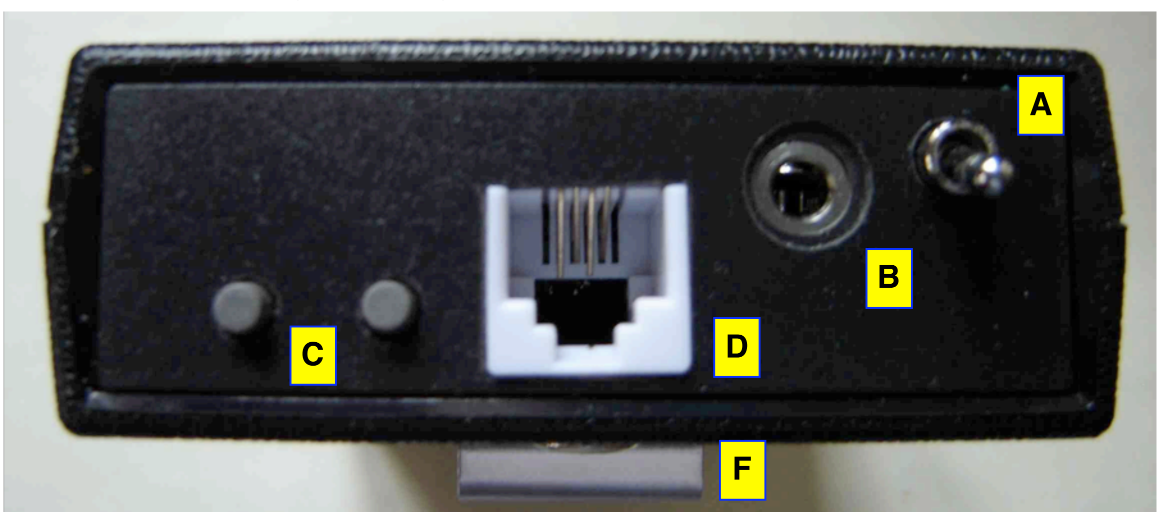
WARNING: THE AIM OF THIS PRODUCT IS TO ALLOW AN EXPERIMENTER, WORKING UNDER CONTROLLED CONDITIONS, TO INFLUENCE THE ABILITY OF THE WEARER OF THE PLATO SPECTACLES TO VIEW THE WORLD AROUND HIM / HER.
CAUTION IS THEREFORE NECESSARY TO ENSURE THAT NO HARM BEFALLS A SUBJECT WEARING THE SPECTACLES WHILE VISION IS OCCLUDED.

1. The spectacle driver unit (the "black box") is powered by a 9 volt battery (not supplied). It can be replaced by opening the battery compartment at the rear of the box. Use of high capacity alkaline batteries is advised. (The piece of foam inside the battery compartment is provided to prevent movement of the battery within the box.) If the unit is to be stored for a significant period of time (several days or more), it is advisable to remove the battery, to protect the unit from possible battery leakage.

2. As an alternative to the 9 volt battery, a DC voltage jack is provided on the side of the spectacle driver unit. For your convenience, an external AC adaptor is also provided. Please select the appropriate wall plug for your particular part of the world before using the AC adaptor.
   (Should you lose or damage your AC adaptor, Translucent Technologies will be able to provide a replacement. Alternatively, if you wish to procure your own, please make sure that you select a *regulated 9 volt DC source, with its central tip positive, and capable of providing at least 600 mA*.)

3. A photograph of the top panel of the spectacle driving circuit is shown in Fig. 1. The ON-OFF toggle switch (A) is situated on the top right hand part of the panel, with ON corresponding to an upward position.
   Note that, because a significant amount of power is consumed within the circuit *even when the spectacles are not operating*, it is advisable to leave the circuit in the OFF state whenever possible, especially if you are using a 9 volt battery as your primary power source.

Fig. 1: Driving Circuit Panel (Top View)



4. The cable leading from the PLATO spectacles is terminated by a 3.5 mm stereo audio jack. It can plug into only one possible receptacle (B) on the driving circuit panel, as shown.

   NB: Make sure that the ON-OFF toggle switch (A) on the panel is in the OFF position before plugging in or unplugging the cable from the spectacles.

   NB: It is important never to disconnect the PLATO spectacles – that is, never to pull out the 3.5 mm stereo jack – while the spectacles are in their transparent state. Doing so may cause short circuiting of the liquid crystal cells, which may render them permanently damaged.

5. Operation of each PLATO lens can be tested with the single push-button switches (C) on the panel. Each PLATO lens will turn from translucent (milky) to transparent for as long as the corresponding switch is depressed. Both switches may be pressed simultaneously.

6. TTL logic signals are to be used to control the switching of the lenses during operation.
   The lenses are naturally "closed" (milky translucent), unless short-circuited, in which case they "open" (become transparent) immediately. See Fig. 2 below.

   The switching logic signals are to be supplied through the modular (RJ-14) phone jack on the panel (D in Fig. 1). For your convenience, one cable has been supplied, terminated on one end by a modular male four connector phone jack, which fits into the modular plug (D) on the panel.
   NB: Commercial telephone equipment is NOT to be connected through this receptacle; serious damage may result if this is done.

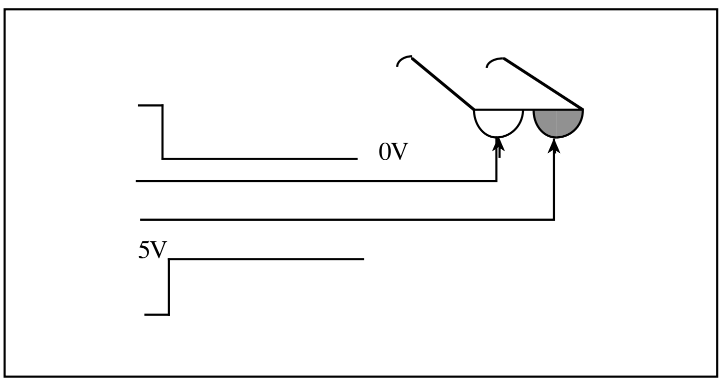
   The wire connections for the TTL logic signals are as follows:

   The **Red** wire controls the **right** lens.
   The **Yellow** wire controls the **left** lens
   The **Black** and **Green** wires can both be used as ground connections.

   Either an open circuit or 5V DC (Red to Black and/or Yellow to Green) will keep the corresponding lens on either side translucent, or milky, as illustrated in Fig. 2.

   Either a short circuit to ground or 0V DC will make the corresponding lens on either side transparent, as illustrated in Fig. 2. (Note: The low voltage (0V) signal can also be achieved simply by short-circuiting the corresponding leads to ground (i.e. to black or green).)

Fig. 2: Switching Circuitry Logic



7. The spectacle driver unit may be inserted in the subject's breast pocket, or it may be clipped on the subject's belt using the attached belt clip (F in Fig. 1).

8. *Cleaning*. The liquid crystal lenses inside the PLATO spectacles are constructed using special plates of glass. The lens surfaces can thus in one sense be cleaned just like any other glass surface. However, it is imperative to keep in mind that there are electrical connections inside the spectacle frame, as well as special sealing material holding the lenses together. One should therefore prevent any water or any other cleaning fluid from entering *inside* of the spectacles. Consequently, if cleaning with a dry cloth proves to be inadequate, you may try using a suitable (non-corrosive, non-abrasive) glass cleaning solution. However, you are advised not to spray any liquids directly onto the lenses or the frame. Instead you should slightly dampen a cloth with the solution and *then* wipe the lenses with the dampened cloth.

In case there are any problems ....

a. Symptom: The spectacles do not respond to any command signals.
   Solution: Check that the battery is in place, or that the external voltage supply is properly connected, and that the On-Off Toggle Switch (A) is in the ON (up) position.

b. Symptom: Liquid crystal cells behave erratically, flickering on and off, etc.
   Solution: The 9 V battery may be too weak (< 6-7 volts). Replace it.
   If an external power source is being used, check that the current supplied is adequate (>500 ma).

c. Symptom: The logic signals do not drive the unit properly.
   Solution: Check that the wire connections for the logic signals are correctly configured, according to Point 6 in the Instructions.

NOTE: Your driving circuit has been equipped with special circuitry to protect it against current surges due to any short circuit in the spectacle system. Whenever this circuit is activated, the driving circuit system will cease to function normally and the spectacles will not be able to operate. The unit must be *restarted* in this condition. Clearly, if this symptom recurs, and persists – that is, if your driving circuit continues to shut itself down – you should assume that something is seriously wrong with your system. In that case, please contact Translucent Technologies, in order to arrange for the problem to be fixed.

Under no circumstances are either the PLATO Spectacles or the Spectacle Driver Unit to be disassembled or are any of the internal connections to be altered. Doing so will void all warranties, and any ensuing damages are the responsibility of the owner.

PLATO Visual Occlusion Device: Technical Specifications

PLATO Spectacles

Weight:	About 100 gm (not counting cable)
Cable to electronic driving circuit:	May be extended using a simple audio extension cord
MRI compatibility:	
Spectacles:	Yes (spectacles held together with nylon screws and glue)
Electronic driving circuit:	No (extra audio cable must be spliced on, to remove from MRI field)

PLATO Electronic Driving Circuit

The data provided here pertain to model P-4, P-5, P-6 electronic driving circuits, shipped on or after July 2007.

Nominal output voltage to PLATO spectacles:	±110 volts square wave (i.e. 220 v peak-to-peak), 250 Hz
Typical current consumption (both lenses open):	160 ma (for 9 V input)
Input (battery) voltage:	9 V DC (±2 V)
External DC supply:	9 V (regulated), 600 ma (preferred), centre positive
Control signals:	TTL: (Low = Open; High = Closed)
Input connector for control signals:	RJ-14 phone jack

PLATO Liquid Crystal Lenses

The data provided here pertain to model S-3 and S-4 PLATO spectacles, shipped on or after February 2006.

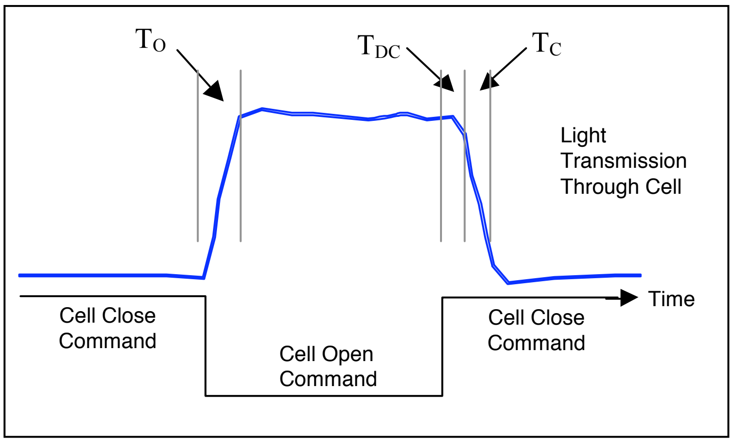
Light Transmission

PLATO l.c. lenses have been estimated to transmit approximately 80% of incident light.

Temporal Response [1]

The estimated parameters are illustrated in the accompanying figure, where the three timing parameters are as follows:

- T_O represents the time taken to switch to the Open state (from the Closed state).
- T_{DC} represents a Time Delay between start of the Close command and start of the transition from Open to Close.
- T_C represents the time taken to switch to the Closed state (from the Open state).



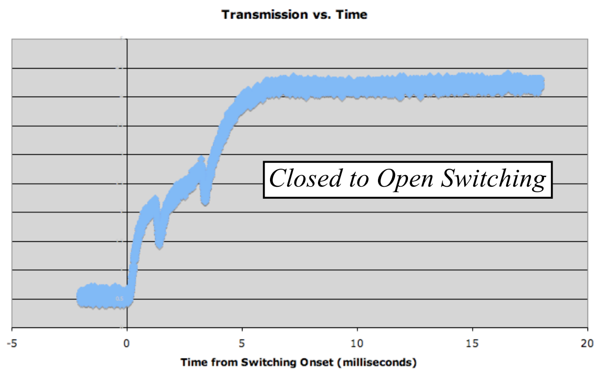
In the graphs below, the horizontal axes are scaled in milliseconds, as indicated.

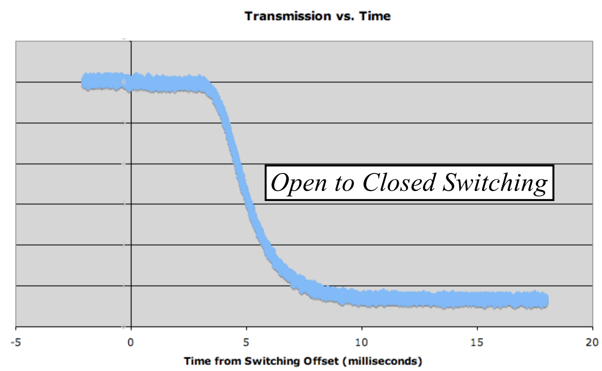
The vertical axis represents light transmission; however, units have intentionally been omitted, to emphasise the fact that this measurement should be interpreted as representing temporal switching response only.[2]

Closed to Open Switching (T_O)

The figure on the left shows the temporal response for switching from the Closed to the Open state, initiated through application of a high voltage square wave at time t=0. (See technical specifications for electronic driving circuit.) [3]

Keeping in mind the cautionary comment regarding switching time definition, a proposed estimate of the transition time from the closed (scattering) state to the open (transmissive) state is: $T_O \approx 4$ ms.





Open to Closed Switching (T_{DC} and T_C)

The figure on the right shows the temporal response for switching from the Open state to the Closed state. This transition is initiated through removal of the high voltage electrical field at time t=0. (Because the electrical field is not present during the transition, we do not see the same discontinuities in this graph.)

The first feature to note is that the transition from scattering to clear does not commence immediately upon reduction of the driving voltage. Rather, there appears to be a pure time delay of $T_{DC} \approx 4$ ms before the transition begins.

The second feature to note is that (keeping in mind the cautionary comment about defining switching times), a proposed estimate of actual transition from scattering to clear is: $T_C \approx 3$ ms.

The implication of the two phase transition noted above is that there are two possible ways in which the Open to Closed transition may be reported: a) ≈ 7 ms or b) ≈3 ms .

For many who use the PLATO spectacles with Open and Closed durations along the order of 100's or 1000's of milliseconds, the first figure of 7 ms is expected to be quite satisfactory.
For those for whom milliseconds are important, the justification for the second figure of 3 ms is that it is entirely feasible, for a great number of cases, simply to program one's TTL driving signal to tell the lenses to close 4 ms earlier than actually desired. With such a strategy, the 4 ms advance will cancel out the 4 ms switching delay, leaving an effective transition time of ≈ 3 ms.

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[1] The temporal measurements presented here were obtained by shining a laser perpendicularly through a sample l.c. lens, while recording the transmitted light using a high speed photodetector, sampled at 500 KHz. The lens was triggered on and off using a pulse generator. Low transmission measurements represent the closed state, where light incident on the sensor is due to scattered laser light plus ambient reflected light. High measurements represent the open state, where the sensor measurements are due primarily to transmitted laser light.

[2] Caution is recommended when estimating absolute switching times from these data, based on the fact that human perception of contralateral visual information does not necessarily vary linearly with the amount of light transmitted. In other words, even though it is straightforward to objectively measure the amount of light being transmitted through and reflected from the surface of the l.c. cell as it is switched between the clear / transmissive state and the scattering / occluding state (using for example a 10% to 90% transition criterion), it is not straightforward to conclude at what point during the transition between clear to scattering a human observer will reach a threshold of scattering, above which features on the other side of the lens can no longer be reliably perceived. A similar challenge exists with regards to transition from scattering to clear; it is not straightforward to estimate the level of decreasing scattering that corresponds to the threshold below which reliable perception begins. In both cases, it is (arguably) reasonable to assume that the actual effective switching times are *less than* the times that would be estimated simply on the basis of an objective measurement of the time taken for minimal-to-maximal scattering or for maximal-to-minimal scattering.

[3] The two discontinuities in the transition curve can be attributed to the cell's transient response to the 250 Hz electrical field. The switching of the polarity of this carrier wave every 2 ms is therefore manifested through the two 'bumps' at 2 ms and 4 ms.