

SELECTION 78 1,180–1,260°C

Lead- and cadmium-free inglaze colors

1. General Information and Color chart

SELECTION 78 series is a range of lead- and cadmium-free, intermixable, fast-fire inglaze colors for hard porcelain, porcelain, bone china, earthenware, fine china and vitreous china.

Options for this series: Please refer to their individual technical information.

SELECTION 64: Lead- free cadmium containing, inclusion inglaze colors.

SELECTION 78 Relief: Lead- and cadmium-free inglaze relief flux and white.



SELECTION 78 1,180–1,260 °C Lead- and cadmium-free, intermixable, fast-fire inglaze colors for hard porcelain, porcelain, bone china, earthenware, fine china and vitreous china.

Table 1

Product No.	Color tone	Pantone No.	Intermixable	Precious metal containing	Lead free(<300ppm)	Cadmium free (<100ppm) *1	Acid resistant, DIN 1388-1-2 *2	Alkali resistant, ASTM C556-88 *3	78 101 mixing and overprinting flux	64 101 mixing and overprinting flux	Tile	Bone, vitreous china, earthenware	Oxidized porcelain (fine china)	Porcelain (<1230°C)	Hard porcelain (>1230°C)	Remarks
78 101	flux		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	mixing and overprinting
78 201	mixing white		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	mixing white
78 204	opaque white		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	opaque white
78 321	yellow	101C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color yellow
78 404	chrome green	364C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 406	blue green	322C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 521	yellow brown	138C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 527	ochre	160C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 508	rose wood	1665C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 528	chestnut	477C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 721	gray	651C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 706	black	Process blackC	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color black
78 821	turquoise	2905C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 804	dark cyan	3015C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color cyan
78 805	sky blue	285C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 806	cobalt blue	Reflex blueC	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 814	cobalt blue	Blue 072C	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	intensive blue, good for soft glaze and high temperature
78 910	violet	2572C			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Tin-Chrome color, limited use
78 923	pink	493C			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Tin-Chrome color, limited use
78 924	maroon	492C			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Tin-Chrome color, limited use
78 902	light red pink	1905C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78 907	red magenta	207C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color magenta
78 918	dark blue maroon	208C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Relief flux & white																
78 180	relief flux		✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	relief flux, can mix with all 64, 78 colors
78 280	relief white		✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	relief white, can mix with all 64, 78 colors
SELECTION 64: Lead-free cadmium containing inclusion inglaze colors, additional colors for SELECTION 78																
64 101	flux		✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	special overprinting flux for 64 inclusion colors
64 312	lemon yellow	Yellow C	✓		✓	*1	✓	✓			✓	✓	✓	✓	✓	four-color orange yellow
64 313	cadmium yellow	Yellow 012C	✓		✓	*1	✓	✓			✓	✓	✓	✓	✓	
64 318	cadmium orange	Orange 021C	✓		✓	*1	✓	✓			✓	✓	✓	✓	✓	
64 412	cadmium green	377C	✓		✓	*1	✓	✓			✓	✓	✓	✓	✓	
64 623	cadmium red	Red 032C	✓		✓	*1	✓	✓			✓	✓	✓	✓	✓	
64 628	cadmium red	186C	✓		✓	*1	✓	✓			✓	✓	✓	✓	✓	four-color red
64 634	cadmium red	187C	✓		✓	*1	✓	✓			✓	✓	✓	✓	✓	

*1: lead- free cadmium containing colors

*2: DIN EN 1388-1-2 : The test pieces are immersed in a 4% acetic acid solution for 24 hours at 22±2°C.

*3: ASTM C556-88 : The test pieces are immersed in a 0.5 % sodium carbonate solution in water at 95° C for 2, 4 and 6 hours.

2. SELECTION 64 Series

SELECTION 64 colors are lead-free cadmium containing inclusion colors. They show very intensive color tone and are stable at low- and high-firing temperatures. Even though, they do not show cadmium release after proper firing, we separated them from the **SELECTION 78** series because they contain cadmium. **SELECTION 64** colors are intermixable and can be used with **SELECTION 78** colors under the same firing conditions. As overprinting flux for **SELECTION 64** colors, we recommend 64101flux instead, if 78101 flux shows rough surface (orange skin problem).

3. Firing Conditions

Type of ware	Firing range
Hard porcelain	1,230–1,260°C
Porcelain	1,180–1,230°C
Vitreous china	1,000–1,200°C
Fine china	1,000–1,200°C
Bone china	1,000–1,050°C
Earthenware	1,000–1,050°C

SELECTION 78 and **64** colors are suitable for fast-firing conditions, 60–150 minutes, cold-to-cold.

Gold-containing colors: 78902 pink, 78907 magenta and 78918 maroon are recommended for firing bellow 1,220°C.

Tin- Chrome colors: 78910 violet, 78923 pink and 78924 maroon are recommended for firing bellow 1,200°C.

4. Application

SELECTION 78 and **64** colors are suitable for screen-transfer printing, direct printing, spraying, pad printing and hand painting

5. Coefficient of Thermal Expansion (C.O.E.)

Product	Thermal Expansion (C.O.E.)
SELECTION 78 and 64 colors (average)	n/a
78101 flux	$7.5 \times 10^{-6}/^{\circ}\text{C}$
64104 flux	$8.5 \times 10^{-6}/^{\circ}\text{C}$
78180 relief flux	$4.3 \times 10^{-6}/^{\circ}\text{C}$
78280 relief white	$4.3 \times 10^{-6}/^{\circ}\text{C}$

6. Particle size of Distribution (P.S.D.)

Product	D ₅₀ average	D ₁₀₀ biggest
SELECTION 78 colors (average)	3–3.5 μ m	30 μ m
SELECTION 64 colors (average)	5 μ m	40–50 μ m
78101, 64101 flux	3–3.5 μ m	30 μ m
78180 relief flux	15–20 μ m	80–100 μ m
78280 relief white	15–20 μ m	80–100 μ m

7. Printing

【7.1 Mesh size】

We recommend mesh sizes that are 180–300 mesh (71–120T) for all screen applications.

Relief flux and relief white: We recommend that 78180 relief flux and 78280 relief white are printed using 100–120 mesh (40–48T). Printing 1–3 times is recommended. Printing by finer mesh shows smoother surface and less pinhole than rough mesh. Adding 78170 mat base into 78180 or 78280 about 5–10% make them higher melting point therefore they do not sink into the glaze. Printing mixture of 78101 flux and 78170 mat base (about 10–30% depend on glaze) as first layer by 200–250 mesh (80–100T) it also helps not relief sink into the glaze.

【7.2 Medium ratio】

SELECTION 78 : Medium PM2/PMT8	10 : 7–9/7.5–9.5
SELECTION 64 color : Medium PM2/PMT8	10 : 6–7/6.5–7.5
66101, 64101 overprinting flux : Medium PM2	10 : 9–11
78180 relief flux, 78280 relief white : Medium PM2/PMT9	10 : 5.5–6.5/6.5–7.5

SELECTION 78 and 64 colors: We recommend PM2 flowing medium, PMT8 thixotropic medium for dot and four-color printing. We recommend C12 cover coat by printing 70 mesh (27T).

Relief flux and relief white: We recommend PM2 flowing medium for smooth relief and PMT9 weak thixotropic medium for high and sharp relief. We recommend C33 cover coat by printing 70 mesh (27T). Adding just sufficient medium will improve the surface of relief, if it has pinhole problems.

Lead-and-cadmium free onglaze colors absorb any moisture easily. Therefore, keep powder colors in a dry place. We recommend drying the color powder before using.

8. Color and Mixability

SELECTION 78 and **64** colors can be mixed with each other in any proportions. However, we recommend testing the stability of mixing colors and overprinted flux colors under end-user's firing conditions before mass production. Please note following points and refer to Table 1.

Mixing white: To obtain pastel-color tone, it is suitable to mix 78201 mixing white.

Mixing flux: 78101 is suitable for mixing all colors. After mixing with flux, the color is lighter and glossier.

Cobalt blue: We recommended that 78806, 78814 cobalt blue should not be mixed with gold containing colors, 78902 pink, 78907 magenta and 78918 maroon.

78814 cobalt blue: 78814 intensive cobalt blue is specially developed for soft-glaze, bone china, vitreous china and earthenware. It has less diffuse problems compared to other cobalt blues but it does not become proper cobalt blue tone on hard glaze if the firing temperature is not high enough. It is also suitable for long and high firing temperature of hard porcelain firing.

Gold containing colors: 78902 pink, 78907 magenta and 78918 maroon contain gold and silver. We recommend fire them lower than 1220°C. Overprinting 78101 flux for these gold containing colors can prevent them from becoming weak color tones. They are intermixable with any of **SELECTION 78** colors except above cobalt blues. They can be mixed with **SELECTION 64** cadmium-containing colors.

Tin-Chrome colors: Tin-Chrome stain colors, 78910 violet 78923 pink, 78924 maroon cannot be used on the glaze which contains zinc. These colors are very sensitive to long and high firing temperature but thicker printing show better and much more stable results. For mixing with other colors, we recommend using gold-containing colors instead of these Tin-Chrome stain colors to get stable results.

Overprinting flux: 78101 flux is suitable as overprinting flux for all colors except 78806, 78814 cobalt blue and **SELECTION 64** inclusion colors. 64101 flux is suitable especially for **SELECTION 64** inclusion colors. Overprinting flux improves color gloss and chemical durability, such as heavy metal release, alkali durability and dishwasher resistance.

Relief flux and white: 78180 relief flux and 78280 relief white are suitable for mixing and overprinting with all colors. After mixing with **SELECTION 78** and **64** colors, color relief can be developed. Adding just sufficient medium will improve the surface of relief, if it has pinhole problems. It is also possible to adjust firing temperature by mixing with 78101 flux or 78201 white if necessary.

9. Four-color printing

【9.1 Choice of colors】

	Combination 1 (without cadmium colors)	Combination 2 (with cadmium colors)
Yellow	78321 lemon yellow	64312 cadmium yellow
Magenta	78907 magenta	78907 magenta
Red		64628 cadmium red
Cyan	78804 cyan	78804 cyan
Black	78706 black	78706 black
Flux	78101 mixing and overprinting flux	64101 mixing and overprinting flux

To adjust each color tone, 78321 lemon yellow can be mixed with 64312 orange yellow.

SELECTION 64 colors can be mixed and overprinted with above colors. For overprinting on **SELECTION 64** colors, 64101 flux is recommended.

【9.2 Printing order】

Combination 1, Y-M-C-K-F: yellow → magenta → cyan → black → overprinting flux.

Combination 2, CdY-M/CdR-C-K-F: cadmium yellow → magenta/cadmium red → cyan → black → overprinting flux. (Additional overprinting of cadmium colors is possible before overprinting flux)

【9.3 Mesh size】

We recommend mesh size that is polyester 300 mesh (120T).

【9.4 Medium ratio】

78321 lemon yellow, 64312 orange yellow : PMT8	10 : 7-8
78907 reddish magenta, 78918 magenta : PMT8	10 : 9-10
64628 cadmium red : PMT8	10 : 7-8
78804 cyan : PMT8	10 : 7.5-8.5
78706 black : PMT8	10 : 7.5-8.5
78101, 64101 overprinting flux : PM2	10 : 9-11

We recommend PMT8 thixotropic medium for printing **SELECTION 78** four colors.

We recommend PM2 flowing medium for overprinting 78101 and 64101 flux.

We recommend C12 or C33 cover coat by printing 70 mesh (27T)

10. Chemical durability (refer to the Table 1)

Chemical durability of **SELECTION 78** colors depends on type of ware, glaze, kiln, color deposit and firing conditions. The following are the results of tests on porcelain, fired at 1,230°C, with 10 minutes of soaking time and 120 minutes of cold-to-cold firing conditions of gas kiln in production

【10.1 Residual lead and cadmium content】

SELECTION 78 colors contain less than 600 ppm residual lead and less than 100 ppm residual cadmium and are therefore in compliance with Californian Proposition 65, FDA, EU and Japanese requirements.

SELECTION 64 colors contain less than 600 ppm residual lead and contain more than 50,000 ppm cadmium. After proper firing **SELECTION 64** colors do not show cadmium release therefore they can pass FDA, EU and Japanese requirements.

【10.2 Lead and cadmium release】

According to the DI EN 1388-1-2 test, **SELECTION 78** and **64** colors show lead and cadmium releases are below AAS limits.

【10.3 Acid resistance】

According to the DI EN 1388-1-2 test, **SELECTION 78** and **64** colors do not show any visible attack after immersion in a 4% acetic acid solution for 24 hours at a room temperature of $22 \pm 2^\circ\text{C}$.

【10.4 Alkali resistance】

According to ASTM C556-88 test, **SELECTION 78** and **64** colors do not show any visible attack for up to 6 hours. If 78101 or 64101 flux are overprinted, they can stand more than 6 hours.

11. Material Safety Data Sheet (MSDS)

Material safety data sheet (MSDS) of **SELECTION 78** and **64** colors are available on request.

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