

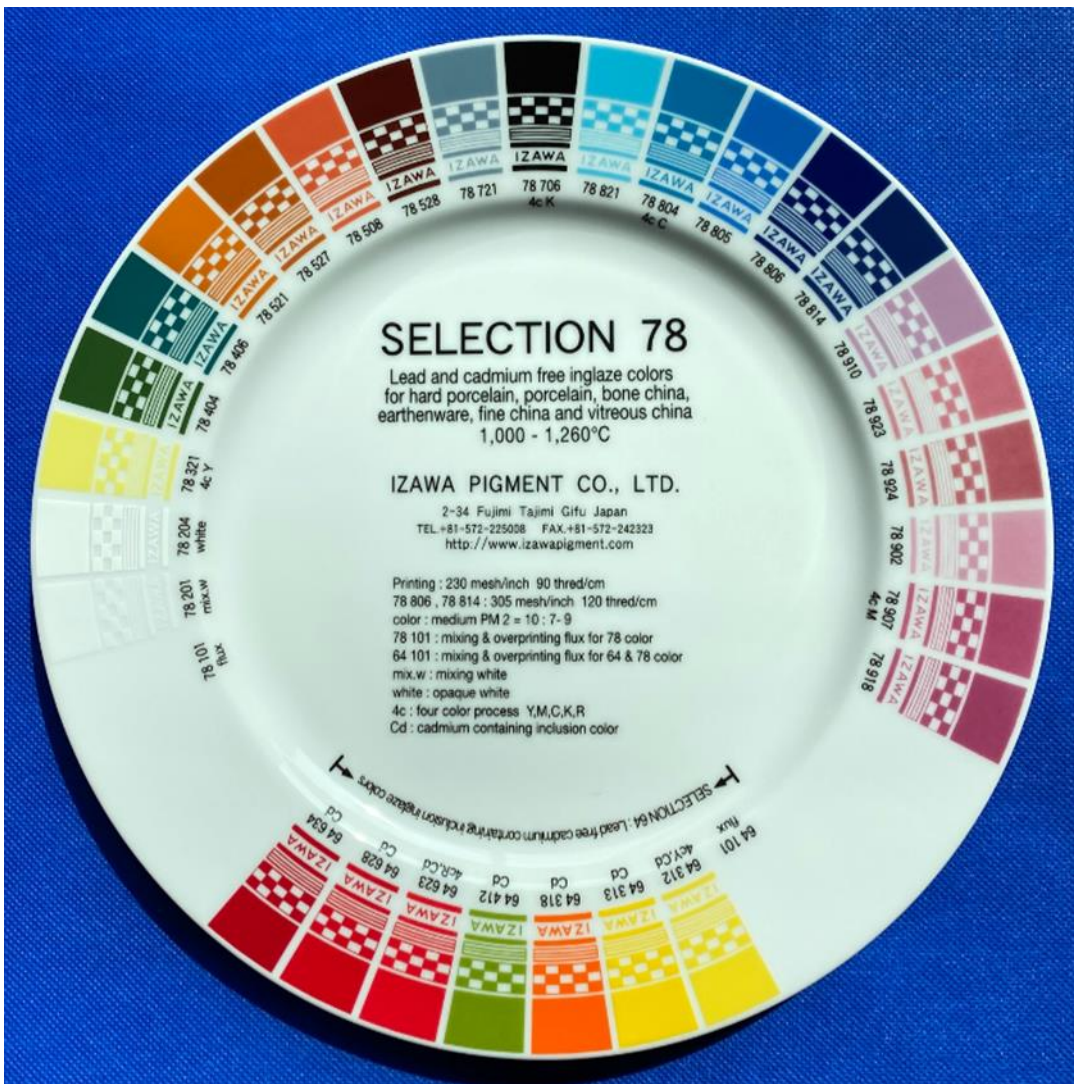
SELECTION 78 1,000–1,260°C

Lead- and cadmium-free inglaze colors

1. General Information and Color chart

Features!

- Lead and cadmium free.
- Intermixable and very intensive colors.
- Very high chemical resistant colors.
- Inglaze gold colors are available.
- 78M metallic colors are available.
- Relief flux and white are available.



SELECTION 78 1,000–1,260 °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 (below 90ppm)	Cadmium free (below 40ppm) *1	Acid resistant, DIN 1388-1-2 *2	Alkali resistant, ASTM C556-88 *3	78101 mixing and overprinting flux	64101 mixing and overprinting flux	Tile	Bone, vitreous china, earthenware	Oxidized porcelain (fine china)	Porcelain (<1230°C)	Hard porcelain (>1230°C)	Remarks
78101	flux		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	mixing and overprinting
78201	mixing white		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	mixing white
78204	opaque white		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	opaque white
78321	yellow	101C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color yellow
78404	chrome green	364C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78406	blue green	322C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78521	yellow brown	138C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78527	ochre	160C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78508	rose wood	1665C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78528	chestnut	477C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78721	gray	651C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78706	black	Process blackC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color black
78821	turquoise	2905C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78804	dark cyan	3015C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color cyan
78805	sky blue	285C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78806	cobalt blue	Reflex blueC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78814	cobalt blue	Blue 072C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	intensive blue, good for soft glaze and high temperature
78910	violet	2572C		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Tin-Chrome color, limited use
78923	pink	493C		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Tin-Chrome color, limited use
78924	maroon	492C		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Tin-Chrome color, limited use
78902	light red pink	1905C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
78907	red magenta	207C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color magenta
78918	dark blue maroon	208C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Relief flux & white																
78180	relief flux		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	relief flux, can mix with all 64, 78 colors
78280	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																
64101	flux		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	special overprinting flux for 64 inclusion colors
64312	lemon yellow	Yellow C	✓	✓	*1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color orange yellow
64313	cadmium yellow	Yellow 012C	✓	✓	*1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
64318	cadmium orange	Orange 021C	✓	✓	*1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
64412	cadmium green	377C	✓	✓	*1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
64623	cadmium red	Red 032C	✓	✓	*1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
64628	cadmium red	186C	✓	✓	*1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	four-color red
64634	cadmium red	187C	✓	✓	*1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

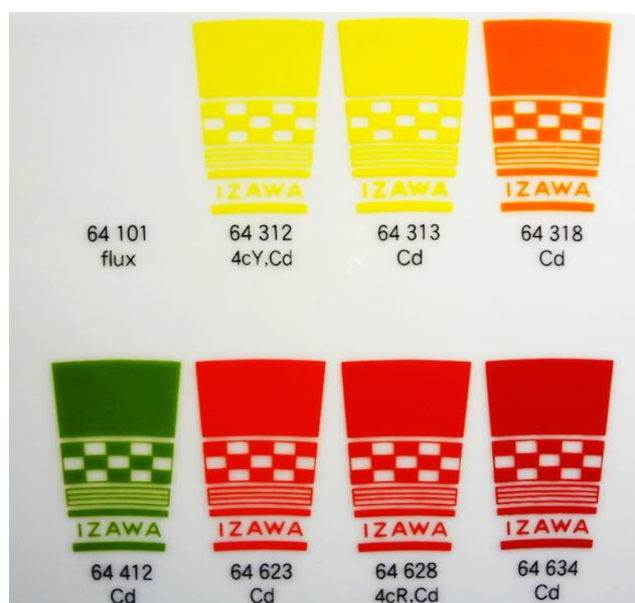
*1: lead-free cadmium containing colors

*2: DIN EN 1388-1-2 : The test pieces are immersed in a 4% acetic acid solution for 24 hours at 22±2°C. Refer section 10.2 and 10.3

*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. Refer section 10.4

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 66** series because they contain cadmium. **SELECTION 64** colors are intermixable and can be used with **SELECTION 66** colors under the same firing conditions. As overprinting flux for **SELECTION 64** colors, we recommend **64101** flux instead, if **66101** 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	1,000–1,150°C
Earthenware	1,000–1,150°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 below 1,220°C.

Tin- Chrome colors: **78910** violet, **78923** pink and **78924** maroon are recommended for firing below 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	$7.5 \times 10^{-6}/^{\circ}\text{C}$
64101 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)	4.5–6 μm (±1.0)	40 μm (±10)
SELECTION 64 colors (average)	5.5–6.5 μm (±1.0)	40–50 μm (±10)
78101, 64101 flux	5.5–6.5 μm (±1.0)	40 μm (±10)
78180 relief flux	15–25 μm (±5.0)	100–150 μm (±20)
78280 relief white	5–15 μm (±2.0)	150–300 μm (±20)

7. Printing

【7.1 Mesh size】

We recommend mesh sizes that are 195–305 mesh/inch (77–120 thread/cm) for all screen applications.

Relief flux and relief white: We recommend that **78180** relief flux and **78280** relief white are printed using 70–123 mesh/inch (27–48 thread/cm). 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 195–260 mesh/inch (77–100 thread/cm) it also helps not relief sink into the glaze.

【7.2 Medium ratio】

SELECTION 78 : Medium PM2/PMT8	10 : 6.5–8.5/7.5–9
SELECTION 64 color : Medium PM2/PMT8	10 : 5.5–7/7–8.5

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/inch (27 thread/cm).

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/inch (27 thread/cm). 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.

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.

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.

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 stabler results.

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.



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 yellow 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 sizes that are 250–305 mesh/inch (100–120 thread/cm) for all screen applications.

【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 cover coat by printing 70 mesh/inch (27 thread/cm)

10. Chemical durability (refer to the Table 1)

Chemical durability of **SELECTION 78** and **64** colors depends on type of ware, glaze, kiln, color deposit and firing conditions. Therefore we recommend testing under end-user's firing conditions before mass production. 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 90 ppm residual lead and less than 40 ppm residual cadmium and are therefore in compliance with Californian Proposition 65, FDA, CPSIA, EU, and Japanese requirements.

SELECTION 64 colors contain less than 90 ppm residual lead and contain more than 50,000 ppm cadmium.

64101 flux contain less than 90 ppm residual lead and less than 40 ppm residual cadmium.

After proper firing, **SELECTION 64** colors show very low 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. Safety Data Sheet (SDS)

Safety data sheet (SDS) of **SELECTION 78** and **64** colors are available on request.

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