# TITUS Dual Duct Terminal Units

# Division 23 – Heating, Ventilating, and Air Conditioning

# Section 23 3600 – Air Terminal Units

# PART 1 – GENERAL

## 1.01 Section Includes

1. Dual Duct Terminal Units.

## 1.02 Related Requirements

1. Section 01 3000 - Administrative Requirements
2. Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and actuators.
3. Section 23 09 93 - Sequence of Operations for HVAC Controls.
4. Section 23 31 00 - HVAC Ducts and Casings.
5. Section 23 33 00 - Air Duct Accessories.
6. Section 23 37 00 - Air Outlets and Inlets.
7. Section 23 82 00 - Convection Heating and Cooling Units: Air coils.
8. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

## 1.03 Reference Standards

1. All referenced standards and recommended practices in this section pertain to the most recent published versions.
2. AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
3. AHRI 880 - Performance Rating of Air Terminals.
4. AHRI 885 - Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets, Appendix E.
5. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality.
6. ASHRAE 130 – Laboratory Methods of Testing for Rating Ducted Air Terminal Units.
7. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
8. ASTM C1338 Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
9. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
10. ASTM E488/E488M - Standard Test Methods for Strength of Anchors in Concrete Elements.
11. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
12. NFPA 70 - National Electrical Code; National Fire Protection Association.
13. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; National Fire Protection Association.
14. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Underwriters Laboratories.
15. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Underwriters Laboratories.

## 1.04 Administrative Requirements

1. Pre-installation Meeting: Conduct a pre-installation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
2. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

## 1.05 Submittals

1. See Section 01 3000 - Administrative Requirements for submittal procedures.
2. Product Data shall be provided with data indicating configuration, general assembly, and materials used in fabrication, including catalog performance ratings that indicate airflow, static pressure, NC levels, electrical characteristics, and connection requirements.
3. Shop Drawings shall indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
* Manufacturer shall include schedules listing discharge and radiated sound power level for each of 2nd thru 7th octave bands at inlet static pressures from 1 to 3 inch water gauge.
1. Certificates shall be issued to certify that the air coil capacities, pressure drops, and selection procedures meet or exceed specified requirements or coils are tested and rated in accordance with AHRI 410.
2. Manufacturer's Installation Instructions shall indicate support and hanging details, installation instructions, recommendations, and service clearances required.
3. Project Record Documents shall record actual locations of units and controls components and locations of access doors.
4. Operation and Maintenance Data shall include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
5. Manufacturer’s warranty shall be submitted and ensure forms have been completed in Owner's name and registered with manufacturer.
6. Maintenance Materials shall be furnished for the Owner's use in maintenance of the project.

## 1.06 Quality Assurance

1. Manufacturer Qualifications shall be specified in this section, with minimum ten years of documented experience.
2. Product Listing Organization Qualifications: The manufacturer shall be listed with an organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

## 1.07 Warranty

1. See Section 01 78 00 – Closeout Submittals, for additional warranty requirements.
2. Provide 12 month manufacturer warranty from date of start-up for air terminal units, integral sound attenuators, integral heating coils, and integral controls.

# PART 2 – PRODUCTS

##  Dual Duct Units

1. Basis of Design: TITUS
2. Variable Volume Dual Duct Terminal Unit (Non-Mixing): DEDV w/o Mixer/Attenuator (direct digital controls).
3. Variable or Constant Volume Dual Duct Terminal Unit (Standard Mixing): DEDV w/ Mixer/Attenuator (direct digital controls).
4. Variable or Constant Volume Dual Duct Terminal Unit (High Mixing): DMDV (direct digital controls).
5. Performance Requirements:
6. The assemblies shall be pressure independent and shall reset to any airflow between zero and the maximum cataloged air volume. Sound ratings of air distribution assemblies: Not to exceed \_\_\_\_ NC at \_\_\_\_ inches water gauge inlet static pressure, with a downstream static pressure of \_\_\_\_\_inches water gauge.
7. Use attenuation values found in AHRI 885.
	1. **Variable Volume Dual Duct Terminal Units (Non-Mixing)**
8. General:
9. Furnish and install TITUS Model DEDV w/o Mixer/Attenuator dual duct terminal units in the sizes and configurations as shown on the plans. The terminal units shall be factory-assembled, AHRI 880 rated and bear the AHRI seal.
10. Unit Casing:
11. The unit casing shall be constructed of a minimum 22 gauge, 0.032 inch (0.81 mm) galvanized steel.
12. Air Inlet Collar: Manufacturer shall provide round inlet collars, suitable for standard flexible duct sizes.
13. Unit Discharge: Manufacturer shall provide rectangular unit discharges with slip-and-drive connections.
14. Liners:
15. Standard:
16. Fiberglass Liner
17. Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
18. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
19. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.
20. Insulation thickness shall be (**select one**):
21. 1/2 inch (13 mm) thick, R-value of 1.9.
22. 1 inch (25 mm) thick, R-value of 3.9.
23. Optional:

1. EcoShield (Natural Fiber Insulation)

1. Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
2. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
3. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.
4. Insulation thickness shall be (**select one**):
5. 1/2 inch (13 mm) thick, R-value of 2.0.
6. 1 inch (25 mm) thick, R-value of 4.0.
7. EcoShield w/ Foil Face (Natural Fiber Insulation)
8. Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
9. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
10. Insulation thickness shall be 1 inch (25 mm) thick, R-value of 4.0.
11. FibreFree (Engineered Polymer Foam Insulation)
12. Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
13. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
14. Insulation thickness shall be (**select one**):
15. 1/2 inch (13 mm) thick, R-value of 2.0.
16. 1 inch (25 mm) thick, R-value of 4.0.
17. SteriLoc (Rigid Scrim-Reinforced, Foil-Faced Fiberglass)
18. Insulation shall comply with UL 181 (erosion, mold growth and humidity) requirements in accordance with ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
19. The insulation shall be secured with adhesive.
20. Insulation edges exposed to airstream shall be covered by galvanized steel Z-brackets and/or foil tape.
21. Insulation thickness shall be 13/16 inch (21 mm) thick, R-value of 3.5.
22. UltraLoc (Dual Wall Construction)
23. Insulation shall comply with UL 181 (erosion, mold growth and humidity) requirements in accordance with ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
24. The insulation shall be secured with adhesive.
25. Insulation edges exposed to airstream shall be covered by 22 gauge, 0.032 inch (0.81 mm) galvanized steel.
26. Insulation thickness shall be 1 inch (25 mm) thick, R-value of 3.9.
27. Damper Assembly:
28. The damper assembly shall be heavy-gauge, made from two 22 gauge, 0.032 inch (0.81 mm) galvanized steel plates riveted together to capture a closed cell foam seal for tight close-off and low leakage.
29. The damper shaft shall measure ½ inch (25 mm) in diameter and be cast from zinc-alloy. No plastic or metallic tubular damper shafts shall be acceptable.
30. The damper shaft shall rotate in self-lubricating Delrin bearings.
31. The damper shaft shall incorporate a visual position indicator cast onto the end of the damper shaft to clearly indicate damper position.
32. Air leakage past the closed damper shall not exceed two percent of the unit maximum airflow at three inch water gauge inlet static pressure, tested in accordance with ASHRAE 130.
33. The damper assembly shall be tested to at least 1 million cycles with visible signs of wear or failure.
34. Airflow Sensor:
35. Airflow sensor shall be a differential pressure pick-up that provides amplified velocity pressure output with a minimum amplification of 2.0.
36. Airflow sensor shall be multi-point and center-averaging with a minimum of 4 total pressure ports, a rear port to measure depressed static pressure, and a central averaging chamber.
37. Airflow sensor shall provide +5% flow sensing accuracy with a hard 90° or 45° elbow mounted directly on the inlet when tested in accordance with ASHRAE 130.
38. Airflow sensor shall be molded from fire-rated plastic, complying with UL 94.
39. Airflow sensor shall be assembled using a vibration welding process to ensure leak-free operation.
40. Sensor tubing shall exit inlet collar through protective grommets.
41. Inlet Valve Features:
42. Inlet duct diameter shall be undersized by 1/8 inch (3 mm) order to fit inside standard supply ductwork and flex duct.
43. Inlet duct shall be roll-formed from minimum 22 gauge, 0.032 inch (0.81 mm) galvanized steel with multiple beads to increase rigidity and maintain roundness.
44. Inlet duct shall include a damper stop pin to provide tight close-off and prevent over-stroke in the closed position.
45. Controls:
46. See Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and actuators for controls requirements.
47. Controls Sequence:
48. See Section 23 09 93 - Sequence of Operations for HVAC Controls for controls sequence requirements.

**2.03 Variable Volume Dual Duct Terminal Units (Standard Mixing)**

1. General:
2. Furnish and install TITUS Model DEDV w/ Mixer/Attenuator dual duct terminal units in the sizes and configurations as shown on the plans. The terminal units shall be factory-assembled, AHRI 880 rated and bear the AHRI seal.
3. Unit Casing:
4. The unit casing shall be constructed of a minimum 22 gauge, 0.032 inch (0.81 mm) galvanized steel.
5. The unit casing shall include an integral mixing chamber and baffle arrangement capable of providing a standard 1:10 mixing ratio when tested in accordance with ASHRAE 130.
6. Air Inlet Collar: Manufacturer shall provide round inlet collars, suitable for standard flexible duct sizes.
7. Unit Discharge: Manufacturer shall provide rectangular unit discharges with slip-and-drive connections.
8. Liners:
9. Standard:
10. Fiberglass Liner
11. Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
12. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
13. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.
14. Insulation thickness shall be (**select one**):
15. 1/2 inch (13 mm) thick, R-value of 1.9.
16. 1 inch (25 mm) thick, R-value of 3.9.
17. Optional:

1. EcoShield (Natural Fiber Insulation)

1. Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
2. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
3. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.
4. Insulation thickness shall be (**select one**):
5. 1/2 inch (13 mm) thick, R-value of 2.0.
6. 1 inch (25 mm) thick, R-value of 4.0.
7. EcoShield w/ Foil Face (Natural Fiber Insulation)
8. Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
9. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
10. Insulation thickness shall be 1 inch (25 mm) thick, R-value of 4.0.
11. FibreFree (Engineered Polymer Foam Insulation)
12. Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
13. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
14. Insulation thickness shall be (**select one**):
15. 1/2 inch (13 mm) thick, R-value of 2.0.
16. 1 inch (25 mm) thick, R-value of 4.0.
17. SteriLoc (Rigid Scrim-Reinforced, Foil-Faced Fiberglass)
18. Insulation shall comply with UL 181 (erosion, mold growth and humidity) requirements in accordance with ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
19. The insulation shall be secured with adhesive.
20. Insulation edges exposed to airstream shall be covered by galvanized steel Z-brackets and/or foil tape.
21. Insulation thickness shall be 13/16 inch (21 mm) thick, R-value of 3.5.
22. UltraLoc (Dual Wall Construction)
23. Insulation shall comply with UL 181 (erosion, mold growth and humidity) requirements in accordance with ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
24. The insulation shall be secured with adhesive.
25. Insulation edges exposed to airstream shall be covered by 22 gauge, 0.032 inch (0.81 mm) galvanized steel.
26. Insulation thickness shall be 1 inch (25 mm) thick, R-value of 3.9.
27. Damper Assembly:
28. The damper assembly shall be heavy-gauge, made from two 22 gauge, 0.032 inch (0.81 mm) galvanized steel plates riveted together to capture a closed cell foam seal for tight close-off and low leakage.
29. The damper shaft shall measure ½ inch (25 mm) in diameter and be cast from zinc-alloy. No plastic or metallic tubular damper shafts shall be acceptable.
30. The damper shaft shall rotate in self-lubricating Delrin bearings.
31. The damper shaft shall incorporate a visual position indicator cast onto the end of the damper shaft to clearly indicate damper position.
32. Air leakage past the closed damper shall not exceed two percent of the unit maximum airflow at three inch water gauge inlet static pressure, tested in accordance with ASHRAE 130.
33. The damper assembly shall be tested to at least 1 million cycles with visible signs of wear or failure.
34. Airflow Sensor:
35. Airflow sensor shall be a differential pressure pick-up that provides amplified velocity pressure output with a minimum amplification of 2.0.
36. Airflow sensor shall be multi-point and center-averaging with a minimum of 4 total pressure ports, a rear port to measure depressed static pressure, and a central averaging chamber.
37. Airflow sensor shall provide +5% flow sensing accuracy with a hard 90° or 45° elbow mounted directly on the inlet when tested in accordance with ASHRAE 130.
38. Airflow sensor shall be molded from fire-rated plastic, complying with UL 94.
39. Airflow sensor shall be assembled using a vibration welding process to ensure leak-free operation.
40. Sensor tubing shall exit inlet collar through protective grommets.
41. Inlet Valve Features:
42. Inlet duct diameter shall be undersized by 1/8 inch (3 mm) order to fit inside standard supply ductwork and flex duct.
43. Inlet duct shall be roll-formed from minimum 22 gauge, 0.032 inch (0.81 mm) galvanized steel with multiple beads to increase rigidity and maintain roundness.
44. Inlet duct shall include a damper stop pin to provide tight close-off and prevent over-stroke in the closed position.
45. Controls:
46. See Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and actuators for controls requirements.
47. Controls Sequence:
48. See Section 23 09 93 - Sequence of Operations for HVAC Controls for controls sequence requirements.

**2.04 Variable Volume Dual Duct Terminal Units (High Mixing)**

1. General:
2. Furnish and install TITUS Model DMDV dual duct terminal units in the sizes and configurations as shown on the plans. The terminal units shall be factory-assembled, AHRI 880 rated and bear the AHRI seal.
3. Unit Casing:
4. The unit casing shall be constructed of a minimum 22 gauge, 0.032 inch (0.81 mm) galvanized steel.
5. The unit casing shall include an integral mixing chamber and baffle arrangement capable of providing a high 1:20 mixing ratio when tested in accordance with ASHRAE 130.
6. Air Inlet Collar: Manufacturer shall provide round inlet collars, suitable for standard flexible duct sizes.
7. Unit Discharge: Manufacturer shall provide rectangular unit discharges with slip-and-drive connections.
8. Liners:
9. Standard:
10. Fiberglass Liner
11. Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
12. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
13. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.
14. Insulation thickness shall be (**select one**):
15. 1/2 inch (13 mm) thick, R-value of 1.9.
16. 1 inch (25 mm) thick, R-value of 3.9.
17. Optional:

1. EcoShield (Natural Fiber Insulation)

1. Insulation shall comply with the requirements of UL 181 (erosion), ASTM C1338 (fungi resistance), ASHRAE 62.1, and ASTM C1071, having a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
2. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
3. Insulation edges exposed to the airstream shall be coated with NFPA 90A approved sealant.
4. Insulation thickness shall be (**select one**):
5. 1/2 inch (13 mm) thick, R-value of 2.0.
6. 1 inch (25 mm) thick, R-value of 4.0.
7. EcoShield w/ Foil Face (Natural Fiber Insulation)
8. Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
9. The insulation shall be secured with both adhesive and weld pin mechanical fasteners.
10. Insulation thickness shall be 1 inch (25 mm) thick, R-value of 4.0.
11. FibreFree (Engineered Polymer Foam Insulation)
12. Insulation shall comply with the requirements of UL 181 (erosion, mold growth and humidity) and ASHRAE 62.1, and shall have a maximum flame/smoke spread of 25/50 for both the insulation and the adhesive when tested in accordance with ASTM E84.
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26. Insulation thickness shall be 1 inch (25 mm) thick, R-value of 3.9.
27. Damper Assembly:
28. The damper assembly shall be heavy-gauge, made from two 22 gauge, 0.032 inch (0.81 mm) galvanized steel plates riveted together to capture a closed cell foam seal for tight close-off and low leakage.
29. The damper shaft shall measure ½ inch (25 mm) in diameter and be cast from zinc-alloy. No plastic or metallic tubular damper shafts shall be acceptable.
30. The damper shaft shall rotate in self-lubricating Delrin bearings.
31. The damper shaft shall incorporate a visual position indicator cast onto the end of the damper shaft to clearly indicate damper position.
32. Air leakage past the closed damper shall not exceed two percent of the unit maximum airflow at three inch water gauge inlet static pressure, tested in accordance with ASHRAE 130.
33. The damper assembly shall be tested to at least 1 million cycles with visible signs of wear or failure.
34. Airflow Sensor:
35. Airflow sensor shall be a differential pressure pick-up that provides amplified velocity pressure output with a minimum amplification of 2.0.
36. Airflow sensor shall be multi-point and center-averaging with a minimum of 4 total pressure ports, a rear port to measure depressed static pressure, and a central averaging chamber.
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45. Controls:
46. See Section 23 09 13 - Instrumentation and Control Devices for HVAC: Thermostats and actuators for controls requirements.
47. Controls Sequence:
48. See Section 23 09 93 - Sequence of Operations for HVAC Controls for controls sequence requirements.