VIRTUALITY®

LED Viewfinder Display

For

Single Lens Reflex Cameras

Prepared for:- Nikon Corporation, Japan.

Prepared by:-

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PART NAME	Virtuality® Viewfinder Display	GM	M	C	Supervisor
		JW			RH
Code		Production Division	Dai Nippon - Japan		
		Production Date	Target Q2, 2007		

DISCLAIMER

Date:		Authorised	
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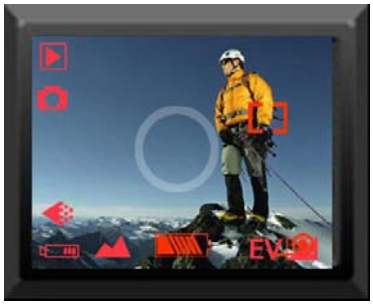
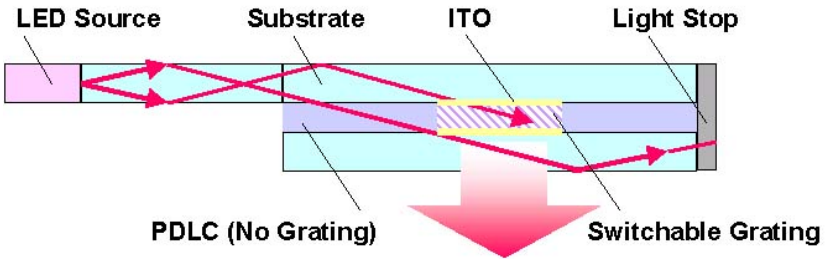
VIRTUALITY® - (Transparent "Heads-Up" Display)

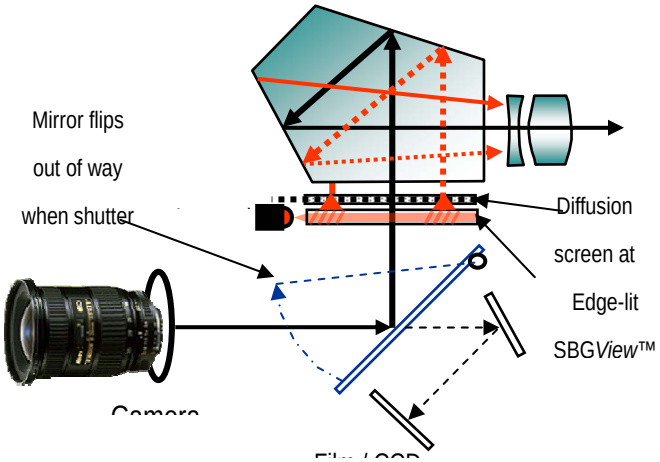
SBG Labs has developed a fundamental new "Heads-Up" display technology called Virtuality®. Aimed at Digital Single Lens Reflex (DSLR) Camera Viewfinders, Cell phones and PDA's, it looks at first sight like a clear glass panel. Switched on however, the display is formed by coupling edge illuminated LED or LASER light and emitting the coupled light using a Switchable Bragg Grating (SBG) film. The SBG film replaces regular Liquid Crystal film. Both are patterned similarly to form symbols, characters or pixels. However, when the grating film is active, the light is coupled with extreme efficiency.





So the display is inherently TRANSPARENT, where the brightness of the overlaid symbology is so intense, that it overwhelms rear view light, providing a bright high contrast display with super high quality colors. The result is a breakthrough, transparent, flat panel camera viewfinder display, ideal for Digital Single Lens Reflex (DSLR) camera applications.

- **World's first - "Heads-Up" Display**
- **Icons, Alpha-Numeric Characters, Frames**
- **Daylight Compatible Brightness**
- **Thin, Lightweight**
- **Low voltage & Power**
- **Full Color availability**



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1-2 Preliminary Application Specifications

PARAMETER	SPECIFICATION
Display Modes	Transparent Viewfinder Information Display. Focal Plane Located.
Display Size	As per attached Drawings
Display Aspect Ratio	As per attached Drawings
Illumination Source	Red, green and blue LEDs
Luminance of Symbols	
Contrast ratio of symbols	>100:1
Switching Speed	Typically < 200-800 microseconds
Switching Voltage	12 volts
DigiLens Diffraction Efficiency	Active: >98% Inactive: 0.01% - Transparency ratio 500:1
Optical Transmission	Typically > 98% for normal incidence.
Spectral Bandwidth	Compatible with any available red, green, blue LED
Wavelength Range	Compatible with any available red, green, blue LED
Bragg Grating Resolution	Bragg fringe separation below 200 nm.
Bragg Grating Layer Thickness	Nominally 3.5 microns
Optical Transmission	Typically > 98% for normal incidence.
Scatter and Stray Light	Scatter less than 1%. Stray light <0.1% of incident light
DigiLens Thickness	Nominally 2-3 mm.
Uniformity And Repeatability	The uniformity is in the region of ± 1%.
Operating Temperature	-5 C to 50C
Non-Operating Temperature	-20C to 60C
Operating Humidity	20% to 80% non-condensing
Non-Operating Humidity	5% to 95% non-condensing
Power Consumption	Nominal <0.05mW/mm2

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1-3 Preliminary Application Specifications

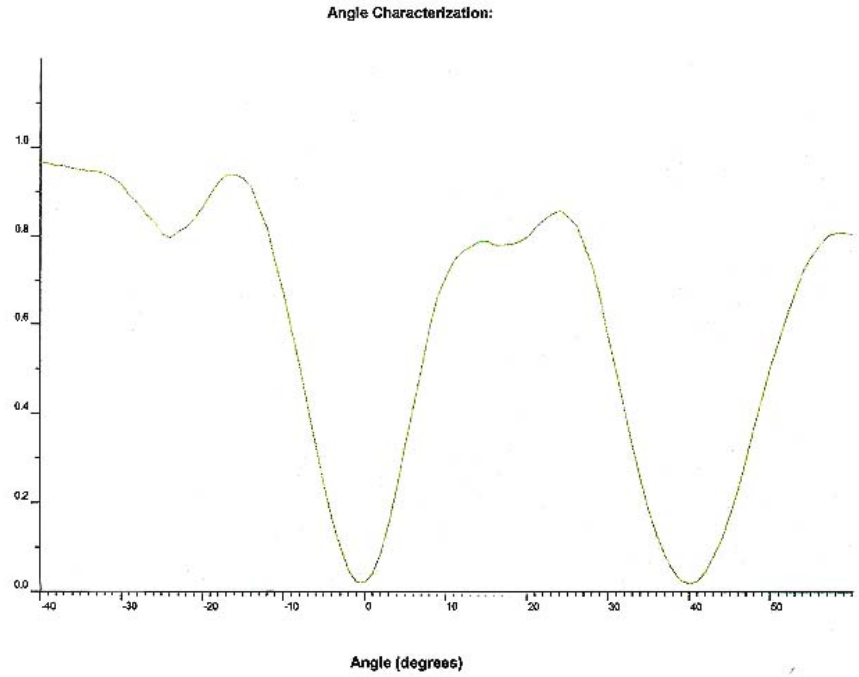

FIG.4 Diffraction Efficiency vs. Angle (Green: 532 nm.)

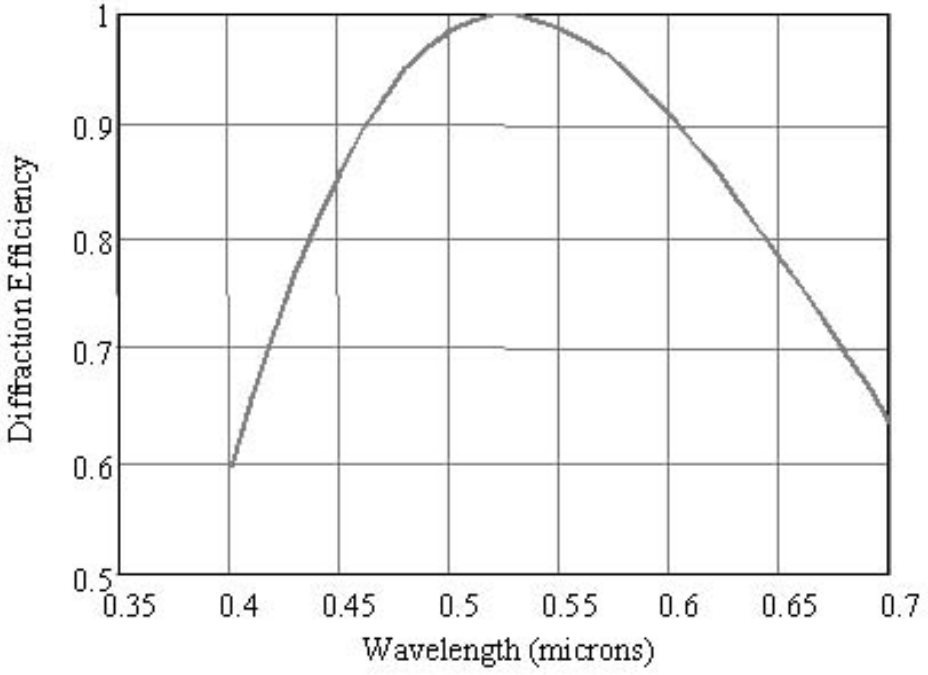

FIG.5 Diffraction Efficiency vs. Wavelength (Green: 532 nm.)

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2. GENERAL VIRTUALITY® DEVICE SPECIFICATIONS

Diffraction Efficiency (Transmission HOE)	Active: >98% Inactive: 0.01% - Transparency ratio 500:1
Diffraction Efficiency (DE) angular variation	@40° Bragg Angle) Angular Bandwidth = 20° (FWHM) @ ± 3° of Bragg Angle 90% of peak DE @ ± 5° of Bragg Angle 80% of peak DE
Scatter and Stray Light	Scatter less than 1%. Stray light <0.1% of incident light
Switching Speed	< 200-800 microseconds (faster if required)
Spectral Bandwidth	High diffractive efficiency for LED bandwidth 20-50 nm
Wavelength Range	Compatible with all laser/ LED sources Can be optimised from ultraviolet to L & S (telecom).
Bragg Grating Resolution	Below 1 micron. Bragg fringe separation below 200 nm.
Hologram Layer Thickness	Around 2 to 12 microns application dependant
Optical Transmission	Typically >98% for normal incidence.
Polarization Characteristics	Max diffraction efficiency for p-polarization each layer
Active Dimensions	As per drawings (subject to laser damage threshold). In general the active dimensions may be designed for compatibility with any practical optical application eg the active dimensions may range from sizes as small as 1/8" diagonal to over 35" diagonal.
DigiLens Thickness	In range 0.2 – 3mm, application dependent
Laser damage threshold	1 W/cm2
Shrinkage Characteristics	Approximately 1.9%. – accounted for in design
Uniformity And Repeatability	The uniformity is in the region of ± 1%.
Power Consumption	Nominal <0.05mW/mm2
Reliability	Batch tested to 5000 hrs 85/85 accelerated life test.
Volume Supply	ISO Manufactured / Supplied FOB in Japan
Environmental Conformance	Less than 1% performance variation 0° to 55°C
Life Expectancy	Similar to PDLC >100,000 hours. Similar to other commercial PDLC based products

3. SHAPE AND DIMENSIONS

As per the attached diagrams. However, delivery specifications are to be submitted prior to delivery.

4. TERMINALS

Comprises a total of 6 common and segment terminals. Specifics thereof are as indicated in the attached diagrams.

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5. ELECTRICAL CHARACTERISTIC STANDARDS

5-1 Absolute maximum rating

ITEM	SYMBOL	STANDARD VALUES	UNIT	REMARKS
Volts alternating current	VAC	40	Vp-p	
Volts direct current	na	na	V	
Direct current residual component	VRE	300	mV	
Operating temperature range	Topr	-5 ~ +50	°C	No dew formation
Storage temperature range	Tstr	-20 ~ +60	°C	No dew formation

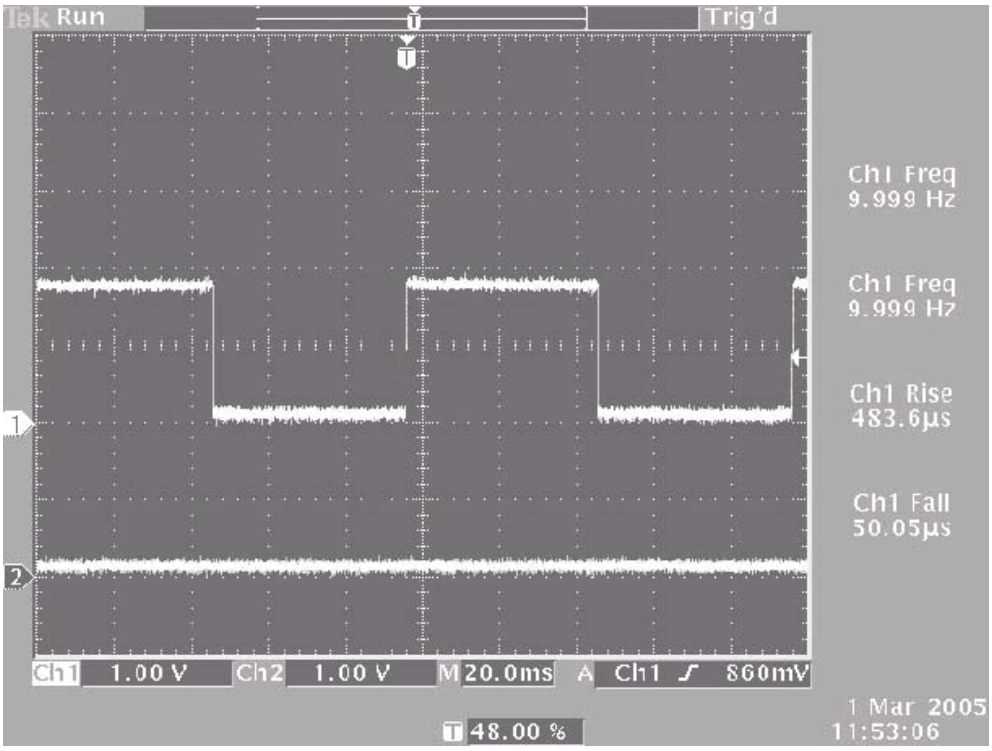

FIG.6 Typical Switching Characteristics

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5-2 Electro-Optic Characteristics

As indicated in the table on the following page.

The drive waveform is constant.

It should be noted that the “standard drive conditions” referred to in the table means driving the liquid crystal using the typical drive voltage and frame frequency indicated by the first and second items of the table.

ITEM		SYMBOL	TEMP °C	SPECIFIED VALUES			UNIT	REMARKS
				Min.	Typical	Max.		
Drive voltage Note 1		V_{LCD}	-5 ~ 50	30	40	50	V	Standard drive state
Frame frequency		f_{FRM}	-5 ~ 50	500	1000	1500	Hz	Standard drive state
Flash frequency		f_{BLNK}	NA		NA		Hz	NA
Rise response speed		t_{r1}	+25	-	500	700	usec	Note 2
		t_{r2}	-5	-	500	900	usec	Standard drive conditions
Fall response speed		t_{f1}	+5	-	2	3	msec	Note 3
		t_{f2}	-5	-	3	4	msec	Standard drive conditions
Direct current resistance		R_{DC}	+25	-	200	-	MΩ	
Transmittivity	Transparent state	T_t	+25	85	90	95	%	Note 6
	Grating state	T_g	+25	75	85	90		Standard drive state
Power consumption value				-	T.B.D	-	μA	40.0V 1000Hz

Note 1; Magnitude of voltage applied to segment terminals and common terminals.

Note 2; Time taken from the signal change OFF ⇒ ON until transmittivity reaches 90% of the stationary transmitted state.

Note 3; Time taken from the signal change ON ⇒ OFF until transmittivity reaches 10% of the stationary transmission state.

Note 4; Measured at drive voltage 40.0v, frequency 1000 Hz using sine waves.

Note 6; Method of measurement of transmittivity to be determined through separate discussions.

Standard drive conditions describe the voltage for driving the liquid crystal using a typical drive voltage and frame frequency.

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6. RELIABILITY

6-1 Direct current voltage resistance characteristics

In an ambient temperature 40 [°C], relative humidity 65 ±5[%] environment, restoration to the original state with no marked change in characteristics following the application of a 40.0 [V] alternating current voltage at 1000Hz for 48 hours across arbitrary terminals.

6-2 High-temperature high-humidity operation characteristics

In an ambient temperature 40 [°C], relative humidity 90^{+5}_{-0}[%] (no dew) environment, no abnormality in operation following retention in said environment for 2^{+1}_{-0} hours.

6-3 High-temperature retention characteristics

In an ambient temperature 70 [°C], relative humidity 60 [%] or less environment, normal operation after retention for 20 hours at room temperature and room humidity following retention for 240 ±2 hours in the non-current-carrying state.

6-4 Low-temperature retention characteristics

In an ambient temperature -30 [°C], relative humidity 60 [%] or less environment, normal operation after retention for 20 hours at room temperature and room humidity following retention for 240 ±2 hours in the non-current-carrying state.

6-5 High temperature high humidity retention characteristics

In an ambient temperature 50 [°C], relative humidity 95 [%] or less environment, normal operation after 20 hours at room temperature and room humidity following retention for 240 ±2 hours in the non-current-carrying state.

6-6 Temperature cycle characteristics

Normal operation after retention at room temperature and room humidity for 20 or more hours following the implementation of 8 cycles of the following temperature cycle in the non-current-carrying state.

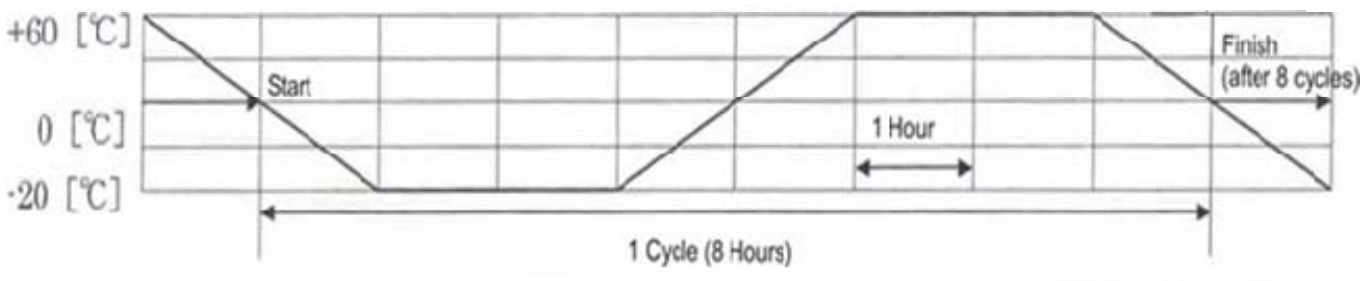

FIG.8 Typical Temperature Cycle Characteristics

6-7 Vibration resistance and impact

No marked impediment to function in normal use.

6-8 Pressure reduction resistance

No abnormality following retention for 8 hours in a 0.1 atm environment.

6-9 Effective lifespan

No marked deterioration following 240 hours irradiation with a 30 [°C], 4000 [lux] (sunlamp).

6-10 Low-temperature operation

No marked darkening at -20 [°C] in the current-carrying state.

6-11 High-Temperature Operation

Less than 15% loss of grating at 60 [°C] in the current-carrying state

No marked change in transmittivity (focus frame border, excluding ϕ 12).

No loss of display at 50 [°C] (including ϕ 12)

6-12 Heat Shock / Impact

No cracking in a 30 second period after immersion for 30 seconds in 35 [°C] to 25 [°C] water.

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7. ASSEMBLY DRAWINGS

7.1 Notes

FIG.9 shows plan views of each of a three level substrate. Level 1 is a first ITO layer. Level 2 is a UV absorbing dielectric coating corresponding to the dielectric. Level 3 is a second ITO layer. Levels 1,2,3 are shown in more detail in the drawings in FIGS.10-12 respectively.

It should be noted that FIGS.9-12 show the substrate with the ITO side facing the viewer and are all clear field. In production the masks will need to be mirror imaged and colored appropriately for the particular process and photo-resist used. The top level ITO mask includes a set of alignment features to facilitate the assembly of the display. Further alignment features may be incorporated if required by the process.

The Level 1 ITO has a coating resistance of typically 300-500 Ohm/sq. A typically example of an ITO film is the N00X0325 film manufactured by Applied Films Corporation (Colorado). Typically, the ITO film has a thickness of 100 Angstrom. Typically, the ITO film is applied to 0.7 mm thickness 1737F glass.

The Level 2 interlayer dielectric should have a thickness of the dielectric sufficient to withstand a peak voltage of 100V between the ITO layers. The dielectric should be free from pinholes to the extent possible. The transmission of the dielectric layer at a wavelength of 365nm and incidence angle in the range 30 to 60 degrees should, ideally, be less than 0.1%.

The third level ITO should have the same properties as the ITO of Level 1.

Typically the layer-to-layer registration should be ± 25 micron (± 0.001 inch).

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8 EXTERNAL APPEARANCE

8-1 Test conditions

(1) Illumination: Illumination transmitted from below using a 4W light box, distance between the Virtuality® and light box less than 10cm.

(2) Direction and Magnification Rate: a 5x binocular magnifying glass is employed for the inner part of the parting line, and confirmation is made vertically from the manufactured product.

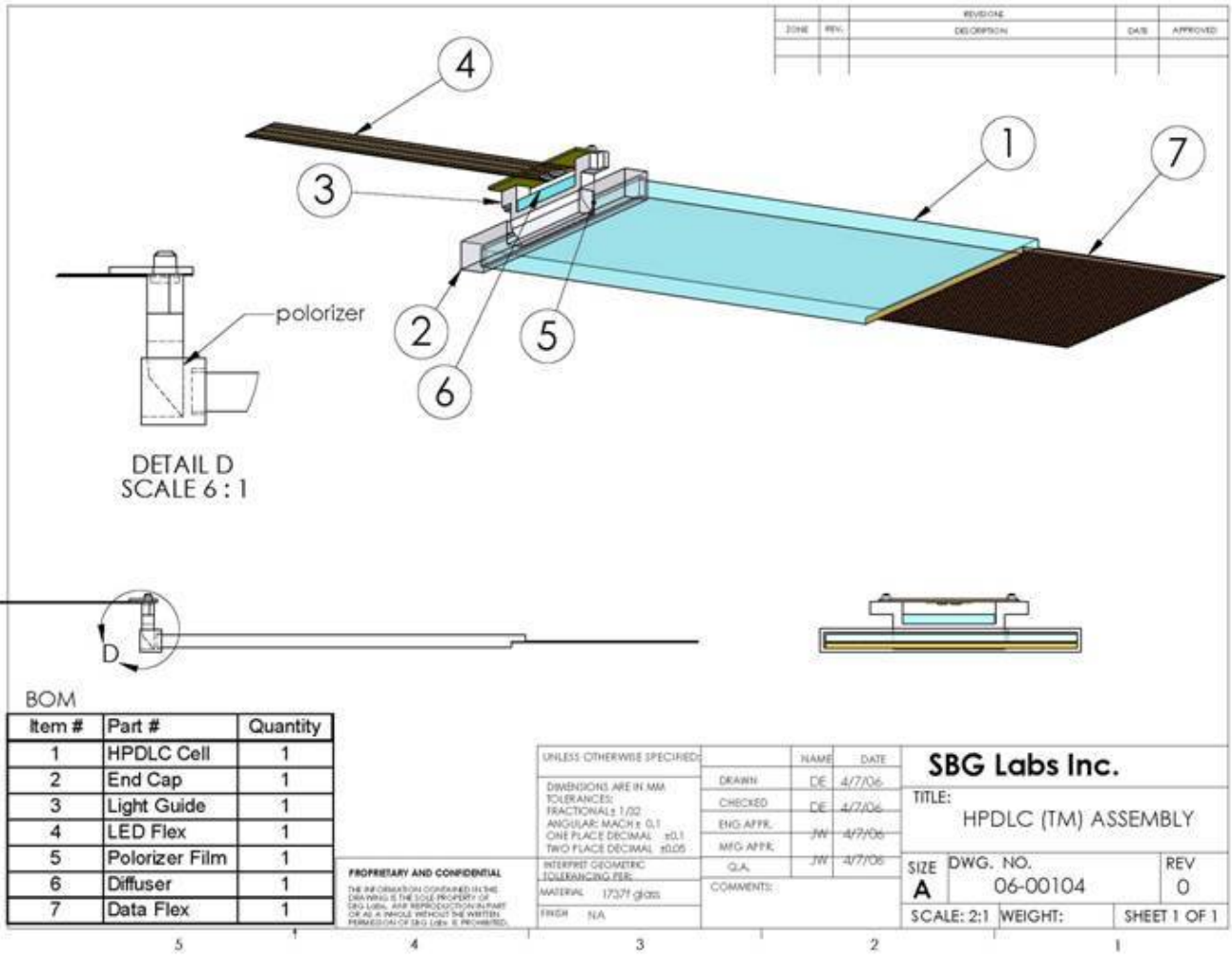
8-2 Definition of applicable zones

Appraisal by division into 3 zones.

Parting line inner part: Centre display part · · · A Zone (□ 7. 8 x 12)

: Edge display part · · · B Zone (□ 7. 8 x 12 outer part)

Parting line outer part: Display outer part · · · C Zone (□ 22. 8 x 15.4 outer part)



BOM

Item #	Part #	Quantity
1	HPDLC Cell	1
2	End Cap	1
3	Light Guide	1
4	LED Flex	1
5	Polorizer Film	1
6	Diffuser	1
7	Data Flex	1

SBG Labs Inc.

TITLE: HPDLC (TM) ASSEMBLY

SIZE A | DWG. NO. 06-00104 | REV 0

SCALE: 2:1 | WEIGHT: | SHEET 1 OF 1

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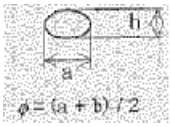
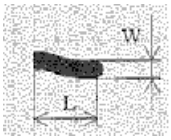
8-3. Test Items and Appraisal Criteria

ITEM		DETAILS	APPLICABLE ZONE
(1) Black dot White dot		Rejected when $\phi > 0.04$, congested even when 0.04 or less and rejected In the non-driven state, rejected when $\phi > 0.3$	A Zone
		Rejected when $\phi > 0.06$ In the non-driven state, rejected when $\phi > 0.5$	B Zone
(2) Black line White line		$W \leq 0.010$, $L \leq 0.3$ · · · Less than 1 and should not affect the focus frame	A Zone
		$W \leq 0.01$ Ignored $W \leq 0.02$, $L \leq 0.4$ · · · Less than 1 $W > 0.02$ · · · Corresponds to the specification of (1) above	B Zone
(3) Damage	Apart from the above-noted (1) and (2)	Corresponds to the specification of (1) and (2) above	A Zone, B Zone
(4) Non-uniformity	Liquid crystal part itself	Non-uniformity cannot be definitively confirmed within the operation temperature range when the liquid crystal is not being driven.	A Zone, B Zone
(5) Contrast non-uniformity Display non-uniformity	Liquid crystal part	Contrast non-uniformity and display non-uniformity cannot be definitively confirmed within the operation temperature range when the liquid crystal is not being driven.	A Zone, B Zone
(6) Evidence of ITO	Evidence of ITO in parting line	ITO cannot be definitively confirmed within the operation temperature range (specifics thereof based on a limited sample)	A Zone, B Zone
(7) Chromaticity	Chromaticity in parting line	Separate specification for spectroscopic characteristics	A Zone, B Zone

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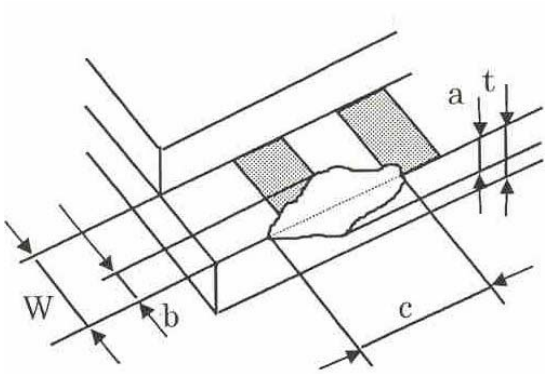
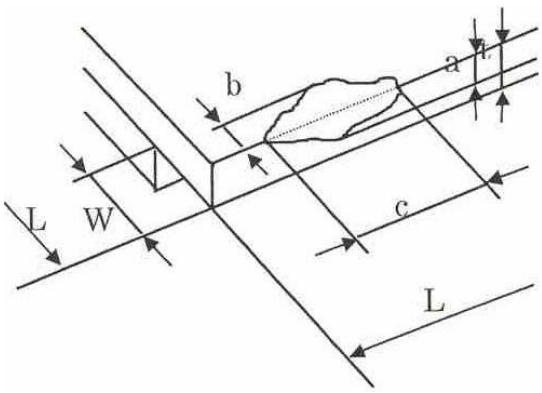
<table>
<tr><td rowspan="2">ITEM</td><td rowspan="2">DETAILS</td><td colspan="3">APPRAISAL CRITERION</td></tr>
<tr><td colspan="2">Segment</td><td>Specification · Permissible number</td></tr>
<tr><td rowspan="4">(8) Glass chip</td><td>(Electrode side)
 
</td><td>a</td><td>b</td><td>c</td></tr>
<tr><td></td><td>≤t/2</td><td>≤W/3</td><td>≤4.0mm</td></tr>
<tr><td></td><td>>t/2</td><td>≤W/3</td><td>≤3.0mm</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="4">(Lower glass side)
L1: Cell long dimension
L2: Cell short dimension
 
</td><td>a</td><td>B</td><td>c</td></tr>
<tr><td></td><td>≤t/2</td><td>≤Parting line -0.5</td><td>≤L1/3, L2/3</td></tr>
<tr><td></td><td>>t/2</td><td>≤W/3*</td><td>≤L1/3, L2/3</td></tr>
<tr><td></td><td>* Effective seal width of no less than 0.3mm ensured</td><td></td><td></td></tr>
<tr><td></td><td>Chip that penetrates 2 pieces of glass in one spot</td><td colspan="2"></td><td>Length ≤ 0.2</td></tr>
</table>

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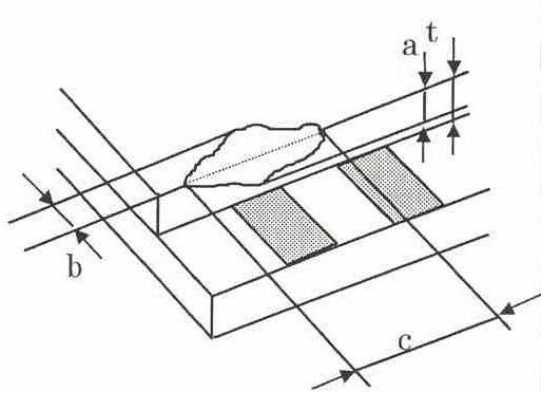
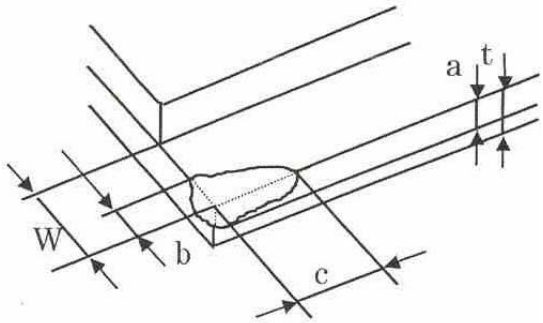
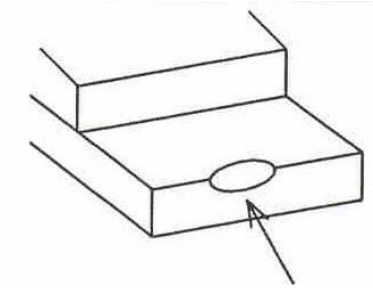
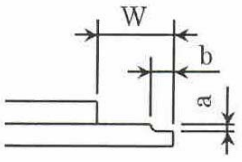
<table>
<tr><th rowspan="2">ITEM</th><th rowspan="2">DETAILS</th><th colspan="3">APPRAISAL CRITERION</th></tr>
<tr><th colspan="2">Segment</th><th>Specification · Permissible number</th></tr>
<tr><td rowspan="5">(9) Glass chip</td><td rowspan="4">(Upper glass side)
  </td><td>a</td><td>B</td><td>c</td></tr>
<tr><td>≤t/2</td><td>≤Parting line -0.5</td><td>≤L1/3, L2/3</td></tr>
<tr><td>>t/2</td><td>≤W/3*</td><td>≤L1/3, L2/3</td></tr>
<tr><td colspan="2">* Effective seal width of no less than 0.3mm ensured</td><td></td></tr>
<tr><td rowspan="4">(Corner part)
  </td><td>A</td><td>b</td><td>c</td></tr>
<tr><td>≤t</td><td>≤W/2</td><td>≤2.0mm</td></tr>
<tr><td>≤t</td><td>≤W/2</td><td>≤3.0mm</td></tr>
<tr><td colspan="2">*1 Effective seal width of no less than 0.3mm ensured
*2 No less than 2/3 of lead terminal surface area ensured</td><td></td></tr>
<tr><td>(10) Glass splinter</td><td>  </td><td colspan="2">  </td><td>b ≤ 0.25mm
a ≤ 0.2mm</td></tr>
</table>

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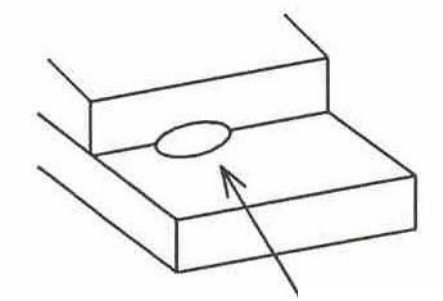
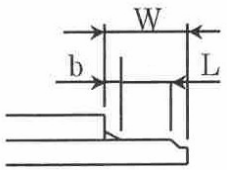
ITEM	DETAILS	APPRAISAL CRITERION	
(11) Glass remainder	 Glass remainder	Segment	Specification · Permissible number
			b ≤ 0.25mm
		If a glass splinter (or glass fragment) and glass remainder are generated simultaneously, L = no less than ½ W	
(12) Terminal part conductive film pinholes	Average diameter 0.2 or less at 2 or less points within ½L length per terminal However, ignored at ϕ 0.1 or less Damaged conductor surface area ≤ ½ So (So refers to the total surface area of one terminal)	C Zone	
(13) Terminal part conductive film residual	Swelling of conductive film maintained within the dimensions shown in the diagram (attached) Striate residual which is the interval B between adjacent patterns shall be B > 0.1.	C Zone	
(14) Crazing / Cracking	Products for which there is a possibility of glass drop-out are rejected Products for which there is a possibility that cracking / crazing will develop in the inner part are rejected	C Zone	
(15) Soiling	No soiling of parting line inner part and long-direction sides. However, if the soiling can be removed using a solvent the product is passed.	A · B Zone Long-direction sides	

NOTES: The product is adjudged to be of appropriate quality if the factors noted in the table above are not visible using a transmitted light,

1. Products for which there is nothing in particular is noted pertaining to the A and B zones will be appraised in the drive state.
2. The specifics thereof shall be determined through discussions to be conducted separately.
3. When problems arise limited samples should be used.

9 OTHER

Amendments to the present specification may be made following discussions between the concerned parties.

Please note that the standard values of this specification are provisional, because this specification document applies to trial / pre-production mass-produced parts.

New test items may be introduced. These may be implemented subsequent to production at SBG discretion.

Inclusion of this part and accreditation all subject to the Terms and Conditions of the Virtuality® License Agreement.

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