

## Table A-3-1 Chemical Composition: Al Alloys

All single values are maximum composition percentages unless otherwise stated.

Aluminum Die Casting Alloys <sup>Ⓐ</sup>											
Commercial:	360	A360	380	A380	383	384	390	13	A13	43	218
ANSI/AA:	360.0	A360.0	380.0	A380.0 <sup>Ⓢ</sup>	383.0 <sup>Ⓢ</sup>	384.0 <sup>Ⓢ</sup>	B390.0	413.0	A413.0	C443.0	518.0
Nominal Comp:	Mg 0.5 Si 9.5	Mg 0.5 Si 9.5	Cu 3.5 Si 8.5	Cu 3.5 Si 8.5	Cu 2.5 Si 10.5	Cu 3.8 Si 11.0	Cu 4.5 Si 17.0	Si 12.0	Si 12.0	Si 5.0	Mg 8.0
Detailed Comp.											
<b>Silicon</b>											
Si	9.0-10.0	9.0-10.0	7.5-9.5	7.5-9.5	9.5-11.5	10.5-12.0	16.0-18.0	11.0-13.0	11.0-13.0	4.5-6.0	0.35
<b>Iron</b>											
Fe	2.0	1.3	2.0	1.3	1.3	1.3	1.3	2.0	1.3	2.0	1.8
<b>Copper</b>											
Cu	0.6	0.6	3.0-4.0	3.0-4.0	2.0-3.0	3.0-4.5	4.0-5.0	1.0	1.0	0.6	0.25
<b>Manganese</b>											
Mn	0.35	0.35	0.50	0.50	0.50	0.50	0.50	0.35	0.35	0.35	0.35
<b>Magnesium</b>											
Mg	0.4-0.6	0.4-0.6	0.10	0.10	0.10	0.10	0.45-.65	0.10	0.10	0.10	7.5-8.5
<b>Nickel</b>											
Ni	0.50	0.50	0.50	0.5	0.30	0.50	0.10	0.50	0.50	0.50	0.15
<b>Zinc</b>											
Zn	0.50	0.50	3.0	3.0	3.0	3.0	1.5	0.50	0.50	0.50	0.15
<b>Tin</b>											
Sn	0.15	0.15	0.35	0.35	0.15	0.35	—	0.15	0.15	0.15	0.15
<b>Titanium</b>											
Ti	—	—	—	—	—	—	0.10	—	—	—	—
<b>Others</b>											
Each	—	—	—	—	—	—	0.10	—	—	—	—
<b>Total</b>											
Others	0.25	0.25	0.50	0.50	0.50	0.50	0.20	0.25	0.25	0.25	0.25
<b>Aluminum</b>											
Al	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance	Balance

<sup>Ⓐ</sup> Analysis shall ordinarily be made only for the elements mentioned in this table. If, however, the presence of other elements is suspected, or indicated in the course of routine analysis, further analysis shall be made to determine that the total of these other elements are not present in excess of specified limits. <sup>Ⓢ</sup> With respect to mechanical properties, alloys A380.0, 383.0 and 384.0 are substantially interchangeable. Sources: ASTM B85-92a; Aluminum Association.

Table A-3-2 Typical Material Properties: Al Alloys

Typical values based on "as-cast" characteristics for separately die cast specimens, not specimens cut from production die castings.

Aluminum Die Casting Alloys											
Commercial:	360	A360	380	A380	383	384	390	13	A13	43	218
ANSI/AA:	360.0	A360.0	380.0	A380.0	383.0	384.0	B390.0	413.0	A413.0	C443.0	518.0
<b>Mechanical Properties</b>											
<b>Ultimate Tensile Strength</b>											
ksi	44	46	46	47	45	48	46	43	42	33	45
(MPa)	(300)	(320)	(320)	(320)	(310)	(330)	(320)	(300)	(290)	(230)	(310)
<b>Yield Strength<sup>Ⓐ</sup></b>											
ksi	25	24	23	23	22	24	36	21	19	14	28
(MPa)	(170)	(170)	(160)	(160)	(150)	(170)	(250)	(140)	(130)	(100)	(190)
<b>Elongation</b>											
% in 2 in. (51 mm)	2.5	3.5	3.5	3.5	3.5	2.5	<1	2.5	3.5	9.0	5.0
<b>Hardness<sup>Ⓑ</sup></b>											
BHN	75	75	80	80	75	85	120	80	80	65	80
<b>Shear Strength</b>											
ksi	28	26	28	27	—	29	—	25	25	19	29
(MPa)	(190)	(180)	(190)	(190)	—	(200)	—	(170)	(170)	(130)	(200)
<b>Impact Strength</b>											
ft-lb	—	—	3	—	3 <sup>Ⓒ</sup>	—	—	—	—	—	7
(J)	—	—	(4)	—	(4)	—	—	—	—	—	(9)
<b>Fatigue Strength<sup>Ⓒ</sup></b>											
ksi	20	18	20	20	21	20	20	19	19	17	20
(MPa)	(140)	(120)	(140)	(140)	(145)	(140)	(140)	(130)	(130)	(120)	(140)
<b>Young's Modulus</b>											
psi x 10 <sup>6</sup>	10.3	10.3	10.3	10.3	10.3	—	11.8	10.3	—	10.3	—
(GPa)	(71)	(71)	(71)	(71)	(71)	—	(81.3)	(71)	—	(71)	—
<b>Physical Properties</b>											
<b>Density</b>											
lb/in <sup>3</sup>	0.095	0.095	0.099	0.098	0.099	0.102	0.098	0.096	0.096	0.097	0.093
(g/cm <sup>3</sup> )	(2.63)	(2.63)	(2.74)	(2.71)	(2.74)	(2.82)	(2.73)	(2.66)	(2.66)	(2.69)	(2.57)
<b>Melting Range</b>											
°F	1035-1105	1035-1105	1000-1100	1000-1100	960-1080	960-1080	950-1200	1065-1080	1065-1080	1065-1170	995-1150
(°C)	(557-596)	(557-596)	(540-595)	(540-595)	(516-582)	(516-582)	(510-650)	(574-582)	(574-582)	(574-632)	(535-621)
<b>Specific Heat</b>											
BTU/lb°F	0.230	0.230	0.230	0.230	0.230	—	—	0.230	0.230	0.230	—
(J/kg°C)	(963)	(963)	(963)	(963)	(963)	—	—	(963)	(963)	(963)	—
<b>Coefficient of Thermal Expansion</b>											
μ in./in./°F x 10 <sup>-6</sup>	11.6	11.6	12.2	12.1	11.7	11.6	10.0	11.3	11.9	12.2	13.4
(μ m/m°C)	(21.0)	(21.0)	(22.0)	(21.8)	(21.1)	(21.0)	(18.0)	(20.4)	(21.6)	(22.0)	(24.1)
<b>Thermal Conductivity</b>											
BTU/ft hr °F	65.3	65.3	55.6	55.6	55.6	55.6	77.4	70.1	70.1	82.2	55.6
(W/m²K)	(113)	(113)	(96.2)	(96.2)	(96.2)	(96.2)	(134)	(121)	(121)	(142)	(96.2)
<b>Electrical Conductivity</b>											
% IACS	30	29	27	23	23	22	27	31	31	37	24
<b>Poisson's Ratio</b>											
(mm/m)	0.33	0.33	0.33	0.33	0.33	—	—	—	—	0.33	—

Ⓐ 0.2% offset Ⓑ 500 kg load, 10mm ball Ⓒ Rotary Bend 5 x 10<sup>8</sup> cycles Ⓓ Notched Charpy. Sources: ASTM B85-92a; ASM; SAE; Wabash Alloys

Die casting alloy selection requires evaluation not only of physical and mechanical properties, and chemical composition, but also of inherent alloy characteristics and their effect on die casting production as well as possible machining and final surface finishing.

This table includes selected die casting and other special characteristics which are usually considered in selecting an aluminum alloy for a specific application.

The characteristics are rated from (1) to

(5), (1) being the most desirable and (5) being the least. In applying these ratings, it should be noted that all the alloys have sufficiently good characteristics to be accepted by users and producers of die castings. A rating of (5) in one or more categories would not rule out an alloy if other attributes are particularly favorable, but ratings of (5) may present manufacturing difficulties.

The benefits of consulting a custom die caster experienced in casting the aluminum alloy being considered are clear.

**Table A-3-3 Die Casting and Other Characteristics: Al Alloys** (1 = most desirable, 5 = least desirable)

Commercial: ANSI/AA:	Aluminum Die Casting Alloys										
	360 360.0	A360 A360.0	380 380.0	A380 A380.0	383 383.0	384 384.0	390 B390.0	13 413.0	A13 A413.0	43 C443.0	218 518.0
<b>Resistance to Hot Cracking</b> Ⓐ	1	1	2	2	1	2	4	1	1	3	5
<b>Pressure Tightness</b>	2	2	2	2	2	2	4	1	1	3	5
<b>Die-Filling Capacity</b> Ⓑ	3	3	2	2	1	1	1	1	1	4	5
<b>Anti-Soldering to the Die</b> Ⓒ	2	2	1	1	2	2	2	1	1	4	5
<b>Corrosion Resistance</b> Ⓓ	2	2	4	4	3	5	3	2	2	2	1
<b>Machining Ease &amp; Quality</b> Ⓔ	3	3	3	3	2	3	5	4	4	5	1
<b>Polishing Ease &amp; Quality</b> Ⓕ	3	3	3	3	3	3	5	5	5	4	1
<b>Electroplating Ease &amp; Quality</b> Ⓖ	2	2	1	1	1	2	3	3	3	2	5
<b>Anodizing (Appearance)</b> Ⓖ	3	3	3	3	3	4	5	5	5	2	1
<b>Chemical Oxide Protective Coating</b> ①	3	3	4	4	4	5	5	3	3	2	1
<b>Strength at Elevated Temp.</b> ③	1	1	3	3	2	2	3	3	3	5	4

**Note:**

Die castings are not usually solution heat treated. Low-temperature aging treatments may be used for stress relief or dimensional stability. A T2 or T5 temper may be given to improve properties. Because of the severe chill rate and ultra-fine grain size in die castings, their "as-cast" structure approaches that of the solution heat-treated condition. T4 and T-5 temper results in properties quite similar to those which might be obtained if given a full T-6 temper. Die castings are not generally gas or arc welded or brazed.

Ⓐ Ability of alloy to withstand stresses from contraction while cooling through hot-short or brittle temperature range. Ⓑ Ability of molten alloy to flow readily in die and fill thin sections. Ⓒ Ability of molten alloy to flow without sticking to the die surfaces. Ratings given for antisoldering are based on nominal iron compositions of approximately 1%. Ⓓ Based on resistance of alloy in standard type salt spray test. Ⓔ Composite rating based on ease of cutting, chip characteristics, quality of finish, and tool life. Ⓕ Composite rating based on ease and speed of polishing and quality of finish provided by typical polishing procedure. Ⓖ Ability of the die casting to take and hold an electroplate applied by present standard methods. Ⓖ Rated on lightness of color, brightness, and uniformity of clear anodized coating applied in sulphuric acid electrolyte. Generally aluminum die castings are unsuitable for light color anodizing where pleasing appearance is required. ① Rated on combined resistance of coating and base alloy to corrosion. ③ Rating based on tensile and yield strengths at temperatures up to 500°F (260°C), after prolonged heating at testing temperature. Sources: ASTM B85-92a; ASM; SAE

**Table A-3-13 Chemical Composition: Zn and ZA Alloys**

All single values are maximum composition percentages unless otherwise stated.

Commercial: ASTM:	Zamak Die Casting Alloys				ZA Die Casting Alloys		
	No. 2	No. 3 AG-40A	No. 5 AC-41A	No. 7 AG-40B	ZA-8	ZA-12	ZA-27
Nominal Comp:	Al 4.0 Mg 0.035 Cu 3.0	Al 4.0 Mg 0.035	Al 4.0 Mg 0.055 Cu 1.0	Al 4.0 Ni 0.013	Al 8.4 Mg 0.023 Cu 1.0	Al 11.0 Mg 0.023 Cu 0.88	Al 27.0 Mg 0.015 Cu 2.25
<b>Detailed Comp.</b>							
<b>Aluminum</b>							
Al	3.5-4.3	3.5-4.3	3.5-4.3	3.5-4.3	8.0-8.8	10.5-11.5	25.0-28.0
<b>Magnesium</b>							
Mg	0.02-0.05	0.02-0.05 <sup>Ⓐ</sup>	0.03-0.08	0.005-0.020	0.015-0.030	0.015-0.030	0.010-0.020
<b>Copper</b>							
Cu	2.5-3.0	0.25 max <sup>Ⓑ</sup>	0.75-1.25	0.25 max	0.8-1.3	0.5-1.2	2-2.5
<b>Iron</b>							
Fe (max)	0.10	0.10	0.10	0.075	0.075	0.075	0.075
<b>Lead</b>							
Pb (max)	0.005	0.005	0.005	0.003	0.006	0.006	0.006
<b>Cadmium</b>							
Cd (max)	0.004	0.004	0.004	0.002	0.006	0.006	0.006
<b>Tin</b>							
Sn (max)	0.003	0.003	0.003	0.001	0.003	0.003	0.003
<b>Nickel</b>							
Ni	—	—	—	0.005-0.020	—	—	—
<b>Zinc</b>							
Zn	Balance	Balance	Balance	Balance	Balance	Balance	Balance

<sup>Ⓐ</sup> The magnesium may be as low as 0.015 per cent provided that the lead, cadmium, and tin do not exceed 0.003, 0.003, and 0.001 per cent, respectively. <sup>Ⓑ</sup> For the majority of commercial applications, a copper content in the range of 0.25-0.75 per cent will not adversely affect the serviceability of die castings and should not serve as a basis for rejection. Source: ASTM B86 and ASTM B791.