Alcoa Engineered Products

ALLOY 6063

Understanding Extruded Aluminum Alloys

Alloy 6063, one of the most popular alloys in the 6000 Series, provides good extrudability and a high quality surface finish. Alloy 6063 is used in a variety of applications that include:

- Architectural and Building Products
- Electrical Components and Conduit
- Pipe and Tube for Irrigation Systems
- Door and Window Frames
- Railings and Furniture

Alcoa produces 6063 for use in standard architectural shapes, custom solid shapes and heatsinks, as well as seamless and structural tube and pipe.

In the heat-treated condition, alloy 6063 provides good resistance to general corrosion, including resistance to stress corrosion cracking. It is easily welded or brazed by various commercial methods (caution: direct contact by dissimilar metals can cause galvanic corrosion). Since 6063 is a heat-treatable alloy, strength in its -T6 condition can be reduced in the weld region. Selection of an appropriate filler alloy will depend on the desired weld characteristics. Consult the Material Safety Data Sheet (MSDS) for proper safety and handling precautions when using alloy 6063.

Alloy 6063 is often used for electrical applications in the -T5, -T52 and -T6 conditions due to its good electrical conductivity. For other applications, alloy 6063 is rated as follows:

CHARACTERISTICS	RATINGS	TEMPERS
Formability/ Cold Workability	Excellent	-0
	Good	-T1, -T4, -T5, -T52
	Fair	-T54, -T6, -T83
Anodizing*	Excellent	-T5, -T52 (“matte finish”), -T53, -T54, -T6 (“lusterous” finish), -T83
Machinability	Fair	-T54, -T6, -T83

* The most common methods are clear anodizing, clear anodizing and color dying, and bright dipping and clear anodizing. Bright dipping and anodizing are economical alternatives to mechanically polished surfaces.

Since 6063 is the alloy of choice for aesthetic applications, special packaging may be required to protect critical exposed surfaces. Alloy 6063 is not typically ink-stenciled in order to preserve its surface finish quality. If stenciling and/or special packaging is required, it should be specified at the time of quotation.

Alcoa offers alloy 6063 in a variety of standard tempers, as well as special tempers developed for unique applications. These are summarized as follows:

6063 Temper Designations and Definitions

Standard Tempers	Standard Temper Definitions*
F	As fabricated. There is no special control over thermal conditions and there are no mechanical property limits.
O	Annealed. Applies to products that are annealed to obtain the lowest strength temper.
T1	Cooled from an elevated temperature shaping process and naturally aged. (See Note B.)
T4	Solution heat-treated & naturally aged. (See Note C.)
T5, T52, T53, T54, T55	Cooled from an elevated temperature shaping process & artifically aged. (See Note B.)
T6	Solution heat-treated & artifically aged. (See Note C.)
Alcoa Special Tempers**	**Alcoa Special Temper Definitions**
T4S18	6063 extrusions and finished products requiring maximum formability in the naturally aged condition that will not be heat treated to -T6 temper. (See Note A and the 6063 Physical Property Limits Table.)
T4S6	For 6063 extrusions requiring maximum formability in the naturally aged condition. This temper is intended for use when extrusions will be formed by the customer in the naturally aged condition and subsequently aged to -T6. May not meet -T4 minimum mechanical properties, but will meet -T6 minimum when properly aged. Test reports will state -T6 properties to demonstrate heat treat capabilities, but product will be supplied in the naturally aged condition. (See Note A.)
T53S22	For 6063 extrusions where -T4 minimum properties are required for strength and a maximum is required for high formability. (See Note A and the 6063 Physical Property Limits Table.)
T6S5	For 6063 extrusions requiring good formability; meets standard 6063 -T6 minimum properties.

* For further details of definitions, see Aluminum Association’s Aluminum Standards and Data manual and Tempers for Aluminum and Aluminum Alloy Products.
Note A: The specified special temper will not conform to Military, Federal, ASTM, ASME and AMS specifications. **Note B:** Applies to products that are not cold worked after cooling from an elevated temperature shaping process, or in which the effect of cold work in flattening or straightening may not be recognized in mechanical properties. **Note C:** Applies to products that are not cold worked after solution heat-treatment, or in which the effect of cold work in flattening or straightening may not be recognized in mechanical properties.
**Alcoa Special Temper designations are unregistered tempers for reference only and provided for customer use to identify unique processing, material, or end use application characteristics.

Alloy 6063 Chemical Analysis

Liquidus Temperature: 1211°F **Solidus Temperature:** 1139°F **Density:** 0.097 lb./in.^{3}

Percent Weight	Elements										
	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Others Each	Others Total	Aluminum
Minimum	.20	—	—	—	.45	—	—	—	—	—	
Maximum	.6	.35	.10	.10	.9	.10	.10	.10	.05	.15	Remainder

Average Coefficient of Thermal Expansion (68° to 212°F) = 13.0 x 10^{-6} (inch per inch per °F)

Alloy 6063 Mechanical and Physical Property Limits

Temper	Specified Section or Wall Thickness [2] (inches)	Tensile Strength (ksi)				Elongation[3]	Typical Brinell Hardness	Typical Ultimate Shearing Strength	Typical Electrical Conductivity
		Ultimate		Yield (0.2% offset)		Percent Min. in 2 inch or 4D[4]	(500 kg load/ 10 mm ball)	(ksi)	(%IACS)
		Min.	Max.	Min.	Max.				
Standard Tempers[1]									
O	All		19.0		—	18	25	10	58
T1	Up thru .500	17.0	—	9.0	—	12	42	14	50
	.501-1.000	16.0	—	8.0	—	12	42	14	50
T4	Up thru .500	19.0	—	10.0	—	14	—	—	—
	.501-1.000	18.0	—	9.0	—	14	—	—	—
T5	Up thru .500	22.0	—	16.0	—	8	60	17	55
	.501-1.000	21.0	—	15.0	—	8	60	17	55
T52	Up thru 1.000	22.0	30.0	16.0	25.0	8	60	17	55
T53	Up thru .249	13.0	21.0	5.0	13.0	8	—	—	—
T54	Up thru .124	33.0	—	30.0	—	8	—	—	—
	.125-.499	33.0	—	30.0	—	10	—	—	—
T55	Up thru .124	28.0	—	23.0	—	8	—	—	—
	.125-.249	27.0	—	22.0	—	10	—	—	—
	.250-.499	26.0	—	21.0	—	12	—	—	—
T6	Up thru .124	30.0	—	25.0	—	8	73	22	53
	.125-1.000	30.0	—	25.0	—	10	73	22	53
Alcoa Special Tempers (Extruded)*									
T4S18	Up thru .500	19.0	—	9.0	—	14	42	14	50
	.501 & above	18.0	—	8.0	—	14	42	14	50
T53S22	Up thru .250	19.0	—	10.0	—	14	42	14	55
T6S5	Up thru .124	30.0	—	25.0	—	8	73	22	53
	.125 - 1.000	30.0	—	25.0	—	10	73	22	53

① The mechanical property limits for standard tempers are listed in the "standards section" of the Aluminum Association's Aluminum Standards and Data manual and Tempers for Aluminum and Aluminum Alloy Products. ② The thickness of the cross section from which the tension test specimen is taken determines the applicable mechanical properties. ③ For material of such dimensions that a standard test specimen cannot be obtained, or for shapes thinner than 0.062", the test for elongation is not required. ④ D = Specimen diameter.

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Comparative Characteristics of Related Alloys/Tempers[1]

Alloy	Temper	Formability	Machinability	General Corrosion Resistance	Weldability (Arc with Inert Gas)	Brazeability	Anodizing Response	Electrical Conductivity (%IACS) @ 68°F
		Low — High	D C B A	D C B A	D C B A	D C B A	D C B A	40 50 60
6063	-O						N/A	
6063	-T1, T4, T4S18,						N/A	
6063	-T5, T52,							
6063	-T53, T53S22							
6063	-T54, T6, T6S5							
6063	-T83, T831, T832							
6101	-T6, T63						N/A	
6101	-T61, T64						N/A	
6061	-T4							
6061	-T6, T6511							
6463	-T5							

① Rating: A=Excellent B=Good C=Fair D=Poor For further details of explanation of ratings, see Aluminum Association's Aluminum Standards and Data manual.

Alcoa Distribution and Industrial Products

53 Pottsville Street
Cressona, PA 17929
Phone: 800-233-3165
FAX: 800-252-4646