

Electrical Level 3



Voice, Data, and Video 26310-14



Objectives

When trainees have completed this lesson, they should be able to do the following:

1. Define the different categories for voice-data-video (VDV) cabling systems.
2. Install raceways, boxes, and enclosures for VDV systems.
3. Interpret and apply *NEC*[®] requirements for installing and grounding VDV systems.
4. Explain the requirements for firestopping.

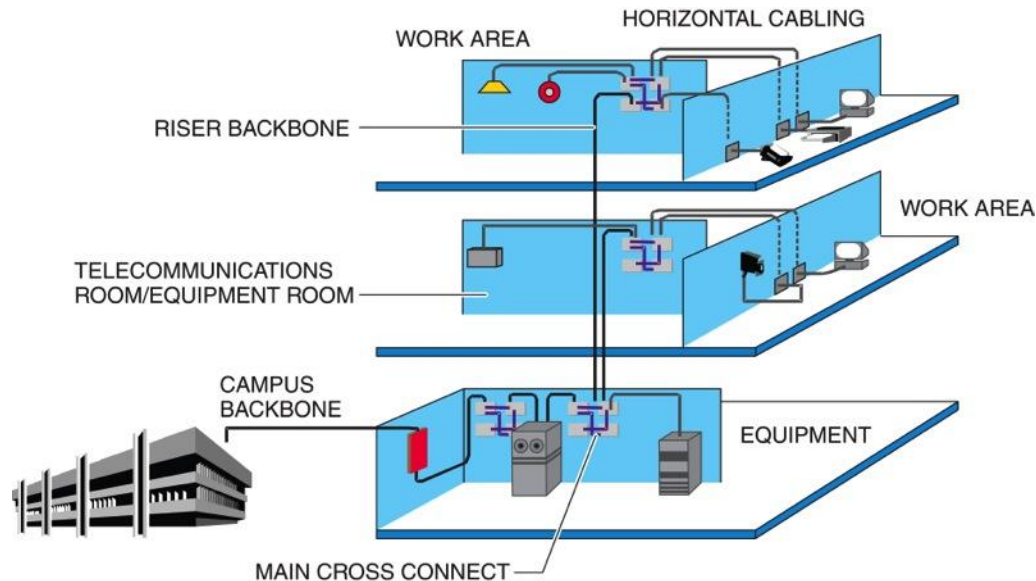
This is a knowledge-based module; there are no Performance Tasks.



1.0.0 – 2.5.4

Introduction; Structured Cabling Systems

- Structured cabling systems are used to route power to voice, data, and video systems.
- Structured cabling systems are classified into five subsystems: campus backbone subsystems, equipment room subsystems, riser subsystems, horizontal cabling subsystems, and work area subsystems.



26310-14_F01.EPS



1.0.0 – 2.5.4

Cables Dressed in an Underfloor Environment with Tie Wrapping and Bundle Breakouts for Each Patch Panel

- When using standard cross connect wire (No. 24 AWG twisted pair), provide a two-finger slack at each block.
- Neatly bundle all cables using tie wraps, Velcro®, or approved cord.
- Install the specified minimum service loop and ensure that it is neatly coiled, labeled, and secured overhead.

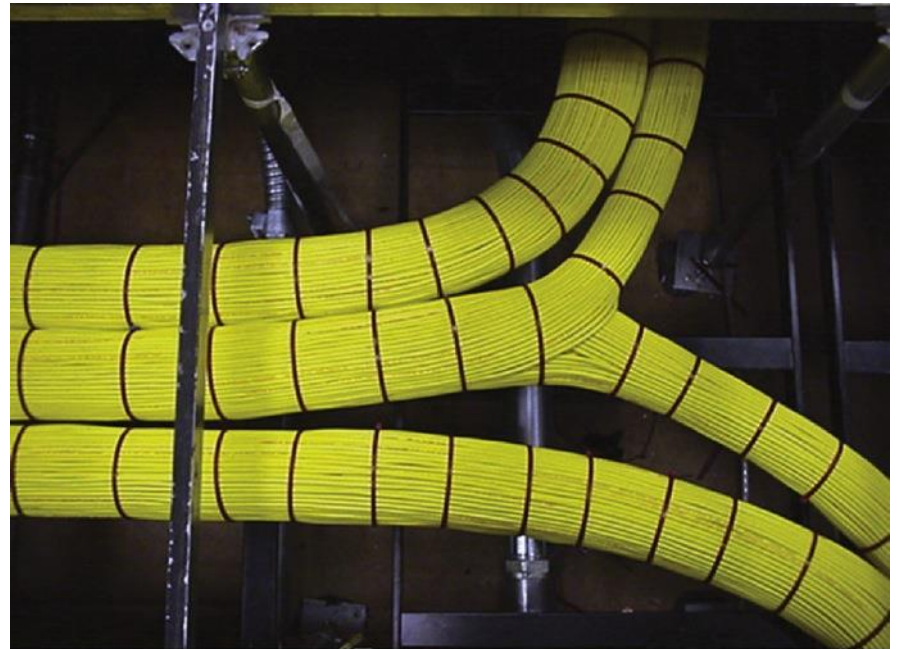


26310-14_F02.EPS

1.0.0 – 2.5.4

Proper Cable Trunk Dressing

- Cables must be dressed from the point of entry to the termination point.
- Proper dressing means that the cables are lying straight with no knots, crossovers, or divers (cables that cross and disappear into the center of the bundle).



26310-14_F03.EPS

1.0.0 – 2.5.4

Another View of Bend Radius, Cable Dressing, and Tie Wrap Tensioning

- Cable bundles must be routed using the appropriate bend radius.
- Avoid sharp edges and angles when routing cable.

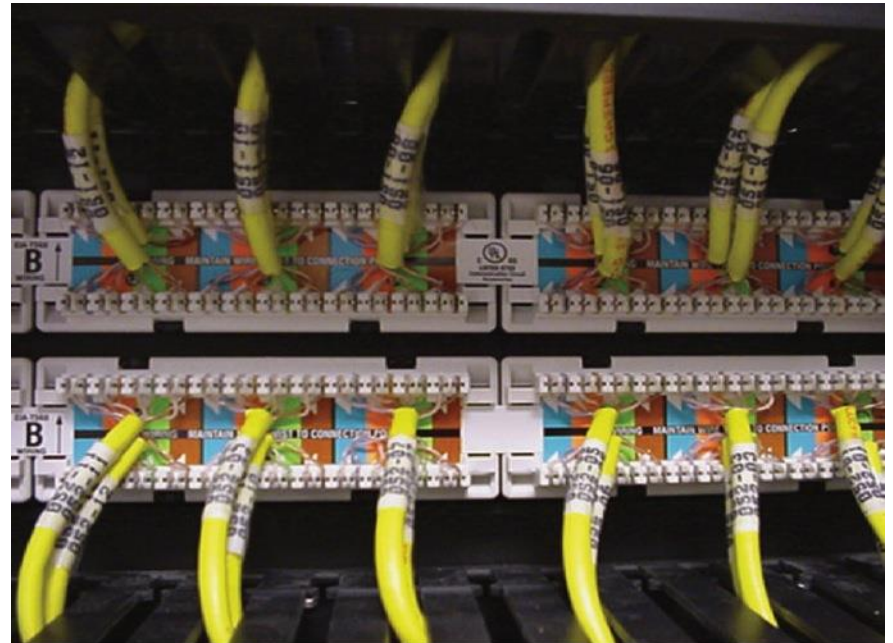


26310-14_F04.EPS

1.0.0 – 2.5.4

Cables Labeled on the Closet End with the Preferred Method of Termination

- Lay the cables in sequentially on the back of the patch panels and label per the job specifications.
- Run wiring so that it is parallel or perpendicular to horizontal, with no beelining or diagonal routing.



26310-14_F05.EPS

1.0.0 – 2.5.4

Horizontal Conduit Cable Capacity Chart

CABLE TYPE	CABLE O.D.	CABLE AREA	¾"	1"	1¼"	1½"	2"	2½"	3"	3½"	4"
	CONDUIT AREA =		0.533	0.864	1.495	2.035	3.354	4.785	7.389	9.882	12.724
4 PAIR CAT 3	0.180	0.025	8	13	23	32	52	75	116	155	200
4 PAIR CAT 5	0.190	0.028	7	12	21	28	47	67	104	139	179
4 PAIR CAT 5	0.220	0.038	5	9	15	21	35	50	77	104	133
25 PAIR CAT 5	0.570	0.255	0	1	2	3	5	7	11	15	19

CABLE TYPE	CABLE O.D.	CABLE AREA	¾"	1"	1¼"	1½"	2"	2½"	3"	3½"	4"
	CONDUIT AREA =		0.533	0.864	1.495	2.035	3.354	4.785	7.389	9.882	12.724
RG-59U (NP) ¹	0.265	0.055	3	6	10	14	24	34	53	71	92
RG-62A/U (P) ²	0.208	0.034	6	10	17	23	39	56	87	116	149
RG-62U (NP)	0.260	0.053	4	6	11	15	25	36	55	74	95

CABLE TYPE	CABLE O.D.	CABLE AREA	¾"	1"	1¼"	1½"	2"	2½"	3"	3½"	4"
	CONDUIT AREA =		0.533	0.864	1.495	2.035	3.354	4.785	7.389	9.882	12.724
25 PAIR NCC ³	0.340	0.091	2	3	6	8	14	21	32	43	56
50 PAIR NCC	0.470	0.173	1	1	3	4	7	11	17	22	29
100 PAIR NCC	0.640	0.322	0	1	1	2	4	5	9	12	15
200 PAIR NCC	0.970	0.739	0	0	0	1	1	2	4	5	6
300 PAIR NCC	1.070	0.899	0	0	0	0	1	2	3	4	5
400 PAIR NCC	1.300	1.327	0	0	0	0	1	1	2	2	3
600 PAIR NCC	1.500	1.766	0	0	0	0	0	1	1	2	2

CABLE TYPE	CABLE O.D.	CABLE AREA	¾"	1"	1¼"	1½"	2"	2½"	3"	3½"	4"
	CONDUIT AREA =		0.533	0.864	1.495	2.035	3.354	4.785	7.389	9.882	12.724
100 PAIR ARMM ⁴	0.890	0.622	0	0	0	1	2	3	4	6	8
200 PAIR ARMM	1.190	1.112	0	0	0	0	1	1	2	3	4
300 PAIR ARMM	1.410	1.561	0	0	0	0	0	1	1	2	3
400 PAIR ARMM	1.480	1.719	0	0	0	0	0	1	1	2	2
600 PAIR ARMM	1.900	2.834	0	0	0	0	0	0	1	1	1
900 PAIR ARMM	2.280	4.081	0	0	0	0	0	0	0	0	1
1200 PAIR ARMM	2.600	5.307	0	0	0	0	0	0	0	0	0

¹ Nonplenum cable

² Plenum cable

³ Network communication cable

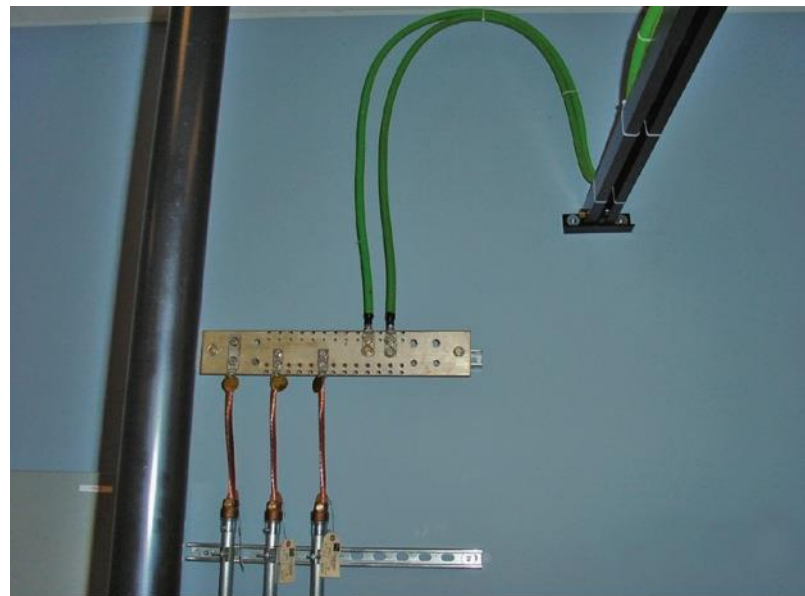
⁴ Armored riser multipurpose multi-pair



1.0.0 – 2.5.4

Telecommunications Main Ground Bus (TMGB) with Conductors Direct from the Building Ground Ring

- Avoid routing power and telecomm cables in the same wireway or tray. A grounded metallic barrier must be provided when both types of cable are run in the same raceway.
- All metallic cable trays must be grounded, but may also be used as a ground conductor. Clearly label any tray that is used as an equipment grounding conductor.



26310-14_F07.EPS

1.0.0 – 2.5.4

Cable Bundle Secured with Velcro® Ties

- The riser support structure and cable must be straight, level, and plumb.
- Cables should be bundled neatly and dressed from cable to cable and end to end. Velcro® is the preferred type of cable tie because it can be easily undone if necessary.

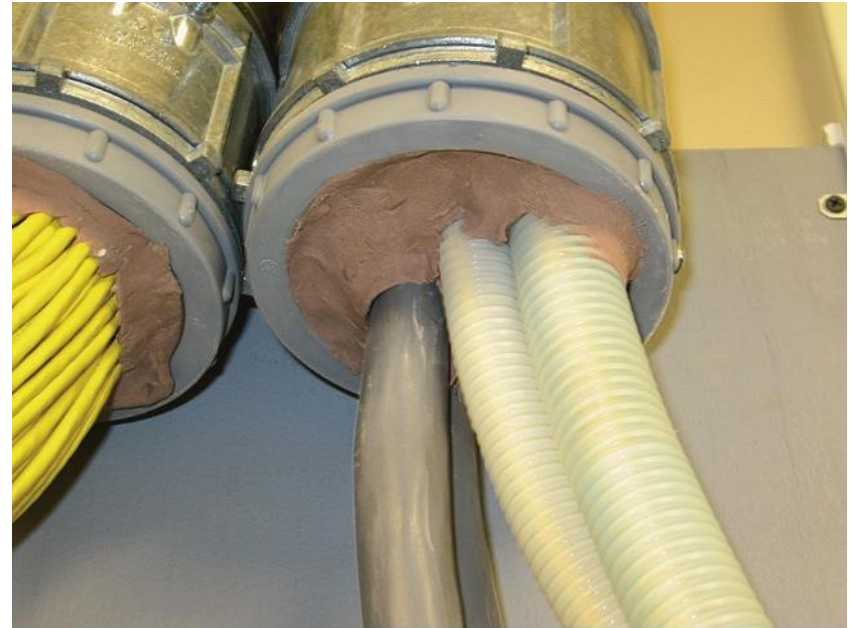


26310-14_F08.EPS

1.0.0 – 2.5.4

Fire-Sealed Conduit

- Horizontal subsystems are typically routed above hallways and common areas. Observe minimum clearances for fluorescent fixtures (5"), power cables (12"), and motors and transformers (48").
- Run conduit using the most direct route and avoid sharp bends. Apply the appropriate firestopping per the job specifications.



26310-14_F09.EPS

1.0.0 – 2.5.4

Ladder Rack/Equipment Rack Grounding System

- The support structure for a horizontal subsystem can consist of J-hooks, bags, bridal rings, and ladder racks/trays.
- Ground all tray and label any tray that is also used as an equipment grounding conductor.



26310-14_F10.EPS

Next Session...Label Windows

- Label all work area subsystem cables, faceplates, and jacks.
- Labels must be machine-printed, protected with a clear shield, and affixed to the front of the cable within 12" of the termination point and in the windows of all faceplates and boxes.

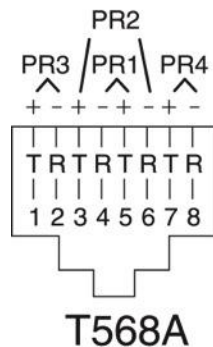
UTP and Coax Cable Terminations



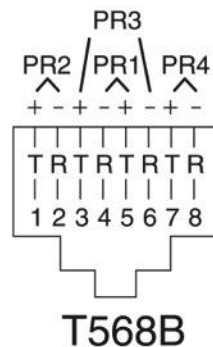
26310-14_F11.EPS

3.0.0 – 3.2.0

UTP and Coax Cable Terminations



568A WIRING		
Pair #	Wire	Pin #
1 – White/Blue	White/Blue	5
	Blue/White	4
2 – White/Orange	White/Orange	3
	Orange/White	6
3 – White/Green	White/Green	1
	Green/White	2
4 – White/Brown	White/Brown	7
	Brown/White	8



568B WIRING		
Pair #	Wire	Pin #
1 – White/Blue	White/Blue	5
	Blue/White	4
2 – White/Orange	White/Orange	1
	Orange/White	2
3 – White/Green	White/Green	3
	Green/White	6
4 – White/Brown	White/Brown	7
	Brown/White	8



3.0.0 – 3.2.0

Typical Punchdown and Tool-Less RJ45 Modular Jacks and Tools



(A) MODULAR CONNECTOR CRIMPING TOOLS



(B) PUNCHDOWN WITH 110/66 BLADE



CAT 3 OR CAT 5e JACKS



CAT 6 TOOL-LESS JACK



CAT 6 JACKS



CAT 5e TOOL-LESS JACKS

(C) JACKS

26310-14_F13.EPS



3.0.0 – 3.2.0

Typical Cat 6 Patch Cable Construction



1. If you are planning to use boots, slide them onto the cable as shown. If you prefer not to use boots, start at Step 2.

Note: Making cables can be very labor intensive. Factory-made cables typically have better tolerances and consequently better quality than field-made cables.



2. Remove approximately 1½" of the cable jacket using a cable stripper.



3. Partially untwist the pairs, leaving one twist remaining at the bottom. Be careful not to untwist into the cable jacket. Straighten and organize the conductors.

Note: Choose 568B (most common) or 568A wiring.



4. (Optional) Cut the ends of the conductors at an angle while holding them in the proper order. This will make it easier to install the load bar in the next step.



5. Slide the conductors into the load bar in their proper order with the hollow portion of the load bar facing the jacket. The holes in the load bar alternate up and down. For that reason, you may find it easier to insert the conductors one at a time. Double-check the color order.



6. Make sure the pairs are twisted at least ¼" beyond the cable jacket. Push the load bar as far down as it will go. Then cut the conductors straight across approximately ⅛" from the front of the load bar. It is very important to get a straight and even cut. The use of a pair of electrician's scissors is highly recommended.



7. Pull the load bar back up near to the cut end of the conductors. Then slide the wires and load bar into the connector body, holding it with the pins facing you. A very slight amount of jiggling may be needed to make the wires find their slots in the connector body.



8. Once all of the wires have entered their slots, firmly push the connector body toward the cable. You will need to be sure that a) the wires have reached the end of the connector body, and b) the cable jacket is about halfway into the connector and past the first crimp point (the jacket crimp).



9. Crimp the connector using a high-quality crimp tool such as a ratchet-type RJ45 tool.

26310-14_F14.EPS



Coax Stripping Tools



26310-14_F15.EPS

- A special coax stripping tool is used to strip coax cable prior to making connections.
- A variety of coax F-type connector terminations are available, including crimp-on, push-on, and twist-on types.

3.0.0 – 3.2.0

Typical Coax Compression Tool and Connector



26310-14_F16.EPS

- Most professional installers use compression connectors to provide a fast and secure connection.
- Always use the correct tool for the size of the connector barrel. Tools may be designed for use with either 19.6mm barrels or 20.3mm barrels, or be able to handle both types.

Next Session... F-Type Compression Connector Installation

Fiber-Optic Installation Considerations



1. Cut the end of the cable off square with a set of sharp cable cutters.



2. Place the coax in the stripper part of the combination tool, with the end flush against the side of the tool or use a separate stripper.

3. Twirl the strip tool around the cable until the crunching sound stops (5 to 10 turns).

4. Remove the combination or strip tool.



5. Fold back the remaining braid over the cable cover so that there is only one layer of foil left against the center white dielectric.

Note: If the braid is not pushed back far enough, it will be very difficult to push on the connector.



7. Untwist the ring from the connector and slide it onto the cable, large end first.

8. Insert the cable into the connector.



9. When inserted properly, the white insulator of the cable should be flush with the metal flange. If the coax does not go in all the way, pull it out and push it in again. Sometimes the cable catches on the inner ring. If the cable jacket is loose, kink the cable slightly in your palm while pressing it into the connector (no more than 45 degrees).

Note: Various tools are available to hold the connector and/or cable for this operation.



10. Slide the ring into the connector and lay the assembly into the crimp tool.

11. Squeeze the handle until the ring seats all the way into the connector. You should hear or feel a click as it pops into position.

12. Remove the coax and connector from the crimper.

26310-14_F11.2PS

4.0.0 – 4.6.0

Fiber-Optic Installation Considerations

- Splice closures are used to provide a mechanical and environmental seal for splices.
- Fiber-optic splice closures can be used to protect up to 144 splices. Splice closures can be used for both straight splices and to switch between cable types.

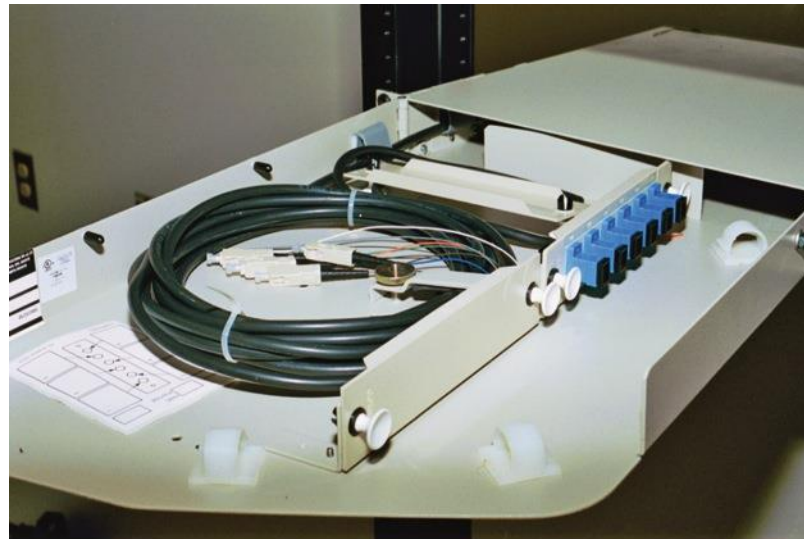


26310-14_F18.EPS

4.0.0 – 4.6.0

Open Rack-Mounted Fiber Termination Box

- Rack boxes are used to organize fiber-optic cable for routing to the distribution point.
- Rack boxes also provide storage room for service loops.

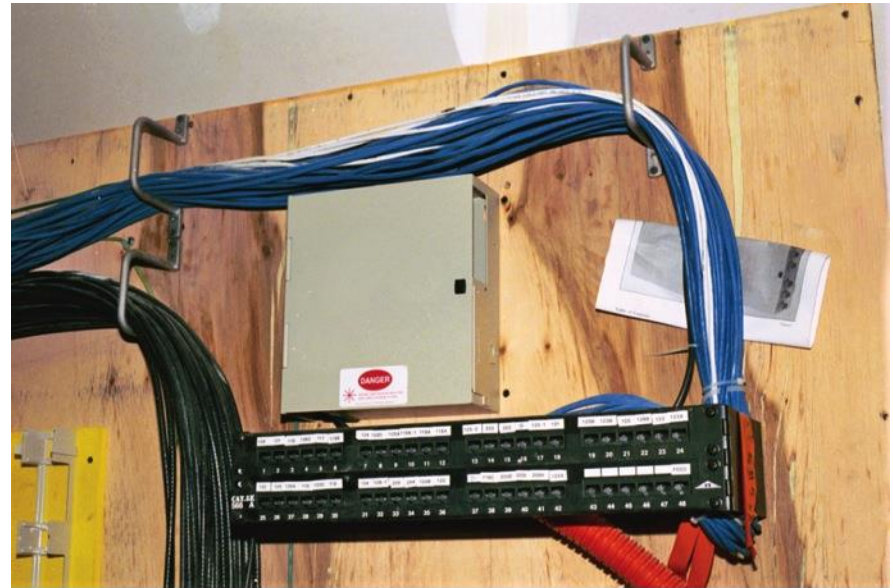


26310-14_F19.EPS

4.0.0 – 4.6.0

Rack-Mounted Fiber Patch Panel

- A patch panel is a metal frame with bushings to which fiber-optic connectors are attached. Fibers can then be connected and disconnected to arrange the circuits as required.
- Patch panels are commonly used in the telephone industry to connect circuits to transmission equipment. They can also be used in the wiring center of a building to rearrange connections.



26310-14_F20.EPS

4.0.0 – 4.6.0

Typical Fiber-Optic Outlet Boxes

- Fiber-optic outlet boxes are similar to electrical boxes and are wall-mounted in the same manner.
- In a control room wired with fiber optics, the box serves as the transition point between the cabling and the instruments.



(A) MULTI-USER OUTLET ASSEMBLY



(B) FIBER OUTLET BOX

26310-14_F21.EPS

5.0.0

Grounding and Bonding

- All conductors for grounding must run in straight lines and be protected from physical damage.
- The *NEC*[®] requirements for sizing the grounding conductors for fiber-optic cable are found in ***NEC Section 770.100(A)(3)***. Other *NEC*[®] requirements for VDV systems are listed here.

Description	Fiber Optics <i>NEC Article 770</i>	Communications Circuits <i>NEC Article 800</i>	Network-Powered Broadband Systems <i>NEC Article 830</i>
Definitions	<i>NEC Section 770.2</i>	<i>NEC Section 800.2</i>	<i>NEC Section 830.2</i>
Other Articles	<i>NEC Section 770.3</i>	<i>NEC Section 800.3</i>	<i>NEC Section 830.3</i>
Mechanical Execution of Work	<i>NEC Section 770.24</i>	<i>NEC Section 800.24</i>	<i>NEC Section 830.24</i>
Abandoned Cables	<i>NEC Section 770.25</i>	<i>NEC Section 800.25</i>	<i>NEC Section 830.25</i>
Spread of Fire	<i>NEC Section 770.26</i>	<i>NEC Section 800.26</i>	<i>NEC Section 830.26</i>
Overhead Wires	<i>n/a</i>	<i>NEC Section 800.44</i>	<i>NEC Section 830.44</i>
Protection	<i>NEC Section 770.93</i>	<i>NEC Section 800.90</i>	<i>NEC Section 830.90</i>
Cable Grounding	<i>NEC Section 770.100</i>	<i>NEC Section 800.100</i>	<i>NEC Section 830.100</i>
Cable Installation	<i>NEC Section 770.133</i>	<i>NEC Section 800.133</i>	<i>NEC Section 800.133</i>
Cable Substitution Hierarchy	<i>NEC Table 770.154(b)</i>	<i>NEC Table 800.154(d)</i>	<i>NEC Table 830.154(b)</i>
Cable Marking	<i>NEC Table 770.179</i>	<i>NEC Table 800.179</i>	<i>NEC Sections 830.179(A) and (B)</i>



6.0.0

Next Session

- After installation, VDV systems must be tested for proper operation using a cable certification test set.
- The types of tests run depend on the cable in use, but may include length, wire map, attenuation, delay, near end crosstalk (NEXT), return loss, and others. Refer to the job specifications for specific requirements.

Wrap Up



(A) AGILENT CABLE CERTIFICATION TESTER



(B) OMNI CABLE CERTIFICATION TESTER

26310-14_F22.EPS



Wrap Up

3-2-1

- 3 – Write 3 important things learned during class
- 2 – Write 2 questions you have about the material
- 1 – Write 1 thought you had about the material



Next Session...

MODULE EXAM

Review the complete module to prepare for the module exam. Complete the Module Review as a study aid.

