



## Understanding Extruded Aluminum Alloys

Among Alcoa Engineered Products' structural 6XXX series alloys, 6005 and 6105 are medium strength alloys that are very similar to alloy 6061 except they contain higher amounts of silicon. These alloys are used in designs that require moderate strength, but are generally not recommended for applications where the structure may be susceptible to impact or overloading.

When bending is required, the naturally aged -T1 temper is preferred. However, due to the excess silicon content, properties may increase more rapidly with room temperature aging than typically experienced with 6063 and 6061 alloys. In comparison to 6061, alloys 6005 and 6105 are easier to extrude and are less quench sensitive, allowing them to be used for more complex shapes. Alloys 6005 and 6105, when produced to a -T5 temper, have the same minimum tensile and yield strength as 6061-T6. In comparison to 6063, alloys 6005 and 6105 in -T5 tempers have better machinability and strength properties than 6063-T6.

Alloys 6005 and 6105 can also be welded or brazed using various commercial methods (caution: direct contact with dissimilar materials can cause galvanic corrosion). The heat from welding or brazing can reduce strength in the weld region. Consult the Material Safety Data Sheet (MSDS) for proper safety and handling precautions when using 6005 and 6105 alloys.

These alloys also offer good finishing characteristics and respond well to common anodizing methods such as clear, clear and color dye and hardcoat.

Typical applications for alloys 6005 and 6105 include:

- Automotive connector stock
- Structural members
- Hand rail tubing
- Seamless tubing
- Ladder structures

| 6005/6105 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.  |
| T1   | Cooled from an elevated temperature shaping process and naturally aged. (See Note A.)  |
| T5   | Cooled from an elevated temperature shaping process & artificially aged. (See Note A.)   |
| Alcoa Special Tempers**<br>(For 6005 Alloy only) | Alcoa Special Temper Definitions   |
| T1S14  | A maximum formability special temper for product that will be formed within 1 to 2 weeks after shipment. Samples are aged and tested in the -T5 condition to verify heat treat capability. |
| T5S3   | An underaged temper to increase formability at a sacrifice of mechanical properties.   |
| T5511  | Same mechanical property limits as -T5. Stretched 1-3% for stress relief.  |

\*For further details of definitions, see Aluminum Association's [Aluminum Standards and Data](#) manual and [Tempers for Aluminum and Aluminum Alloy Products](#).  
**Note A:** 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.  
 \*\*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 6005 Chemical Analysis |          | Liquidus Temperature: 1210°F |     | Solidus Temperature: 1125°F |     | Density: 0.097 lb./in. <sup>3</sup> |     |     |             |              |           |
|------------------------------|----------|------------------------------|-----|-----------------------------|-----|-------------------------------------|-----|-----|-------------|--------------|-----------|
| Percent Weight               | Elements |                              |     |                             |     |                                     |     |     | Others Each | Others Total | Aluminum  |
|                              | Si       | Fe                           | Cu  | Mn                          | Mg  | Cr                                  | Zn  | Ti  |             |              |           |
| Minimum                      | .6       | —                            | —   | —                           | .40 | —                                   | —   | —   | —           | —            | Aluminum  |
| Maximum                      | .9       | .35                          | .10 | .10                         | .6  | .10                                 | .10 | .10 | .05         | .15          | Remainder |

| Alloy 6105 Chemical Analysis |          | Liquidus Temperature: 1200°F |     | Solidus Temperature: 1110°F |     | Density: 0.097 lb./in. <sup>3</sup> |     |     |             |              |           |
|------------------------------|----------|------------------------------|-----|-----------------------------|-----|-------------------------------------|-----|-----|-------------|--------------|-----------|
| Percent Weight               | Elements |                              |     |                             |     |                                     |     |     | Others Each | Others Total | Aluminum  |
|                              | Si       | Fe                           | Cu  | Mn                          | Mg  | Cr                                  | Zn  | Ti  |             |              |           |
| Minimum                      | .6       | —                            | —   | —                           | .45 | —                                   | —   | —   | —           | —            | Aluminum  |
| Maximum                      | 1.0      | .35                          | .10 | .15                         | .8  | .10                                 | .10 | .10 | .05         | .15          | Remainder |

| Alloy | Average Coefficient of Thermal Expansion (68° to 212°F) |
|-------|---|
| 6005  | 13.0 X 10 <sup>-6</sup> (inch per inch per °F)          |
| 6105  | 13.0 X 10 <sup>-6</sup> (inch per inch per °F)          |

## Alloy 6005/6105 Mechanical and Physical Property Limits

| Temper   | Specified Section or Wall Thickness (inches) <sup>2</sup> |      | Tensile Strength (ksi) |      |                     |      | Elongation <sup>3</sup><br>Percent<br>Min. in<br>2 inch<br>or 4D <sup>4</sup> | Typical Thermal Conductivity<br>at 77°F<br>btu-in./ft <sup>2</sup> hr°F | Typical Electrical Conductivity <sup>5</sup><br>(% IACS) |
|--|---|------|------------------------|------|---------------------|------|---|---|--|
|  |   |      | Ultimate               |      | Yield (0.2% offset) |      |   |   |  |
|  | Min.  | Max. | Min.                   | Max. | Min.                | Max. |   |   |  |
| <b>Alloy 6005 Standard Tempers<sup>1</sup></b> |   |      |                        |      |                     |      |   |   |  |
| F  | All   |      | No Properties Apply    |      |                     |      |   | N/A   | N/A  |
| T1   | —   | .500 | 25.0                   | —    | 15.0                | —    | 16  | 1250  | 47   |
| T5   | —   | .124 | 38.0                   | —    | 35.0                | —    | 8   | 1310  | 49   |
| T5   | .125  | —    | 38.0                   | —    | 35.0                | —    | 10  | 1310  | 49   |
| <b>Alloy 6105 Standard Tempers<sup>1</sup></b> |   |      |                        |      |                     |      |   |   |  |
| F  | All   |      | No Properties Apply    |      |                     |      |   | N/A   | 46   |
| T1   | —   | .500 | 25.0                   | —    | 15.0                | —    | 16  | 1220  | —  |
| T5   | —   | .500 | 38.0                   | —    | 35.0                | —    | 8   | 1340  | 50   |
| <b>Alloy 6005 Special Tempers*</b>             |   |      |                        |      |                     |      |   |   |  |
| T1S14 <sup>6</sup>                             | —   | .124 | 38.0                   | —    | 35.0                | —    | 8   | 1250  | 47   |
| T1S14 <sup>6</sup>                             | .125  | —    | 38.0                   | —    | 35.0                | —    | 10  | 1250  | 47   |
| T5S3   | All   |      | 35.0                   | —    | 30.0                | —    | 8   | N/A   | N/A  |
| T5511 <sup>7</sup>                             | —   | .124 | 38.0                   | —    | 35.0                | —    | 8   | 1310  | 49   |
| T5511 <sup>7</sup>                             | .125  | —    | 38.0                   | —    | 35.0                | —    | 10  | 1310  | 49   |

① The mechanical property limits for standard tempers are listed in the Property Limits 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 materials of such dimensions that a standard test specimen cannot be taken, or for shapes thinner than .062", the test for elongation is not required. ④ D=Specimen diameter. ⑤ Minimum, unless stated as typical. ⑥ These properties apply to the material after proper artificial aging. No properties apply to shipped product. ⑦ For stress-relieved tempers, the characteristics and properties other than those specified may differ somewhat from the corresponding characteristics and properties of material in the basic temper.

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## Comparative Characteristics of Related Alloys/Tempers<sup>1</sup>

| Alloy | Temper    | Formability |   |   |   | Machinability |   |   |   | General Corrosion Resistance |   |   |   | Weldability (Arc with Inert Gas) |   |   |   | Brazeability |   |   |   | Anodizing Response |   |   |   | Typical Conductivity (%IACS) |    |    |
|-------|-----------|-------------|---|---|---|---------------|---|---|---|------------------------------|---|---|---|----------------------------------|---|---|---|--------------|---|---|---|--------------------|---|---|---|------------------------------|----|----|
|       |           | D           | C | B | A | D             | C | B | A | D                            | C | B | A | D                                | C | B | A | D            | C | B | A | D                  | C | B | A | 40                           | 50 | 60 |
| 6005  | -T1       | N/A         |   |   |   | N/A           |   |   |   | N/A                          |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |
|       | -T5, T511 | N/A         |   |   |   | N/A           |   |   |   | N/A                          |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |
| 6105  | -T1       | N/A         |   |   |   | N/A           |   |   |   | N/A                          |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |
|       | -T5       | N/A         |   |   |   | N/A           |   |   |   | N/A                          |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |
| 6061  | -T4       |             |   |   |   |               |   |   |   |                              |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |
|       | -T6       |             |   |   |   |               |   |   |   |                              |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |
| 6063  | -T4       |             |   |   |   |               |   |   |   |                              |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |
|       | -T6       |             |   |   |   |               |   |   |   |                              |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |
| 6262  | -T6       |             |   |   |   |               |   |   |   |                              |   |   |   |                                  |   |   |   |              |   |   |   |                    |   |   |   |                              |    |    |

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

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