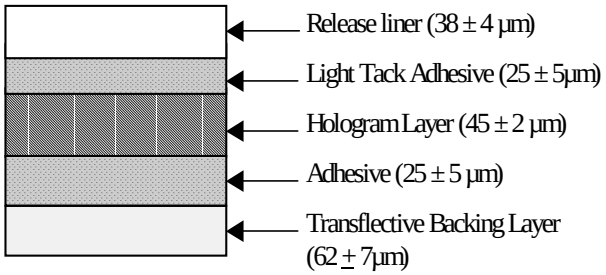
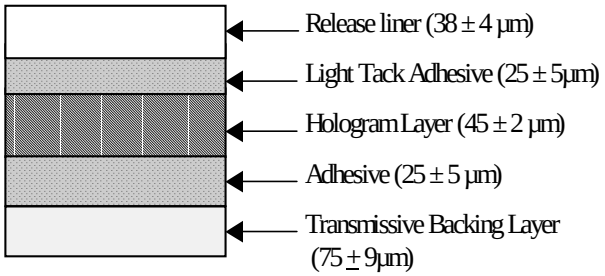
This document is the specification for high performance Green Holographic Reflector (HR) Watch Roll.



(Figure 1. Holographic Transflective Structure)

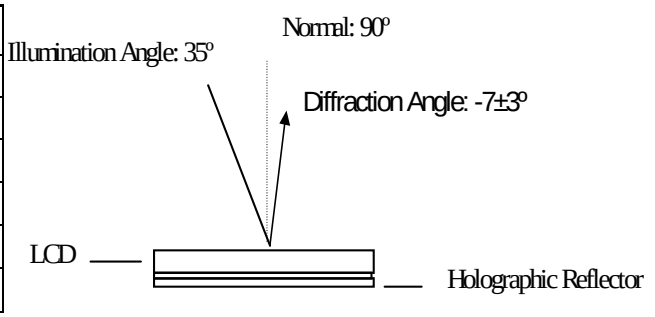


(Figure 2. Holographic Transmisisve Structure)

1.0 Holographic Performance Specifications

The optical performance of the holographic reflector is described by four parameters: Brightness, Color, Geometry, and Angle of View, as described below.

Dominant Wavelength*	Green, λ_0 ± 15nm
Color Purity *	75 +/- 15%
Brightness**	≥ 3.0 X White
Geometry:	
Illumination Angle (degree)	35°
Diffraction Angle (degree)	- 7° ± 3°
Angle of View***	≥14°



(**Figure 3. Nominal Geometry for Holographic Reflectors)**

λ_0 can be 550nm, 567nm, or 580 nm.

*The color of the holographic reflector is specified by two CIE 1932 standard color values, the dominant color and the color purity, measured using CIE standard illuminant "A".

** Brightness is measured in reflectance and is reported relative to a lossless, Lambertian diffuse white reflectance standard.

***The angle of view is defined as the range of observation angles over which the brightness is at least one-half its peak value.

2.0 General and Environmental Specifications

Roll Length	>137.16m
Shelf Life of HR	6 Months @20+/-5C @50 +/- 15%RH
High Temperature Humidity Performance:	
Conditions	70°C / 90% RH, 240 hours
Construction	HR adhesive side laminated to glass
Change in Dominant Wave length	Initial value + 15 nm, - 5 nm or less
Change in Brightness	Initial value + 10 %, -3 % or less
Cosmetics	Pass
Peel Strength:	
Release liner	≤50g / 25 mm (180° peel @ 12”/minute)
Reflector to glass	≥500g / 25 mm (180° peel @ 12”/minute) on glass

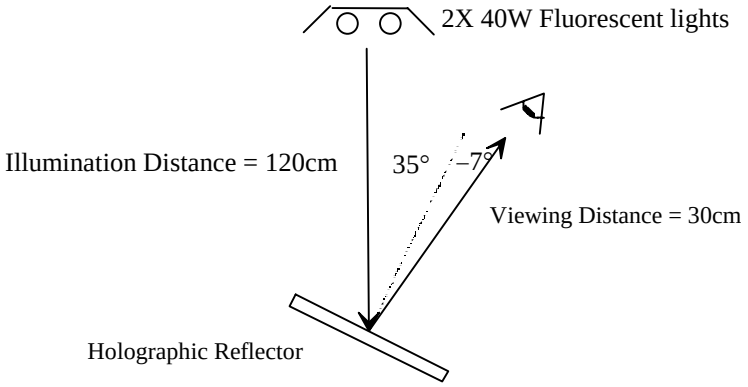
3.0 Packaging and Shipping

The roll will be packaged in a plastic bag with core holders on both sides of the roll. The full roll will be shipped in a cardboard box, and the slit rolls will be packaged in small boxes and placed in a larger box. The box will have a shipping label on the outside of the box with a DHI part number, description, quantity, date, and DHI lot number. Best commercial standard practices shall be applied in packaging and shipping. Detailed packaging information will be available upon request.

4.0 Cosmetic Requirements

4.1 Observation Requirements

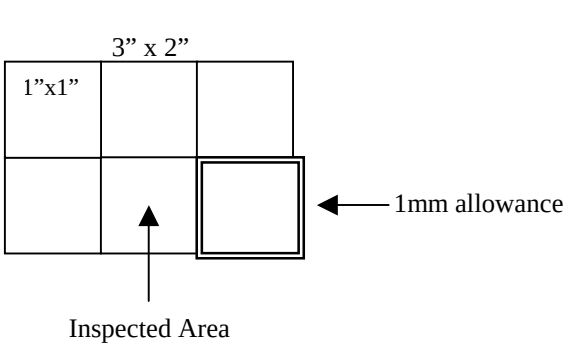
Cosmetic quality will be observed in HRs under the following conditions: two 40W fluorescent lights (approximately 18.5 – 19.0cm in length and 0.4 – 0.6cm in diameter with a spectral energy distribution similar to that of GE F40T12/CW/EG ENVIR-O-LIGHT) for illumination at a distance of 1.2 m from the part, viewed from a distance of 30 cm for a period no longer than 10 seconds. Spots and optical defects are defects if they appear in the viewing area (>1 mm from edge) and are larger than the specified values shown in the defect category table. The inspection setup and viewing conditions shown in Figure 4 must be used to judge the cosmetic quality of the HRs.

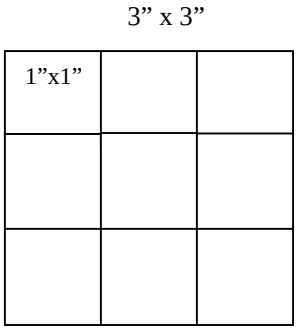


(Figure 4. Inspection setup and viewing conditions)

4.2. Master Tile Inspection

Each master tile contains either six or nine 1-inch-square "watch heads" based on the master tile size. Each "watch head" is inspected for Lines, Dents, Color, Spots, and Others in that order. A 1mm allowance is given around the perimeter of each "watch head", and defects that fall within that millimeter allowance are considered acceptable (see Figure 4). Other defects that fall within the inspected area of the "watch head" are judged according to the Watch Roll cosmetic specification in table 3. A 5% representative sample inspection is performed to assess the cosmetic quality of a watch roll.





(Figure 5. Master Tile Dimension)

5.0 Yield Requirement

Watch roll yield is calculated based on cosmetic inspection of the 1" X 1" sub-tiles. Watch rolls will yield ≥ 83% per this test. Watch rolls have a minimum length of 450 ft.

DEFECT CATEGORY TABLE

Defect Category	Pass Criteria and Limitations			
	Description	Size Limit	Frequency Limit	Distance Limit
Black Lines: Optical line defects in the hologram viewing area. They can range from a distinct black to a semi-transparent color, measuring in length from 0.25mm up to the full dimension of a master tile. Widths are normally less than 0.1mm.	See Defect Book	See Defect Book	See Defect Book	See Defect Book
Bubbles: Physical defects caused by packets of air trapped between HR layers during HR construction. "b" is defined as the average diameter of the bubble.	Bubbles without color	No Limit	No Limit	No Limit
	Bubbles with color	b < 0.15mm	No Limit	No Limit
		0.15mm ≤ b ≤ 0.30mm	4	No Limit
		0.30mm ≤ b ≤ 0.50 mm	2	D ≥ 15mm
		b > 0.50mm	0	
Color Variation: Optical defects that are characterized by color change across the surface of the HR. They tend to be large areas or bands showing distinct or gradual color change.	See Defect Book	See Defect Book	See Defect Book	See Defect Book
Dents: Physical concave or convex impressions in the HR film Depths are usually greater than 0.1mm. They can vary in size and in frequency. "d" is defined as the average diameter of the dent.	Dents without color	No Limit	No Limit	No Limit
	Dents with color	d < 0.15mm	No Limit	No Limit
		0.15mm ≤ d ≤ 0.30mm	4	No Limit
		0.30mm ≤ d ≤ 0.50 mm	2	D ≥ 15mm
		d > 0.50mm	0	
Spots: Either physical or optical defects such as colored spots (red, green, blue, or black) or foreign matter such as lint and dust. They can vary in size and frequency. They are defined as follows: Spots have a maximum dimension "a" and a minimum dimension "b" with aspect ratio a/b ≤ 2.5. The average diameter "s" of a spot is given by s = (a+b)/2.	Spots with High Contrast	s ≤ 0.25mm	2	D ≥ 15mm
		s > 0.25mm	0	
	Spots with Low Contrast	s < 0.15mm	No Limit	No Limit
		0.15mm ≤ s ≤ 0.30mm	4	No Limit
		0.30mm ≤ s ≤ 0.50mm	2	D ≥ 15mm
		s > 0.50mm	0	
Wood Grain: An optical defect appearing to come from the surface of the HR. It appears as dark wavy lines. The lines are predominantly in the vertical direction and can vary in intensity from almost black to semi-transparent (see Color Variation).	See Defect Book	See Defect Book	See Defect Book	See Defect Book