

CVF (Circular Variable Filter) Specifications

CVF 5A:

Spectral Range: $\leq 400\text{nm}$ – $\geq 650\text{nm}$

Blocking Range: 300nm – 2800nm

Resolution: 1.5-1.7% typical, with 1.9% (maximum) at any point in the range bandwidth FWHM

Transmission: T (peak) > 45% (Design objective >70% typical)

At 400nm-440nm range T (peak) > 25%.

Blocking Efficiency: 0.1%T (avg.), individual leaks not exceed 0.5%

Out of band transmission < 0.1% average and < 0.5% peak

Substrate – 2.7mm SCHOTT KG3 glass

See attached drawing, CI P/N: G00001000-05A, Rev. A, for physical dimensions.

CVF 5B:

Spectral Range: $\leq 630\text{nm}$ – $\geq 930\text{nm}$

Blocking Range: 300nm – 1100nm

Resolution: 1.5-1.7% typical, with 1.9% (maximum) at any point in the range bandwidth FWHM

Transmission: T (peak) > 50% (Design objective >70% typical)

Blocking Efficiency: 0.1%T (avg.), individual leaks not exceed 0.5%

Out of band transmission < 0.1% average and < 0.5% peak

Substrate – 2.7mm SCHOTT B270 glass

See attached drawing, CI P/N: G00001000-05B, Rev. A, for physical dimensions.

CVF 6:

Spectral Range: $\leq 900\text{nm}$ – $\geq 1350\text{nm}$

Blocking Range: 300nm – 2600nm

Resolution: 1.5% bandwidth FWHM

Transmission: T (peak) > 50% (Design objective >70% typical)

Blocking Efficiency: 0.1%T (avg.), individual leaks not exceed 0.5%

Out of band transmission < 0.1% average and < 0.5% peak

Substrate – 2.7mm SCHOTT B270 glass

See attached drawing, CI P/N: G00001000-06, Rev. A, for physical dimensions.

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CVF 1:

Coating specification – spectral range 1.3 to 2.5 micron

Blocking range 0.8-15 μm

Blocking Efficiency 0.1% avg. 0.3% peak (best effort)

BW $\leq 1.5\%$ (up to 2%)

Peak T Highest possible, but at least >50%.

Below 1.4 μm , highest possible, but at least >20% (best effort).

Out of band transmission < 0.1% average and < 0.5% peak

Substrate – 2.7mm SCHOTT B270 glass

See attached drawing, CI P/N: G00001000-01, Rev. A, for physical dimensions.

CVF 2:

Coating specification – spectral range 2.4 to 4.6 micron

Blocking range 0.8-15 μm

Blocking Efficiency 0.1% avg. 0.3% peak (best effort)

BW $\leq 1.5\%$ (up to 1.6%)

Peak T Highest possible, but at least >50%

Out of band transmission < 0.1% average and < 0.5% peak

Substrate – 2.3mm Sapphire

See attached drawing, CI P/N: G00001000-02, Rev. B, for physical dimensions.

CVF 3:

Coating specification – spectral range 4.3 to 8.1 micron

Blocking range 0.8-15 μm

Blocking Efficiency 0.1% avg. 0.3% peak (best effort)

BW $\leq 1.5\%$ (up to 1.6%)

Peak T Highest possible, but at least >50%

Out of band transmission < 0.1% average and < 0.5% peak

Substrate – 1mm Germanium

See attached drawing, CI P/N: G00001000-03, Rev. B, for physical dimensions.

CVF 4:

Coating specification – spectral range 7.7 to 14.3 micron

Blocking range 0.8-15 μm

Blocking Efficiency 0.1% avg. 0.3% peak (best effort)

BW $\leq 1.5\%$ (up to 2%)

Peak T Highest possible, but at least $>50\%$ (best effort)

Out of band transmission $< 0.1\%$ average and $< 0.5\%$ peak

Substrate – 1mm Germanium

See attached drawing, CI P/N: G00001000-04, Rev. B, for physical dimensions.

All Segments

a) Segment angular size shall be $88^{\circ} \pm 10^{\circ}$, per CI P/N: G00001000-xx drawings.

b) Clear aperture shall be $1^{\circ} \pm 0.5^{\circ}$ away from the edges, i.e.: total CLA angular size shall be 86° .

c) Active Circular Variable Filter (CVF) angular size shall be $3^{\circ} \pm 0.3^{\circ}$ away from edges, i.e.: total nominal active CVF angular size shall be 82° .

d) Angular points to be tested for λ_1 and λ_2 spectral limits and peak transmissions shall be 5° away from the edges, i.e.: $5^{\circ} \pm 0.3^{\circ}$ and $83^{\circ} \pm 0.3^{\circ}$.

Witness piece

MIL-C-48497A – Para 4.1.2

Unless otherwise specified, witness pieces as defined in 4.1.3 or coated components may be used to test the optical and durability requirements of the coated component. (See 4.2, 4.3 & 6.2). The witness pieces shall be positioned in the coating chamber such that they represent the optical and durability characteristics of the whole evaporated lot (see 6.4). CI Systems reserves the right to test the actual coated component with the same test to which the witness pieces were subjected. Should a component fail, even though the witness pieces pass the test, the lot shall be rejected.

The witness piece shall be $\varnothing 25\text{mm}$ of the same substrate material as the segments.

The whole batch shall be identified for traceability with S/N and batch delivery documents.

Packaging

Each segment shall be individually wrapped with rice paper and then placed inside a plastic box ("jewel box"), properly labeled and marked:

- Segment Type
- CI P/N
- CI P.O Number
- Batch Number
- Date of Production
- Date of Delivery

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Environmental Testing

A durability test report shall be included with each coating batch, in addition to the optical scan reports.

- **Coating Adhesion** MIL-C-48497A – Para 4.5.3.1 Tape Pull Test
Performed on all deliverable products.

The coated component or witness samples shall be subjected to an adhesion test using 1/2" wide cellophane tape conforming to Type I of L-T-90. Press the adhesive surface of the cellophane tape firmly against the coated surface and quickly remove at an angle normal to the coated surface. A visual inspection shall be made for conformance to 3.4.1.1. Subsequent to this test, the coated component or witness sample shall be subjected to the test of 4.5.3.2 (Humidity).

- **Humidity Stability** MIL-C-48497A – Para 4.5.3.2 24hrs exposure, humidity (or, in the absence of a climatic cabinet, substituted to Wet Cleanability test, MIL-C-48497A – Para 4.5.4.2 , Resistance to Water & Solvents, representative of handling during use).

The coated components or witness samples shall be placed into an environmentally controlled test chamber and exposed to a temperature of 120°F (49°C) and 95%-100% relative humidity. The coating shall be exposed for a minimum of 24 hours. Subsequent to this exposure, the coating shall be cleaned and evaluated for conformance to 3.3.1 and 3.3.3. The coated component or witness sample shall then be subjected test specified in 4.5.3.3 (moderate abrasion).

- **Coating Abrasion** MIL-C-48497A – Para 4.5.3.3 Cloth Rub Test, 50 rub, moderate, performed on a sample of each process batch.

Within one hour after the humidity test of 4.5.3.2, the coated component or witness sample shall be subjected to a moderate abrasion test. It shall consist of rubbing a minimum of 50 strokes across the surface in straight lines. The abrader shall be a 1/4" thick by 3/8" wide pad of clean dry, laundered cheesecloth conforming to CCC-C-440. The bearing force shall be a minimum of 1 pound and shall be applied approximately normal to the coated surface. The actual test apparatus shall be the Eraser Abrasion Coating Tester of Drawing 7680606 except that the eraser portion shall be completely covered with cheesecloth and the cheesecloth shall be secured to the shaft of the tester with an elastic band. Subsequent to this test, the coating shall be evaluated for conformance to 3.4.1.3. Following the tests of 4.5.3.1, 4.5.3.2 and 4.5.3.3 the coated component or witness sample shall be evaluated for conformance to 4.5.6.

- **Thermal Stability** MIL-C-48497A – Para 4.5.4.1 High Temp Cycle
Heat cycle after coating, necessary to ensure good stable transmission and optimize the spectral characteristics after the deposition process: All parts - heat cycles at 200°C @rate 10°/min, soak at max before cooling.

The witness samples shall be subjected to temperatures of -80°F ±2°F (-62°C) and 160°F ±2°F (71°C) for a period of 2 hours at each temperature. After each exposure the coated components or witness samples shall be stabilized at an ambient temperature between 60°F and 90°F (16÷32°C) and subjected to the test specified in 4.5.3.1. Subsequent to this test, the coating shall be evaluated for conformance to 3.4.1.3 and 3.3.1. The rate of temperature change between any two temperature levels shall not exceed 4°F/minute (~2.2°C / min).

- **Visual inspection** & final optical scans are done after the heat cycles.

ATP/ATR

Acceptance Test Report (ATR) shall include spectral measurements at 3 points on each CVF segment and all environmental testing results.

Each segment delivered, shall have an attached Excel sheet report of at least 3 measured points, at 3 angular positions, (5° , 44° and 83°), showing the peak wavelength, B.W (FWHM) and peak transmittance. The goal of the report is to show that at least the full specified spectrum from λ_1 to λ_2 active wavelengths is properly mapped within the angular positions (3° to 85°) of the CVF, i.e. the full specified spectrum is well covered (λ_1 to λ_2).

Preferred CVF angular positions to be measured are at the edges: 5° , 44° , 83° .

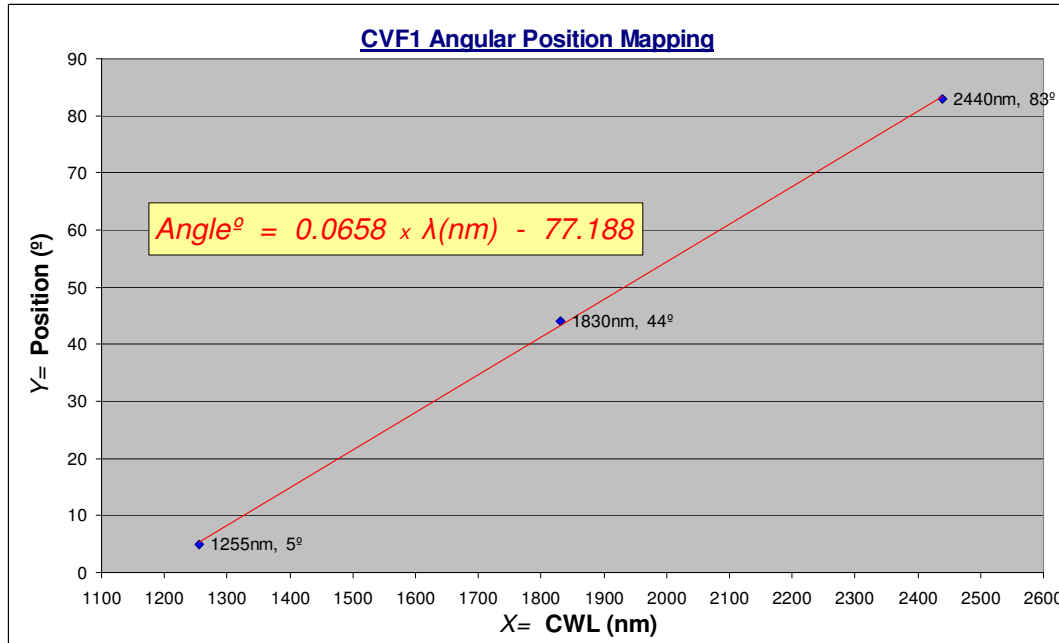
The peak T wavelength at 5° should be $< \lambda_1$ and the peak T wavelength at 83° should be $> \lambda_2$.

See attached Excel sheet as an example.

For each coating run, 2pcs of 25mm Dia. supplied as witness piece. Witness pieces are to be coated at the same time as the segments.

Segment Inspection Report

Example:

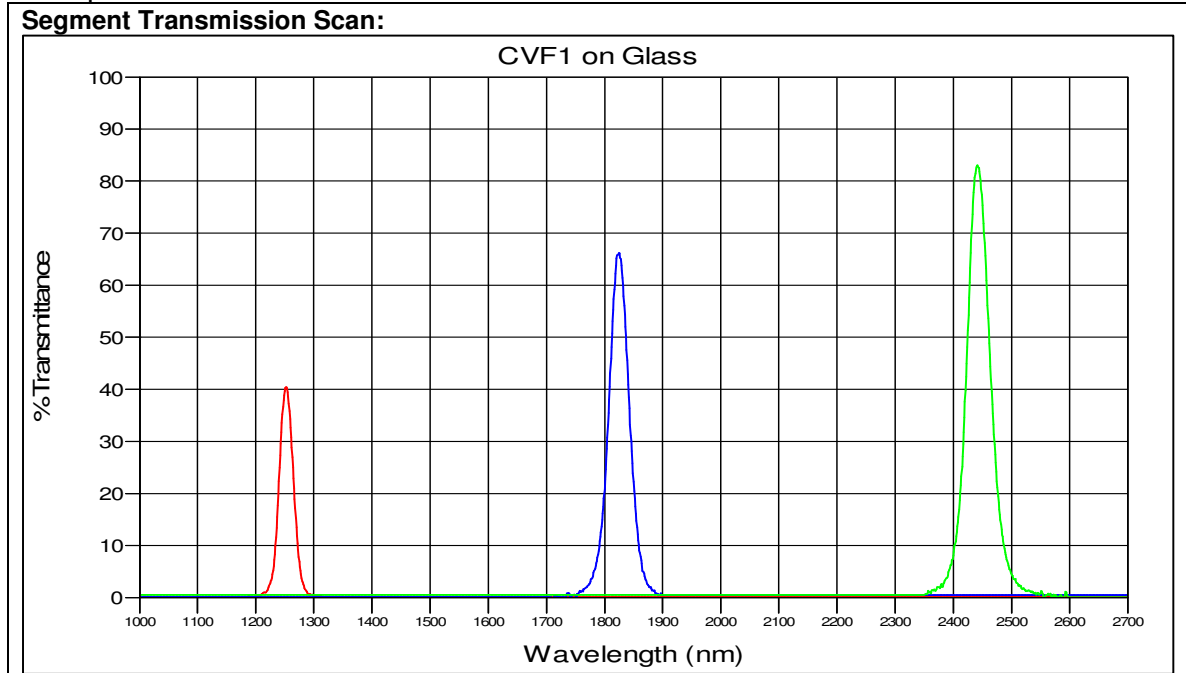


Angular Position [°]		5	44	83
Center	n	1255	1830	2440
Peak T	%	40.5	65.8	83.0
HBW	%	2.2	2.1	1.74

Degrees	Criteria	WL (nm)	Result
5°	1300≥	1255	✓ Pass
83°	2500≤	2440	X Fail

Segment Inspection Report

Example:



Batch Durability Inspections:

Test	Method	Results
Coating Adhesion:	Tape Pull, across optical track (all segments).	See attached table
Coating Abrasion:	Dry Tissue, x50 Rub Test (witness piece)	
Humidity Stability/ Wet Cleanability:	Wet cleaning with water & alcohol. (witness piece)	
Thermal Cycle:	200°C @rate 10°/min rate heat cycle (all segments) MIL-C-48497A – Para 4.5.4.1 High Temp Cycle (witness piece)	See attached table
Visual inspection:	all segments	See attached table
Blocking Test	On one segment from each coating batch.	Three angles (5°, 44°, 83°) are to be covered for the whole blocking range 0.3-1.1µm or 0.8-15µm. The Excel data files shall include transmission measurements and graphs over the full blocking spectra.

CI SYSTEMS**CVF Specifications****ATR Table for Particular Filters:**

CVF Type: _____

 $\lambda_1 =$ _____ nm $\lambda_2 =$ _____ nm

Batch Coating Run: _____

Date: _____

Serial No:	Coating Adhesion	Thermal Cycle	Visual inspection	$\lambda_{\min}@5^\circ \leq \lambda_1$ [nm]	$\lambda_{\max}@83^\circ \geq \lambda_2$ [nm]	Checker Name	Date of inspection	Notes
001	pass/fail	pass/fail	pass/fail					
002	pass/fail	pass/fail	pass/fail					
003	pass/fail	pass/fail	pass/fail					
004	pass/fail	pass/fail	pass/fail					
005	pass/fail	pass/fail	pass/fail					
006	pass/fail	pass/fail	pass/fail					
007	pass/fail	pass/fail	pass/fail					
008	pass/fail	pass/fail	pass/fail					
009	pass/fail	pass/fail	pass/fail					
010	pass/fail	pass/fail	pass/fail					
011	pass/fail	pass/fail	pass/fail					
012	pass/fail	pass/fail	pass/fail					
013	pass/fail	pass/fail	pass/fail					
014	pass/fail	pass/fail	pass/fail					
015	pass/fail	pass/fail	pass/fail					
016	pass/fail	pass/fail	pass/fail					
017	pass/fail	pass/fail	pass/fail					
018	pass/fail	pass/fail	pass/fail					
019	pass/fail	pass/fail	pass/fail					
020	pass/fail	pass/fail	pass/fail					
021	pass/fail	pass/fail	pass/fail					
022	pass/fail	pass/fail	pass/fail					
023	pass/fail	pass/fail	pass/fail					
024	pass/fail	pass/fail	pass/fail					
025	pass/fail	pass/fail	pass/fail					

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