



# Diamond Grade™ DG<sup>3</sup> Reflective Sheeting

Series 4090



Product Bulletin 4090

Jan 2009

Replaces PB 4090 dated January 2006

## Health and Safety Information

Read all health hazard, precautionary and first aid statements found in the Material Safety Data Sheets and/or product label of chemicals prior to handling or use.

## Description

3M™ Diamond Grade™ DG<sup>3</sup> Reflective Sheeting Series 4090 is a super-high efficiency, full cube retroreflective sheeting designed for the production of traffic control signs and delineators that are exposed vertically in service. Diamond Grade DG<sup>3</sup> is designed to have the highest retroreflective characteristics at medium and short road distances as determined by the R<sub>A</sub> value at 0.5°, 1.0° and 1.5° observation angle in Table B. The performance at this angle represents the most common viewing geometries encountered by the driving public. Diamond Grade DG<sup>3</sup> also provides brightness at high entrance angles shown by the values at 40° in Table B.

During the daytime, Diamond Grade DG<sup>3</sup> Fluorescent Reflective Sheeting provides higher visibility than ordinary (non-fluorescent) colored sheetings.

Applied to properly prepared sign substrates, Diamond Grade DG<sup>3</sup> provides long-term reflectivity and durability.

Sheeting	Color
4090	White
4091	Yellow
4092	Red
4095	Blue
4097	Green
4081	Fluorescent Yellow – FY
4083	Fluorescent Yellow Green – FYG
4084	Fluorescent Orange - FO



3M™ Diamond Grade™ DG<sup>3</sup> Reflective Sheeting Series 4090 is approved for the manufacturing of signfaces for traffic signs with a European Technical Approval (ETA).

All provisions concerning the attestation of conformity and the performances described in the ETA 07/0272 were applied and the product fulfills all the prescribed requirements (see the EC-declaration of conformity at the end of this document for more details).

## Properties

The initial minimum coefficient of retro-reflection of Diamond Grade DG<sup>3</sup>, when measured in accordance with the procedure specified in CIE Publication No. 54.2 using CIE standard illuminant A, conforms to the values in Table A and B.

Table A conforms to the requirements for Class RA3A in DIN 67520:2008 (see also Class R3A for Germany in ETA 07/0272), intended for long distance performance.

$R_A$ [cd/lx/m <sup>2</sup> ] $\beta_2 = 0, \epsilon = 0$	$\alpha = 0.1^\circ$			$\alpha = 0.2^\circ$			$\alpha = 0.33^\circ$		
	$\beta_1 =$			$\beta_1 =$			$\beta_1 =$		
	5°	20°	30°	5°	20°	30°	5°	20°	30°
<b>Color</b>									
<b>White</b>	850	600	425	625	450	325	425	300	225
<b>Yellow</b>	550	390	275	400	290	210	275	195	145
<b>Red</b>	170	120	85	125	90	65	85	60	45
<b>Blue</b>	55	40	28	40	30	20	28	20	15
<b>Green</b>	85	60	40	60	45	30	40	30	20
<b>Fl. Yellow</b>	550	390	275	400	290	210	275	195	145
<b>Fl. YG</b>	700	480	340	500	360	260	340	240	180
<b>Fl. Orange</b>	260	130	95	140	100	70	95	65	49

Table A: Long Distance Performance Class RA3A\*

Table B characterizes the sheeting for the medium and short distance range. This is relevant for the sign action distance when traffic signs become legible. This is also the range when larger entrance angles are encountered. All values exceed the respective requirements in DIN 67520:2008 Class RA3B and Class R3B in ETA 07/0272.

$R_A$ [cd/lx/m <sup>2</sup> ] $\beta_2 = 0, \epsilon = 0$	$\alpha = 0.5^\circ$				$\alpha = 1.0^\circ$				$\alpha = 1.5^\circ$			
	$\beta_1 =$				$\beta_1 =$				$\beta_1 =$			
	5°	20°	30°	40°	5°	20°	30°	40°	5°	20°	30°	40°
<b>White</b>	320	240	160	80	120	90	60	30	32	24	16	8
<b>Yellow</b>	224	168	112	56	84	63	42	21	22	16,5	11	5,5
<b>Red</b>	64	48	32	16	24	18	12	6	6,5	5	3	1,5
<b>Blue</b>	16	12	8	4	6	4,5	3	1,5	1,5	1	-	-
<b>Green</b>	32	24	16	8	12	9	6	3	3	2,5	1,5	1
<b>Fl. Yellow</b>	224	168	112	56	84	63	42	21	28	21	14	7
<b>Fl. YG</b>	256	192	128	64	96	72	48	24	32	24	16	8
<b>Fl. Orange</b>	96	72	48	24	36	27	18	9	12	9	6	3

Table B: Minimum  $R_A$  in the sign action distance\*

\*The angular definitions apply for the CIE Goniometer system (co-planar geometry). The sheeting shall be mounted in 0° orientation on the goniometer (as shown below).

The initial chromaticity coordinates and luminance factors conform to the color boxes of Table C, when illuminated with CIE standard illuminant D65 and measured with 45/0 geometry. The colorboxes comply with ETA 07/0272 (similar to CR2 of EN 12899-1:2007 for Class RA 2 materials for ordinary colors except orange. The luminance factors for white and yellow are exceeding Class CR2 requirements to demonstrate superior daytime performance).

Color	1		2		3		4		Luminance factor Class B2 $\beta$
	x	y	x	y	x	y	x	y	
White	0,305	0,315	0,335	0,345	0,325	0,355	0,295	0,325	$\geq 0,40$
Yellow	0,494	0,505	0,470	0,480	0,513	0,437	0,545	0,454	$\geq 0,24$
Red	0,735	0,265	0,700	0,250	0,610	0,340	0,660	0,340	$\geq 0,03$
Green	0,110	0,415	0,170	0,415	0,170	0,500	0,110	0,500	$\geq 0,03$
Blue	0,130	0,090	0,160	0,090	0,160	0,140	0,130	0,140	$\geq 0,01$
FY	0,521	0,424	0,557	0,442	0,479	0,520	0,454	0,491	$\geq 0,38$
FYG	0,387	0,610	0,460	0,540	0,438	0,508	0,376	0,568	$\geq 0,70$
FO	0,595	0,351	0,645	0,355	0,570	0,429	0,531	0,414	$\geq 0,20$

Table C: Chromaticity and luminance factors

## Printed Colors and Overlay Films

For printed transparent color areas on white sheeting, when processed according to 3M™ recommendations, the coefficients of retroreflection shall not be less than 70% of the value for the corresponding color in table A and B. For white sheeting, covered with 3M™ Electrocut™ Film Series 1170, when processed according to 3M recommendations, the coefficients of retroreflection shall not be less than 100% of the value for the corresponding color in Table A and B.

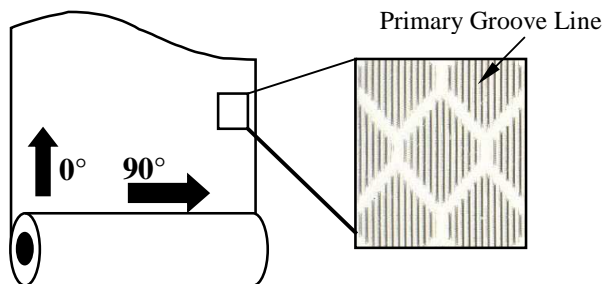
The chromaticity coordinates and luminance factors shall conform to table C.

This complies with respective requirements in EN 12899-1 and ETA 07/0272.

## Orientation

Diamond Grade DG<sup>3</sup> is designed to be an effective wide angle reflective sheeting regardless of the orientation on the substrate or ultimate application orientation after installation. However, because the efficiency of light return from cube corner reflectors is not equal at all rotation angles, the sheeting should be positioned in 0° or 90° application orientation on the completed sign when wide entrance angle performance is important for a given sign type or situation.

Only if high entrance angle performance beyond 40° is a requirement for your signs, the completed sign should have the sheeting positioned at the 0° application orientation.

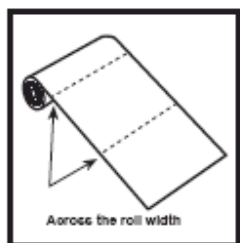


**Figure 1** – Sheeting is positioned at 0° orientation

When the “primary groove line” is vertical in the completed sign, sheeting is said to be at a 0° application orientation. When the “primary groove line” is horizontal in the completed sign, the sheeting is said to be at a 90° application orientation.

### Fabrication Lines

The manufacturing of prismatic sheeting results in fabrication lines being present in the product. In Diamond Grade DG<sup>3</sup> sheeting these lines are slightly thicker than the seal pattern legs. Fabrication lines are noticeable in shop light but are not observable on the road either in daylight or at night (Figure 2).



**Figure 2** - Tooling Lines

### Application

Diamond Grade DG<sup>3</sup> sheeting should be conditioned prior to application to provide a minimum sheeting temperature of 18°C throughout the roll or sheeting stack.

The sheeting should be applied with mechanical squeeze roll applicators to properly prepared substrates. Hand application is recommended for legend and copy only. Use firm pressure with a rubber roller or equivalent to obtain maximum initial adhesion. Use multiple, heavy overlapping strokes. Re-roll all edges. Application of Diamond Grade sheeting for complete signs or backgrounds must be done with a roll laminator, either mechanical or hand. For further information refer to Information Folder IF 1.4, IF 1.5 and IF 1.6.

### Splices

Diamond Grade DG<sup>3</sup> sheeting should be butt spliced when more than one piece of sheeting is used on one piece of substrate. The sheeting pieces should not touch each other. A splice gap of up to 1,5mm is acceptable. This is to prevent buckling as the sheeting expands in extreme temperature and humidity exposure.

### Substrates

For traffic sign use, product application is limited to properly prepared aluminum (see Information Folder 1.7). The substrate should be conditioned prior to application to provide a minimum surface temperature of 15°C.

Extrusions are to be wrapped and flat panel signs are to be carefully trimmed, so that sheeting from adjacent panels do not touch on assembled signs. Users are urged to carefully evaluate all other substrates for adhesion and sign durability. Diamond Grade DG<sup>3</sup> sheeting is designed primarily for applications to flat substrates. Rivets or bolts should also support any use that requires a radius of curvature of less 130mm.

Sign failures caused by the substrate or improper surface preparation are not the responsibility of 3M.

### Compatible Products

#### Screenprint Applications

- 3M™ Process Colors 880I
- 3M™ Process Colors 880N

#### Digital Printing Applications

- 3M™ Piezo Inkjet Ink Series 8800UV  
(for Durst Rho 161TS printer)

#### Copy Part Applications

- 3M™ Scotchcal™ Film 3650-12 (Black)
- 3M™ Scotchcal™ ElectroCut™ Film 100-12
- 3M™ ElectroCut™ Film Series 1170
- 3M™ TFEC 260 D

#### All Applications

- Selected 3M application tapes

**Important: Care should be taken to avoid flexing Series 4090 sheeting before and especially after screening.**

**Screen-printed sign faces must be sufficiently ventilated during the filling of the rack or immediately run through a conveyor. If the print is not ventilated properly, the solvents may**

**damage the top film of the sheeting. Refer to Product Bulletin 880I and Information Folder 1.8 for more details.**

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### **General Performance Considerations**

The performance and durability of 3M™ Diamond Grade DG<sup>3</sup> Reflective Sheeting Series 4090 will depend upon a number of factors including (but not limited to):

- Selection, preparation and temperature of the substrate
- Application procedures
- Geographic area
- Exposure and atmospheric conditions (e.g. snow, frost)
- Correct combination of sheeting, ink and overlay film
- Ink formulation
- Ink drying/curing methods
- Cleaning and maintenance methods

### **Warranty**

3M™ Diamond Grade™ DG<sup>3</sup> Reflective Sheeting Series 4090 sold by 3M to be used for traffic control signs and devices in Europe is warranted for a period up to 12\* years from date of application (concrete definition of the period is subject to the terms of sale) to be free of defects in material and workmanship, subject to the following provisions:

If Sheeting Series 4090 is processed and applied to a vertical ±10° surface in accordance with all 3M application and fabrication procedures provided in 3M's product and information folders, technical memos (which will be furnished to the agency upon request), including the exclusive use of 3M matched component systems, process colors, overlay films and recommended application equipment.

\*(10 years for Fluorescent Yellow and Yellow Green, 3 years for Fluorescent Orange)

### **Important Notice to Purchaser**

All statements, technical information and recommendations herein are based on tests we believe to be reliable, but the accuracy or completeness thereof is not guaranteed. Before using, user shall determine the suitability of the product for its intended use, and user assumes all risk and liability whatsoever in connection therewith. All questions of warranty and liability relating to this product are governed by the terms of the sale subject where applicable to the prevailing law.

No statement or recommendation not contained herein shall have any force or effect unless in an agreement signed by authorized personnel of seller and manufacturer.

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### **Literature Reference**

Instructions for Squeeze Roll Applicator	IF 1.4
Hand Application Instructions	IF 1.5
Instructions for Hand Squeeze Roll Applicator	IF 1.6
Sign Base Materials	IF 1.7
Instructions for using 3M Process Colors	IF1.8
Cutting, Matching, Premasking and Prespacing Instructions	IF 1.10
Storage and Packaging	IF 1.11
3M Process Color 880I	PB 880I
3M Process Color 880N	PB880N
3M Piezo Inkjet Ink 8800UV	PB8800UV

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### **For Further Assistance**

For help on specific questions relating to 3M™ reflective products, please contact your local 3M Technical Service person or contact:

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Traffic Safety Systems Division  
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# EC-Declaration of Conformity



0970-CPD-0002/CE/0108

**08**

ITC – CNR Istituto per le Tecnologie della Costruzione  
ETA 07/0272



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Microprismatic Retroreflective Sheeting

3M Diamond Grade DG<sup>3</sup> series 4000  
3M Diamond Grade DG<sup>3</sup> series 4000 + 3M Electrocut Film (EC-Film) Series 1170  
3M Diamond Grade DG<sup>3</sup> series 4000 printed with 3M Process Color Series 880

**Product Performance (CUAP / ETA Request No. 01.06/04)**

**Visibility Characteristics**

Daytime Colour and Luminance Factor: Pass, Class B2  
Coefficient of Retroreflection: Class R2 (Europe); R3A + R3B (Germany, Greece, Belgium)  
Rotational Symmetry: Pass  
Impact Resistance: Pass

**Durability**

Temperature Resistance: Class 1 (80°C)  
Daytime Colour and Luminance Factor: Pass, Class B2 (after exposure)  
Coefficient of Retroreflection: Pass (> 80% after exposure)

Neuss, dec 2008

John Jackson  
3M Technical Director