



Diamond Grade™ DG³ Reflective Sheeting

Series 4090

Product Bulletin 4090

Aug 2013

Replaces PB 4090 dated march 2012

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™ DG³ 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 DG³ is designed to have the highest retroreflective characteristics at medium and short road distances as determined by the R_A 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 DG³ also provides brightness at high entrance angles shown by the values at 40° in Table B.

During the daytime, Diamond Grade DG³ Fluorescent Reflective Sheeting provides higher visibility than ordinary (non-fluorescent) colored sheetings.

Applied to properly prepared sign substrates, Diamond Grade DG³ 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™ DG³ 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 11/0521, 11/0522 and 13/0303 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 DG³, 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.

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).

Table A conforms to the requirements for Class RA3A in DIN 67520:2008 (see also Class R3A for Germany in ETA 11/0521), intended for long distance performance.

R_A [cd/lx/m ²] $\beta_2 = 0, \epsilon = 0$	$\alpha = 0.1^\circ$			$\alpha = 0.2^\circ$			$\alpha = 0.33^\circ$		
	$\beta_1 =$			$\beta_1 =$			$\beta_1 =$		
	5°	20°	30°	5°	20°	30°	5°	20°	30°
Color									
White	850	600	425	625	450	325	425	300	225
Yellow	550	390	275	400	290	210	275	195	145
Red	170	120	85	125	90	65	85	60	45
Blue	55	40	28	40	30	20	28	20	15
Green	85	60	40	60	45	30	40	30	20
Fl. Yellow	550	390	275	400	290	210	275	195	145
Fl. YG	700	480	340	500	360	260	340	240	180
Fl. Orange	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 11/0521.

R_A [cd/lx/m ²] $\beta_2 = 0, \epsilon = 0$	$\alpha = 0.5^\circ$				$\alpha = 1.0^\circ$				$\alpha = 1.5^\circ$			
	$\beta_1 =$				$\beta_1 =$				$\beta_1 =$			
	5°	20°	30°	40°	5°	20°	30°	40°	5°	20°	30°	40°
Color												
White	320	240	160	80	120	90	60	30	32	24	16	8
Yellow	224	168	112	56	84	63	42	21	22	16,5	11	5,5
Red	64	48	32	16	24	18	12	6	6,5	5	3	1,5
Blue	16	12	8	4	6	4,5	3	1,5	1,5	1	-	-
Green	32	24	16	8	12	9	6	3	3	2,5	1,5	1
Fl. Yellow	224	168	112	56	84	63	42	21	28	21	14	7
Fl. YG	256	192	128	64	96	72	48	24	32	24	16	8
Fl. Orange	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 11/0521 (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 β
	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 11/0521, 11/0522 and 13/0303.

Orientation

Diamond Grade DG³ 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.

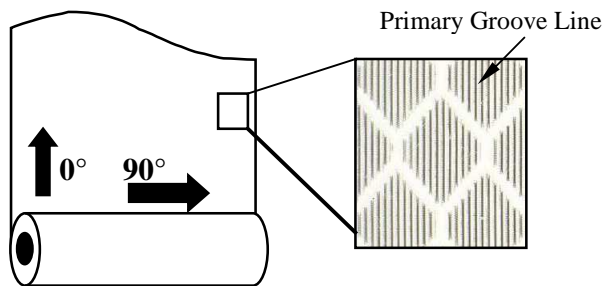


Figure 1 – Sheeting is positioned at 0° orientation

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 DG³ 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).

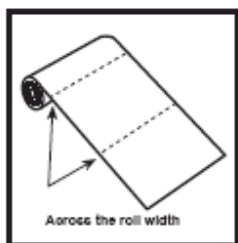


Figure 2 - Tooling Lines

Application

Diamond Grade DG³ 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 DG³ 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 DG³ 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 and 162TS printer)

Copy Part Applications

- 3M™ Scotchcal™ ElectroCut™ Film 100-12
- 3M™ ElectroCut™ Film Series 1170
- 3M™ TFEC 260 D

All Applications

- Selected 3M application tapes

Important: 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. Care should be taken to avoid flexing Series 4090 sheeting before and especially after screening. Convert from series 880I to series 880N when ink triggered cracking first appears in your shop.

General Performance Considerations

The performance and durability of 3M™ Diamond Grade DG³ 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™ DG³ 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 $\pm 10^\circ$ 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.

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

For Further Assistance

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

3M Deutschland GmbH
TSS Laboratory
Traffic Safety Systems Division
Carl-Schurz-Str. 1, D-41453 Neuss

Phone: +49 21 31/14-33 94
Fax: +49 21 31/14-36 94

All rights reserved
© 3M Company, 2013

Declaration of Performance/ Leistungserklärung 3M Diamond Grade DG³

Construction Product Code / Bezeichnung des Bauproduktes

Microprismatic Retroreflective Sheeting

1. 3M Diamond Grade DG³ Series 4000
2. 3M Diamond Grade DG³ Series 4000 + 3M Electrocut Film Series 1170
3. 3M Diamond Grade DG³ Series 4000 printed with 3M Process Colour Series 880 I or N
4. 3M Diamond Grade DG³ Series 4000 printed with 3M Process Colour Series 4700
5. 3M Diamond Grade DG³ Series 4000 + 3M Piezo Inkjet Ink Series 8800UV + 3M Electrocut Film 1170
6. 3M Diamond Grade DG³ Series 4000 + 3M Piezo Inkjet Ink Series 8800UV + 3M Dew Resistant Overlay Film 1180
7. 3M Diamond Grade DG³ Series 4000 + 3M Dew Resistant Overlay Film 1180
8. 3M Diamond Grade DG³ Series 4000 + 3M Premium Protective Overlay Film 1160
9. 3M Diamond Grade DG³ 4090 + 3M Electrocut Film 1176 with or without 3M Protective Overlay Film
10. 3M Diamond Grade DG³ Series 4000 + 3M Piezo Inkjet Ink Series 8800UV + 3M Premium Protective Overlay Film 1180
11. 3M Diamond Grade DG³ Series 4000 + 3M Electrocut Film Series 1170 + 3M Dew Resistant Overlay Film 1180

Intended Use / Verwendungszweck

The construction product is used to manufacture sign faces for permanent traffic signs. The intended use includes, for example:

- Retro-reflective signs, retro-reflective and transilluminated signs (see also EN 12899-1)
- Variable message signs (see also EN 12966-1)

Das Bauprodukt wird für die Herstellung von Signalbildern von ortsfesten, vertikalen Verkehrszeichen verwendet. Der Verwendungszweck schließt z.B. ein:

- Retroreflektierende Verkehrszeichen, retroreflektierende und innenbeleuchtete Verkehrszeichen (siehe EN 12899-1)
- Wechselverkehrszeichen (siehe EN 12966-1)

Manufacturer / Hersteller



3M Deutschland GmbH
Carl-Schurz-Str.1
D – 41453 Neuss

Assessment and Verification of Constancy of Performance / Bewertung und Überprüfung der Leistungsbeständigkeit

System 1

StrAus-Zert, notified body 0913, Steinhausstr. 79, D-58099 Hagen performs the continuous surveillance, assessment and evaluation of the factory production control under system 1 and issued the certificate of conformity 0913-CPD-2012 / 03.

/

StrAus-Zert, notifizierte Stelle Nr. 0913, Steinhausstr. 79, D-58099 Hagen führt die laufende Überwachung, Beurteilung und Anerkennung der werkseigenen Produktionskontrolle nach System 1 durch und hat die Konformitätsbescheinigung 0913-CPD-2012 / 03 ausgestellt.

UBAtc, Rue du Lombard 42, B-1000 Brussels, performed the initial type testing and initial inspection of the factory and the FPC under system 1 and issued ETA 11/0521, ETA 11/0522 and ETA 13/0303.

UBAtc, Rue du Lombard 42, B-1000 Brussels, führte die Erstprüfung und Erstinspektion des Werks und der werkseigenen Produktionskontrolle nach System 1 durch und hat ETA 11/0521, ETA 11/0522 und ETA 13/0303 ausgestellt.

Declared Performance / erklärte Leistung (ETA 11/0521, 11/0522, 13/0303)

Safety in Use / Nutzungssicherheit

Essential Characteristics / Wesentliche Merkmale	Performance / Leistung	Technical Specification / Technische Spezifikation
Visibility Characteristics		
Daytime Colour and Luminance Factor	Pass, Class B1 & B2	ETA 11/0521, ETA 11/0522, ETA 13/0303
Coefficient of Retroreflection (Construction Product 1 - 3 of above product code list)	Class R2 (Europe); R3A + R3B (Germany, Greece, Belgium)	
Coefficient of Retroreflection (Construction Product 4 - 11 of above product code list)	Class R3B (Germany)	
Rotational Symmetry	Pass	
Impact Resistance	Pass	
Durability		
Temperature Resistance (only combination 1-3 of above product code list)	Class 1 (80°C)	ETA 11/0521, ETA 11/0522, ETA 13/0303
Daytime Colour and Luminance Factor:	Pass, Class B1 & B2 (after exposure)	
Coefficient of Retroreflection	Pass (> 80% after exposure)	

The performance of the construction product identified above is in conformity with the declared performance. This declaration of performance is issued under the sole responsibility of the manufacturer. /

Die Leistung des oben genannten Bauproduktes entspricht der erklärten Leistung. Verantwortlich für die Erstellung dieser Leistungserklärung ist allein der Hersteller.

Neuss, august 2013



John Jackson
3M Technical Director

Amendment to the Declaration of Performance '3M Diamond Grade DG³'

This declaration covers the product 'Microprismatic retroreflective sheeting'. Sign plates or complete assemblies of fixed vertical road traffic signs according to EN 12899-1:2007 can be manufactured with the following products and product combinations, according to ETA 11/0521, ETA 11/0522 and ETA 13/0303.

<i>Components</i>	<i>Trade name</i>	<i>Colours/code</i>
Micro-prismatic retro-reflective sheeting	3M™ Diamond Grade™ DG ³ Reflective Sheeting Series 4000	White 4090 Red 4092 Yellow 4091 Green 4097 Blue 4095 Fluorescent Yellow 4081 Fluorescent Orange 4084 Fluorescent Yellow/Green 4083
Overlay film	3M™ Electrocut Film series 1170	Yellow 1171 Red 1172 Blue 1175 Green 1177 Brown 1179 Dark Green (Green 2) 1176 Colourless 1170
Process colour	3M™ Process Colour Series 880 I or N	Yellow 884I or N Red 882I or N Blue 883I or N Green 888I or N French Red 889I or N
Process colour	3M™ Process Colour Series 4700	Yellow 4704 Red 4702 Blue 4703 Green 4708
Process colour for digital printing	Piezo Inkjet Ink Series 8800 UV	Yellow Red Blue Green Brown
Protective Overlay films	3M™ Dew Resistant Overlay Film 1180	
	3M™ Premium Protective Overlay Film 1160 (anti-graffiti)	
	3M™ Protective Overlay Film 1150	