Cable Management Solutions for Rack Systems

CPI

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Summary

The care given to communications cable during installation and use is the primary factor in maintaining high circuit performance. Industry standards recognize this fact and recommend installation and management practices that will minimize changes in the physical properties of cable.

Chatsworth Products, Inc. (CPI) Cable Management Solutions support and protect cables to help maintain cable performance. This guide will help you understand how to specify the right Cable Management Solution for CPI Rack Systems including freestanding two-post and four-post racks.

Cable Performance

Cable performance is dependant on the physical properties of the cable, and therefore, circuit performance is directly related to the care given to cable during installation and use. For example, copper 4-pair UTP cable relies on the size (cross-section) of the individual conductors, the twist rates of these conductors and the relative proximities of the individual cable pairs to create a given circuit performance over a specific distance. Also, each cable pair is twisted at a different rate - meaning the length of each pair group is different.

Whenever cable changes direction, the bend in the cable (especially a sharp bend) has potential to change the electrical properties of the cable by changing the size, twist rate, relative proximities or lengths of the individual conductors. Tight bundling of the cable or improper support of cable that deforms, stretches or adds tension to the cable can negatively affect circuit performance. There are similar concerns with fiber.

The Standards

Network speeds and bandwidth requirements are always increasing. To get the most out of the physical layer, communication systems designers have developed network protocols that transmit information as multiple data packets over multiple pairs of cable in a full duplex arrangement.

Industry standards provide guidelines that define which cables and connectors are appropriate to support each type of network and suggest methods for maintaining high levels of cable performance, which includes room layout and the importance of cable management.

The *Commercial Building Telecommunications Pathways and Spaces Standard [ANSI/TIA/EIA-569B]* suggest size, layout and provisioning for planning Telecommunications Rooms based on the number of users and floor space being served.

The *Commercial Building Telecommunications Cabling Standard [ANSI/TIA/EIA-568B]* defines specific types of cables that can be used within the network, maximum distances for these cables at each point-to-point within the network and minimum performance requirements for testing the installed cables as 'standards-compliant'.

Cable Management Solutions

Use cable management solutions to help maintain smooth turns in cables and to minimize negative effects on circuit performance. Generally accepted <u>minimum</u> bend radius for cable transitions are listed below. Refer to the cable manufacturer's installation guidelines for specific requirements.

> 100Ω Cabling
>> Bend Radius, 4-pair UTP, no load, 4X cable diameter
>> Bend Radius, 4-pair ScTP, no load, 8X cable diameter
>> Bend Radius, Multi-pair UTP (i.e., 25 pair, etc), no load, 10X cable diameter

> Fiber (2- or 4-fiber optical cables)
>> Bend Radius, no load, 1" (25 mm)
>> Bend Radius, under pulling load tension, 2" (50 mm)

It is important to note that bend radius requirements apply to patch cords as well as premise cable because circuit testing includes all components of the channel.

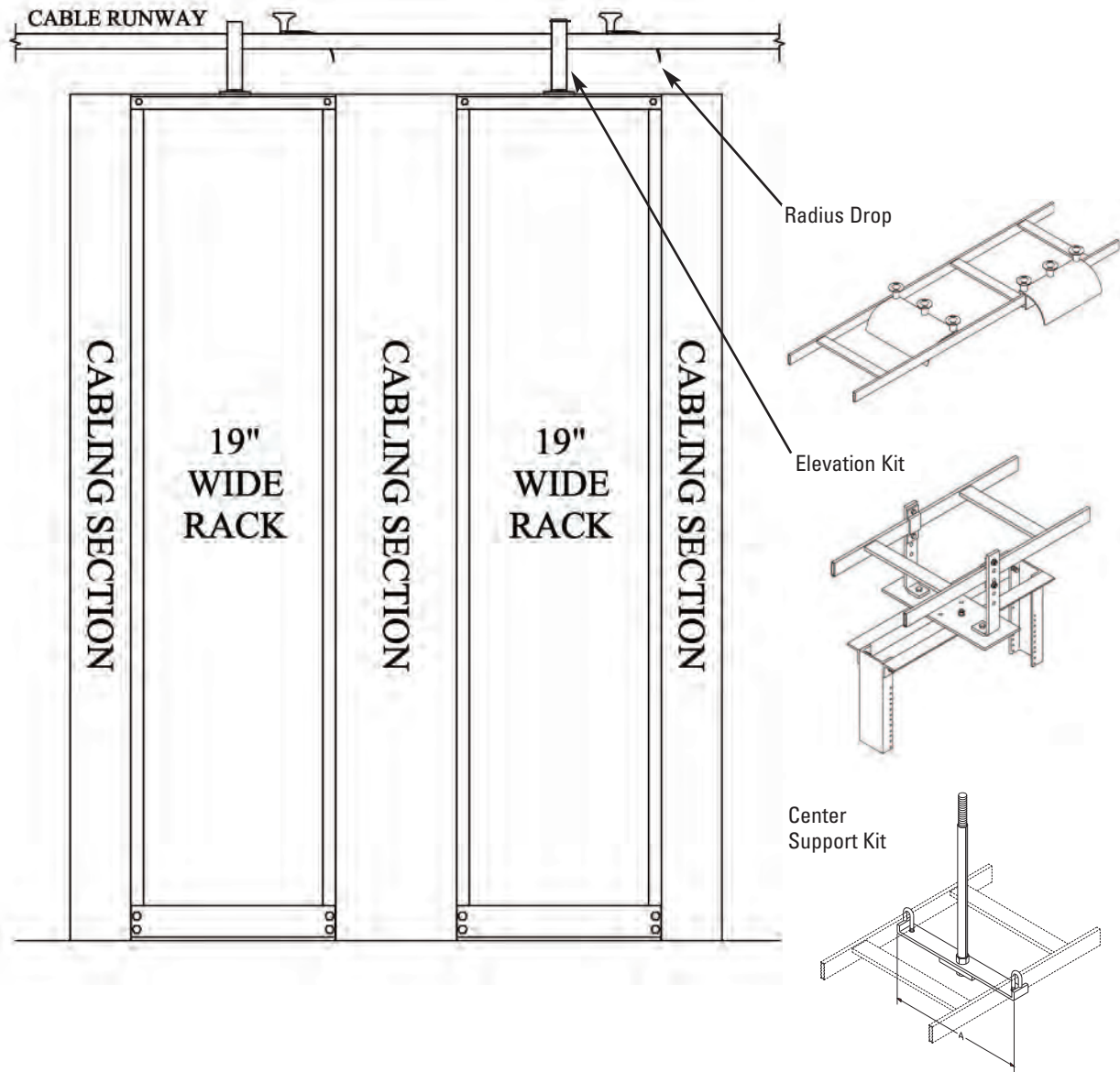## The Basics of Cable Management for CPI Rack Systems

The basic support solution is a two-post rack with cabling sections along both sides of the rack (as shown below, at left) to provide a vertical pathway for premise cable and patch cords. Cabling sections in between adjacent racks in a multiple rack bay must be larger (wider and/or deeper) to support cable from both racks (as shown below, at right).
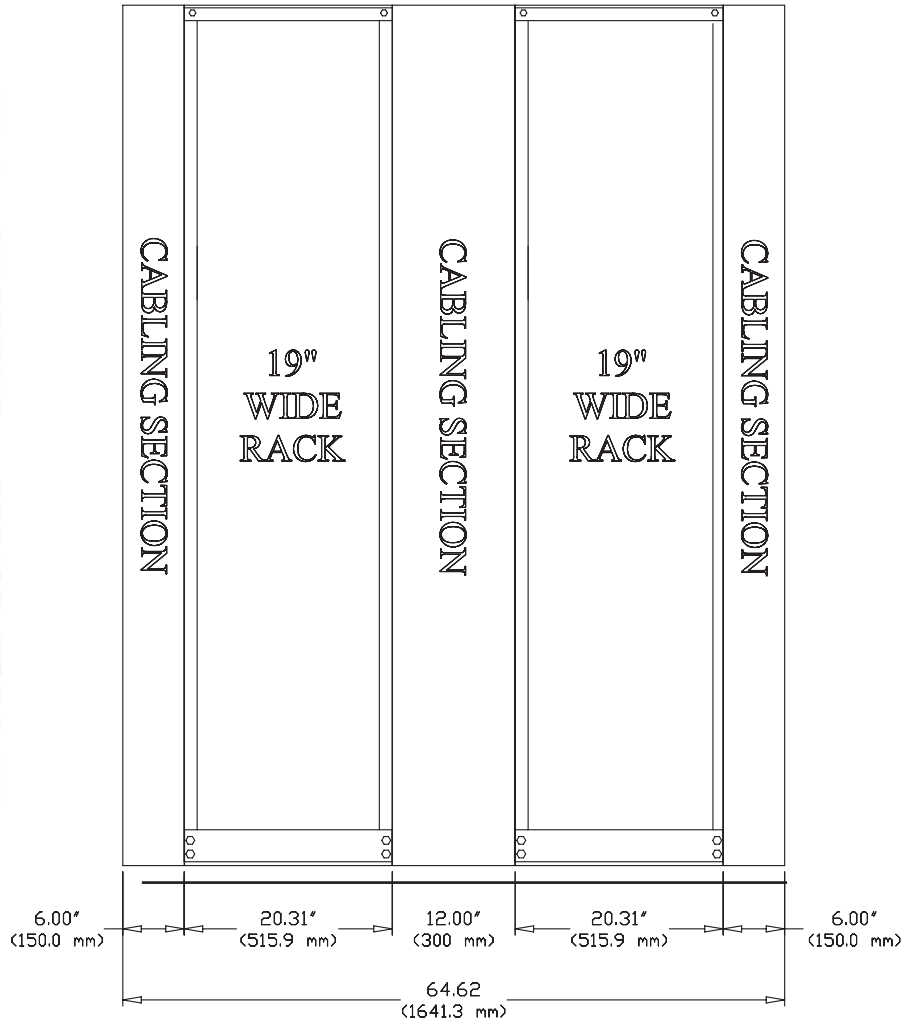
Open two-post racks provide the most cost-effective and efficient use of floor space, but four-post racks are superior when supporting larger equipment, like modular network switches. CPI offers three styles of two-post racks, six styles of four-post racks and five styles of vertical cabling section in various sizes.
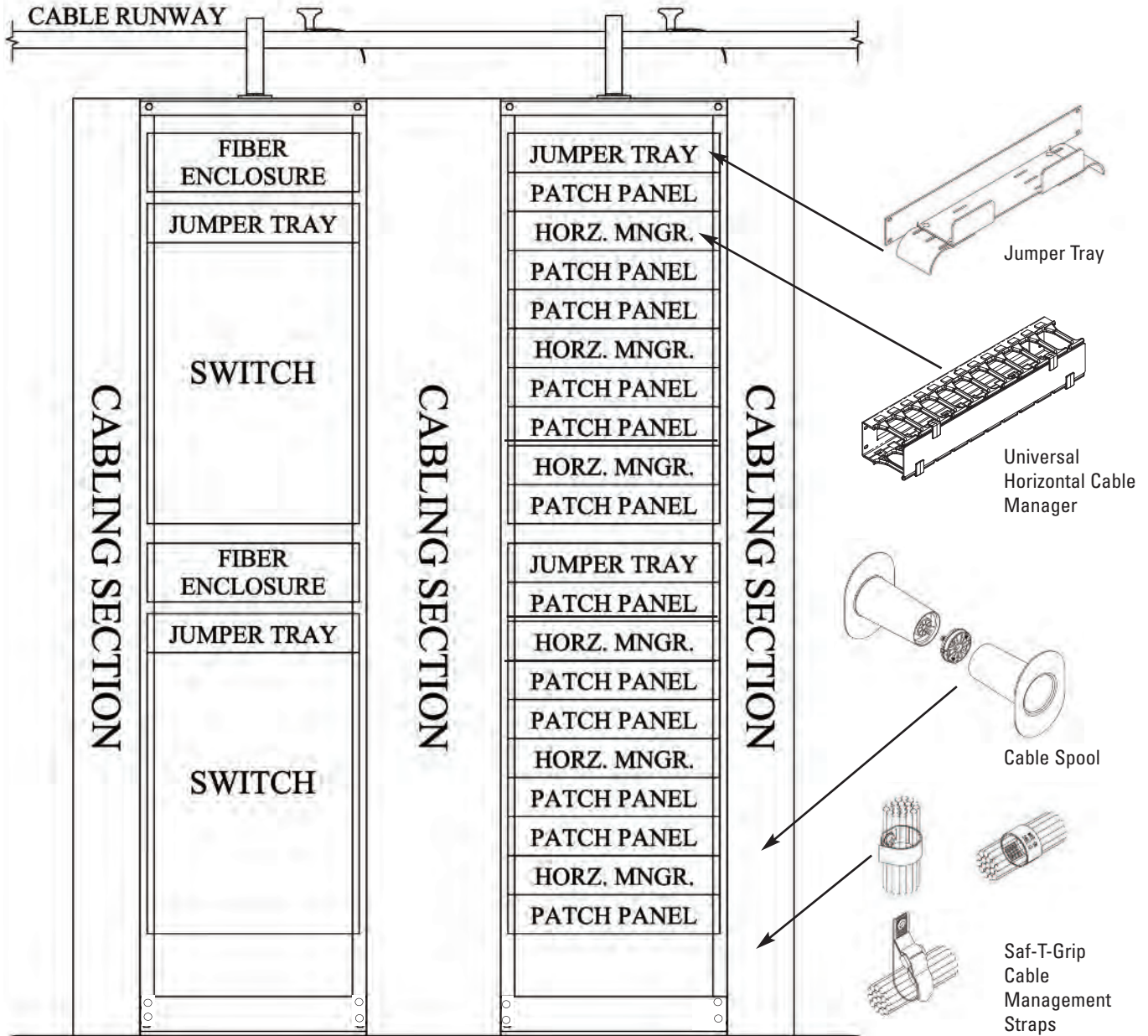
Use cable runway or cable tray to create a pathway for premise cables through the room. Premise cables typically enter the cabling sections from overhead cable runway (ladder rack) or cable tray. Be sure to provide radius drops where cable enters or exits the overhead pathway (as shown below). Also, elevate cable runway 3" to 6" (80 mm to 150 mm) above racks to get the full benefit of the radius drop.

CABLE RUNWAY

CABLING SECTION

19" WIDE RACK

CABLING SECTION

19" WIDE RACK

CABLING SECTION

Radius Drop

Elevation Kit

Center Support Kit

Cable runway or cable tray can be supported from the tops of racks with elevation kits or from the ceiling with threaded rods. Cable runway or cable tray can also be divided to allow cable segregation by media or use/application and tiered to increase capacity.

Use jumper trays and horizontal managers on the racks in between patch panels and network switches (as shown below) to guide patch cords between connections. Use cable spools inside the cabling sections to control patch cord slack. Loosely bundle cables with CPI's Saf-T-Grip® Cable Management Straps.

CABLE RUNWAY

CABLING SECTION

FIBER ENCLOSURE
JUMPER TRAY
SWITCH
FIBER ENCLOSURE
JUMPER TRAY
SWITCH

CABLING SECTION

CABLING SECTION

JUMPER TRAY
PATCH PANEL
HORZ. MNGR.
PATCH PANEL
PATCH PANEL
HORZ. MNGR.
PATCH PANEL
PATCH PANEL
HORZ. MNGR.
PATCH PANEL

JUMPER TRAY
PATCH PANEL
HORZ. MNGR.
PATCH PANEL
PATCH PANEL
HORZ. MNGR.
PATCH PANEL
PATCH PANEL
HORZ. MNGR.
PATCH PANEL

Jumper Tray

Universal Horizontal Cable Manager
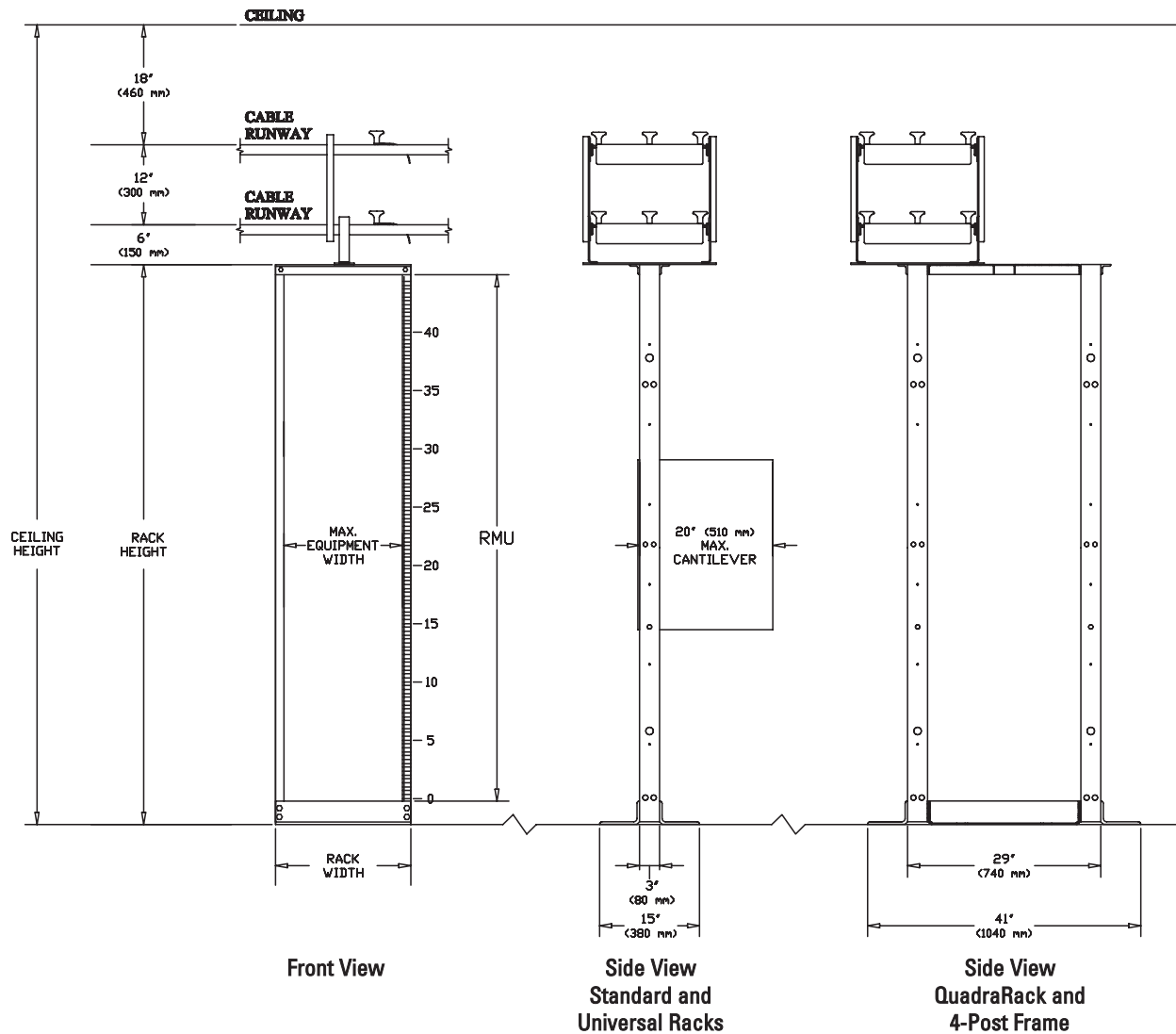
Cable Spool

Saf-T-Grip Cable Management Straps

How to Select a CPI Rack System

CPI offers four styles of rack system including three models of two-post rack and six models of four-post rack available in 19"EIA rack-mount widths and various heights. Two-post racks can be used in most applications, but generally are used with rack-mount equipment that is less than 20"D (510 mm). Four-post racks are a good solution for larger and heavier equipment, like switches, because they surround equipment and provide front and rear support. The table below lists CPI Rack Systems.

CPI Product Image	CPI Product Name	Key Features
	Universal Rack	Heavy-duty two-post rack with a 3"D (80 mm) mounting channel. Available in 19" EIA and 23" rack-mount widths and heights from 3' to 9' (0.9 m to 2.7 m). Supports 1500 lb (680.4 kg) of equipment. UL Listed versions available.
	Standard Rack, 3"D (80 mm)	Standard two-post rack with a 3"D (80 mm) mounting channel. Available in 19" EIA rack-mount width and 7', 8' and 9'H (2.1 m, 2.4 m and 2.7 m). Supports 1000 lb (453.6 kg) of equipment. UL Listed.
	Standard Rack, 6"D (150 mm)	Standard two-post rack with a 6"D (150 mm) mounting channel. Available in 19"EIA and 23" rack-mount widths and 7'H (2.1 m). Supports 1000 lb (453.6 kg) of equipment. UL Listed.
	QuadraRack® 4-Post Frame	Fixed 29"D (740 mm) four-post rack with threaded mounting holes available in 19" EIA rack-mount width and 7', 8' and 9'H (2.1 m, 2.4 m and 2.7 m). Supports 2000 lb (907.2 kg) of equipment.
	QuadraRack® Server Frame (shown)	Fixed 29"D (740 mm) four-post rack with square-punched mounting holes available in 19" EIA rack-mount width and 7'H (2.1 m). Supports 1000 lb (453.6 kg) of equipment.
	Adjustable QuadraRack®	Adjustable depth four-post rack with four depth ranges from 15.8" to 42.3" (400 mm to 1075 mm). Depth adjusts during assembly and is fixed once the rack is assembled. QuadraRack has #12-24 threaded equipment mounting holes. ServerRack has square-punched equipment mounting holes that accept cage nuts. Available in 19"EIA rack-mount width and 6', 7', 8' and 9'H (1.8 m, 2.1 m, 2.4 m and 2.7 m). Supports 2000 lb (907.2 kg) of equipment.
	Adjustable ServerRack	
	Adjustable Rail QuadraRack®	Fixed 23.6"D (600 mm) and 35.4"D (900 mm) four-post racks adjustable depth rear equipment mounting rails that extend up to 5.9" (150 mm) beyond the rack to support deeper equipment. QuadraRack has #12-24 threaded equipment mounting holes. ServerRack has square-punched equipment mounting holes that accept cage nuts. Available in 19"EIA rack-mount width and 6', 7' and 8'H (1.8 m, 2.1 m and 2.4 m). Supports 2200 lb (1000 kg) of equipment.
	Adjustable Rail ServerRack	

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Cable Management Solutions for Rack Systems

The rack-mount width must match equipment requirements. The depth of the rack, especially a four-post rack, must be carefully selected. Generally, you should plan a minimum 3' (0.9 m) aisle at the front and rear of the rack. The height of the rack also determines the number of rack-mount unit (U) spaces on the rack.

Front View

**Side View
Standard and
Universal Racks**

**Side View
QuadraRack and
4-Post Frame**

Rack Width	Max. Equipment Width
19"	17.75" (450.9 mm)
23"	21.75" (552.5 mm)

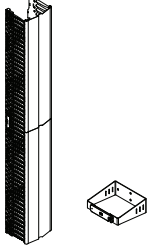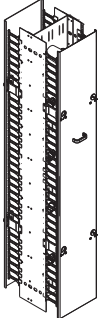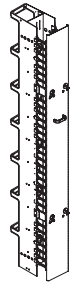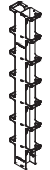| Rack Height	U
6' (1.8 m)	38
7' (2.1 m)	45
8' (2.4 m)	51
9' (2.7 m)	58
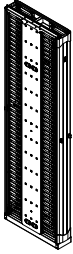
It is important to pick a height that provides enough overhead space for cable runway or cable trays. Note the relationship of rack height to ceiling height in the graphic above. Always leave 3" to 6" (80 mm to 150 mm) of space between the top of racks and cable runway. Leave 12" (300 mm) between each tier of cable runway and 18" (460 mm) between the ceiling and the top tier of cable runway.

How to Select a Vertical Cabling Section

CPI offers five styles of cabling section (vertical managers) to complement the two-post and four-post open rack systems. Cabling sections attach to the sides of the racks to provide a cable management space along the side of rack-mount equipment.
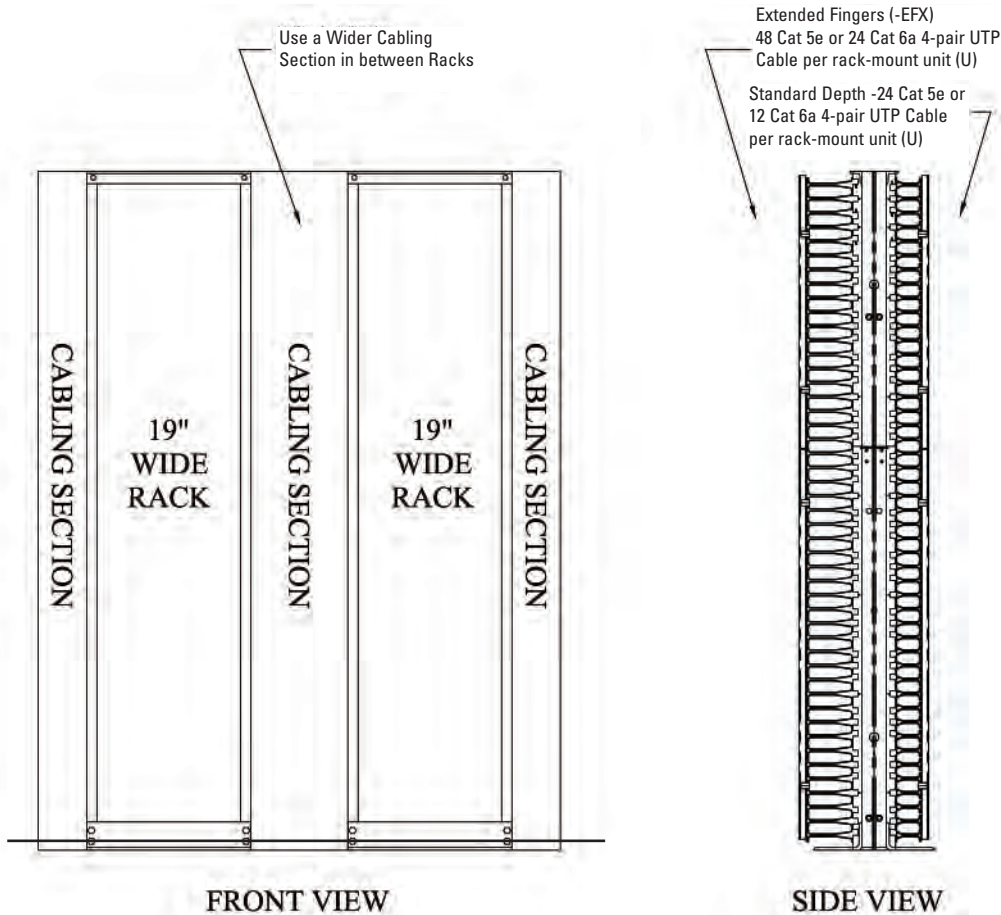
Cabling sections can be single or double-sided. Double-sided cabling sections are used alongside racks that support patch panels, fiber enclosures or a mix of active equipment and cable termination hardware to provide separate front and rear pathways for patch cords and premise cables.

CPI cabling sections are listed in the table below.

CPI Product Image	CPI Product Name	Key Features
	Evolution® Cable Management	CPI's largest cable managers designed to handle high density cabling in the data center and computer and equipment rooms. Features plastic T-shaped cable guides and side openings that align with each rack-mount unit (U) space on the rack providing by-U cable management and a hinged, single latch door that secures cables inside the manager. The mid-section on double-sided managers can be moved to provide a 50/50, 60/40 or 40/60 front/rear split of internal storage space. Single-sided (g1), double-sided (g2) and combination (g3) versions – 6", 8", 10", 12" or 15"W (150 mm, 200 mm, 250 mm, 300 mm or 380 mm).
	Velocity™ Cable Management	Economical cable management solution for everyday use in equipment rooms. Snap-together design ships unassembled in a compact carton. Features plastic T-shaped cable guides and side openings that align with each rack-mount unit (U) space in the rack providing by-U cable management and a snap-on cover to protect cables. Single or double-sided versions – 3.6", 6", 10" or 12"W (91 mm, 152 mm, 254 mm or 305 mm).
	Velocity™, Cable Ring Kit	Set of accessory cable rings that can be attached to the rear of single-sided Velocity Cable Managers to create a combination CCS-style solution.
	MCS Master Cabling Section	Features patented T-shaped cable guides and side openings that align with each rack-mount unit (U) space on the rack providing by-U cable management and a hinged door/cover to protect cables. Feed 24 Cat 5e or 12 Cat 6a 4-pair UTP cables per rack-mount unit. Single or double-sided versions - 4.4", 6" or 10"W (112 mm, 150 mm or 250 mm).
	MCS-EFX Master Cabling Section with Extended Fingers	Deeper versions of MCS providing by-U cable management. Features patented T-shaped cable guides and side openings that align with each rack-mount unit (U) space on the rack and a hinged door/cover to protect cables. Feed 48 Cat 5e or 24 Cat 6a 4-pair UTP cables per rack-mount unit. Single or double-sided versions - 6", 10" or 12"W (150 mm, 250 mm or 300 mm).
	CCS Combination Cabling Section	Combination MCS front and VCS back allows by-U cable management of patch cords with larger bundles of premise cable. Select to match 3"D (80 mm) CCS or 6"D (150 mm) CCS-6DR rack channel. Feed 24 Cat 5e or 12 Cat 6a 4-pair UTP cables per rack-mount. Double-Sided only versions - 3.65", 6" or 10"W (92.7 mm, 150 mm or 250 mm).
	CCS Combination Cabling Section with Extended Fingers	Deeper version of CCS and is a combination MCS front and VCS back which allows by-U cable management of patch cords with larger bundles of premise cable. Feed 48 Cat 5e or 24 Cat 6a 4-pair UTP cables per rack-mount unit. Double-sided only versions - 6", 10" or 12"W (92.7 mm, 250 mm or 300 mm).
	VCS Vertical Cabling section	CPI's original vertical cable manager. Open trough with spin-latch closures. Allows large cable bundles to enter or exit the manager. Good for general use. Single or double-sided versions - 3.65" or 6"W (92.7 mm or 150 mm).

How to Determine Cable Fill

Cabling section width and the corresponding cable fill capacity must be carefully considered, especially when a cabling section is shared in between adjacent racks (as shown below). CPI recommends using a 50% cable fill when selecting vertical and horizontal cable management. This allows sufficient space for maintaining cable bend radius for patch cords. Extended Fingers (- EFX) versions are recommended whenever angled-face patch panels are used. Use the table below to compare cable fill values and select the correct size cabling section.
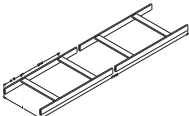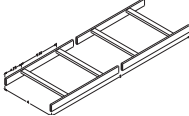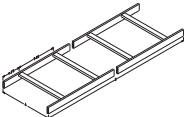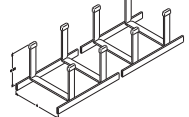
Use a Wider Cabling Section in between Racks

Extended Fingers (-EFX)
48 Cat 5e or 24 Cat 6a 4-pair UTP Cable per rack-mount unit (U)

Standard Depth -24 Cat 5e or 12 Cat 6a 4-pair UTP Cable per rack-mount unit (U)

CABLING SECTION — 19" WIDE RACK — CABLING SECTION — 19" WIDE RACK — CABLING SECTION

FRONT VIEW

SIDE VIEW
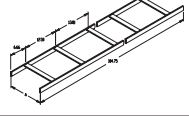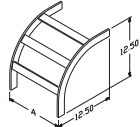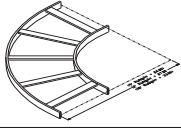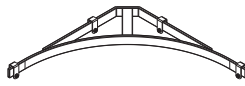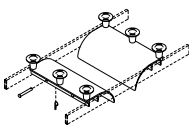
CPI Cabling Section Cable Fill Comparison Table															
Style	Cat 5e - .20" (5 mm) OD - 50% Fill					Cat 6 - .25" (6 mm) OD - 50% Fill					Cat 6a - .30" (8 mm) OD - 50% Fill				
	6" (150 mm)	8" (200 mm)	10" (250 mm)	12" (300 mm)	15" (380 mm)	6" (150 mm)	8" (200 mm)	10" (250 mm)	12" (300 mm)	15" (380 mm)	6" (150 mm)	8" (200 mm)	10" (250 mm)	12" (300 mm)	15" (380 mm)
Evolution g1	399	569	739	910	1166	252	360	467	576	737	176	252	327	403	516
Evolution g2	371	534	696	859	1103	235	338	440	543	697	164	236	308	380	488
Evolution g3*	261	356	451	546	689	165	225	285	345	436	115	157	200	242	305
Velocity SS	298	-	545	670	-	188	-	345	423	-	132	-	241	296	-
Velocity DS*	219	-	400	491	-	138	-	253	310	-	97	-	177	217	-
Velocity Rings	317	-	537	646	-	201	-	339	409	-	140	-	237	286	-
MCS	283	-	502	-	-	179	-	317	-	-	125	-	222	-	-
MCS-EFX	371	-	672	822	-	235	-	425	520	-	164	-	297	364	-
CCS*	234	-	402	-	-	148	-	254	-	-	103	-	178	-	-
CCS-6DR*	270	-	464	-	-	171	-	293	-	-	120	-	205	-	-
CCS-EFX*	234	-	402	486	-	148	-	254	307	-	103	-	178	215	-
VCS	270	-	-	-	-	171	-	-	-	-	120	-	-	-	-

*Note: All cable fills are loose fill estimates based on .20" (5 mm) outside diameter (OD) Cat 5e, .25" (6 mm) OD Cat 6 and .30" (8 mm) OD Cat 6a 4-pair UTP Cable. Different cable types, sizes and fill ratios will result in different fill values. Refer to the CPI Cable Fill Table (www.chatsworth.com/cablefill) for more details. *Evolution g3, Velocity DS, CCS, CCS-6DR and CCS-EFX Cable Fills are for rear side only, front side is larger. Narrower widths are available.*

How to Select Pathway Components

Use cable runway to support backbone and premise cable between the wall and the rack. It is best to bring cable runway over the rack(s) so that the weight of the cable is supported by the runway and does not pull against the connections on the patch panels. CPI Cable Runway Products are listed in the table below.

CPI Product Image	CPI Product Name	Key Features
	Universal Cable Runway	Ladder-style cable runway in 9'-11 1/2"L (3.0 m). Manufactured from 1 1/2"H x 3/8"W (38 mm x 9.53 mm) tubular steel, .065" thick (1.65 mm). Cross-members are welded on 12" (300 mm) centers. Available 4", 6", 9", 12", 15", 18", 24", 30" or 36"W (100 mm, 150 mm, 230 mm, 300 mm, 380 mm, 460 mm, 610 mm, 760 mm or 910 mm).
	TELCO - Style Cable Runway	Ladder-style cable runway in 9'-8 1/2"L (2.9 m). Stringers are 1 1/2"H x 3/8"W (38 mm x 9.53 mm) tubular steel, .065" thick (1.65 mm). Cross-members are 1/2"H x 1"W (10 mm x 30 mm) tubular steel, .065" thick (1.65 mm). Cross-members are welded on 9" (230 mm) centers. Available 6", 9", 10", 12", 15", 18" or 20"W (150 mm, 230 mm, 250 mm, 300 mm, 380 mm, 460 mm or 510 mm).
	UL Classified Cable Runway	Similar in construction to TELCO-Style Cable Runway with zinc finish. Suitable as an equipment-grounding conductor. Available 6", 9", 12", 15", 18", 20" or 24"W (150 mm, 230 mm, 300 mm, 380 mm, 460 mm, 510 mm or 610 mm).
	Trough Cable Runway	Ladder-style cable runway in 9'-11 1/2" or 9'-8 1/2"L (3.0 m or 2.9 m). Manufactured from 1 1/2"H x 3/8"W (38 mm x 9.53 mm) tubular steel, .065" thick (1.65 mm). Cross-members are welded on 9" or 12" (230 mm or 300 mm)centers and are 8"H (200 mm). Available 9", 10", 12", 15" or 18"W (230 mm, 250 mm, 300 mm, 380 mm or 460 mm).
	Alternate Space Cable Runway	Ladder-style cable runway in 8'-8 3/4"L (2.6 m). Manufactured from 1 1/2"H x 3/8"W (38 mm x 9.53 mm) tubular steel, .065 thick (1.65 mm). Cross-members are welded on alternating 12 1/2" and 13 13/16" (318 mm and 350 mm) centers. Designed specifically for use over 19" racks bayed with 6"W (150 mm) cabling sections. Available 6", 12", 18" or 24"W (150 mm, 300 mm, 460 mm or 610 mm).
	Cable Runway Radius Bend	Fabricated 90° transition for smooth vertical-to-horizontal or horizontal-to-vertical cable pathway direction changes. Available 6", 9", 12", 15", 18", 20" or 24"W (150 mm, 230 mm, 300 mm, 380 mm, 460 mm, 510 mm or 610 mm).
	Cable Runway E-Bend	Fabricated 90° transition for smooth right or left horizontal turns in cable pathway direction. Available 9", 12" or 18"W (230 mm, 300 mm or 460 mm).
	Cable Runway Corner Bracket	Fabricated radius for use at L, T or X junctions formed by intersections of straight cable runway. Allows cable to turn corners around a smooth 90° bend. Available 15" or 24"W (380 mm or 610 mm).
	Cable Runway Radius Drop	Fabricated radius attaches to side stringers or cross members of cable runway to provide a smooth 90° horizontal-to-vertical transition for cables exiting the cable pathway.

Support CPI Cable Runway from the top of racks, walls, ceilings or floors. Use Radius Drops when cable enters or exits the pathway and use bends and corner brackets when the pathway changes directions or forms a 90° intersection, "T" intersection or crossing intersection.

The ANSI/EIA/TIA-569B standard limits cable runway cable fill to 50% and cable cannot be stacked more than 6"H (150 mm) on the cable runway. Cable runway typically supports multiple cabling sections as shown in the graphic at the bottom of the page. The cable fill value for cable runway should equal the combined cable fill values of the cabling sections. Use the table below to select a width to match cable fill requirements. Use multiple tiers of cable runway if required.
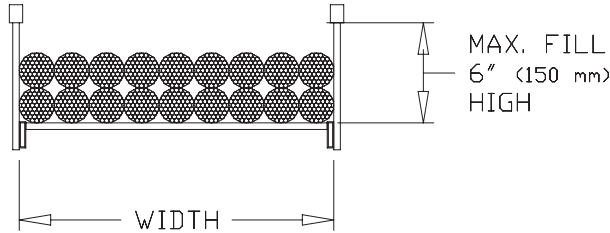
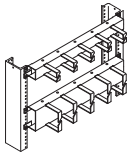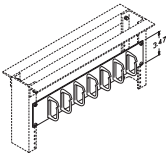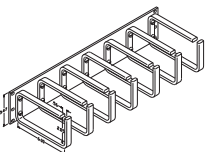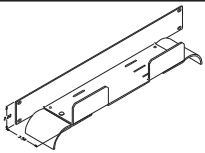| CPI Cable Runway Cable Fills			
Width	**Max. Fill**		
	Cat 5e*	Cat 6*	Cat 6a*
4" (100 mm)	387	244	169
6" (150 mm)	580	367	253
9" (230 mm)	870	551	380
10" (250 mm)	967	612	422
12" (300 mm)	1161	734	507
15" (380 mm)	1451	918	633
18" (460 mm)	1741	1102	760
20" (510 mm)	1935	1224	845
24" (610 mm)	2322	1469	1014
30" (760 mm)	2903	1836	1267
36" (910 mm)	3483	2204	1521
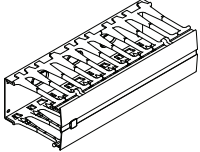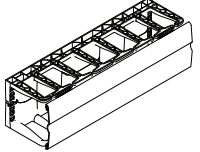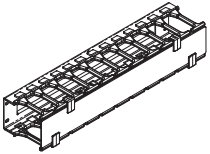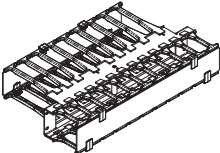
Note: All Cable Fills are loose fill estimates based on .20" (5 mm) outside diameter (OD) Cat 5e, .25" (6 mm) OD Cat 6 and .30" (8 mm) OD Cat 6a 4-pair UTP Cable. Listed values are maximum fills based on 6"D (150 mm) Cable Runway at 50% fill. Different cable types, sizes and fill ratios will result in different fill values. Refer to the CPI Cable Fill Table (www.chatsworth.com/cablefill) for more details.

Elevate cable runway 3" to 6" (80 mm to 150 mm) above the rack and support runway every 5' (1.5 m) of span and within 2' (0.6 m) of every intersection or splice. CPI Cable Runway will support a maximum of 132 lb/ft (196 kg/m) when supported every 5' (1.5 m) of span.
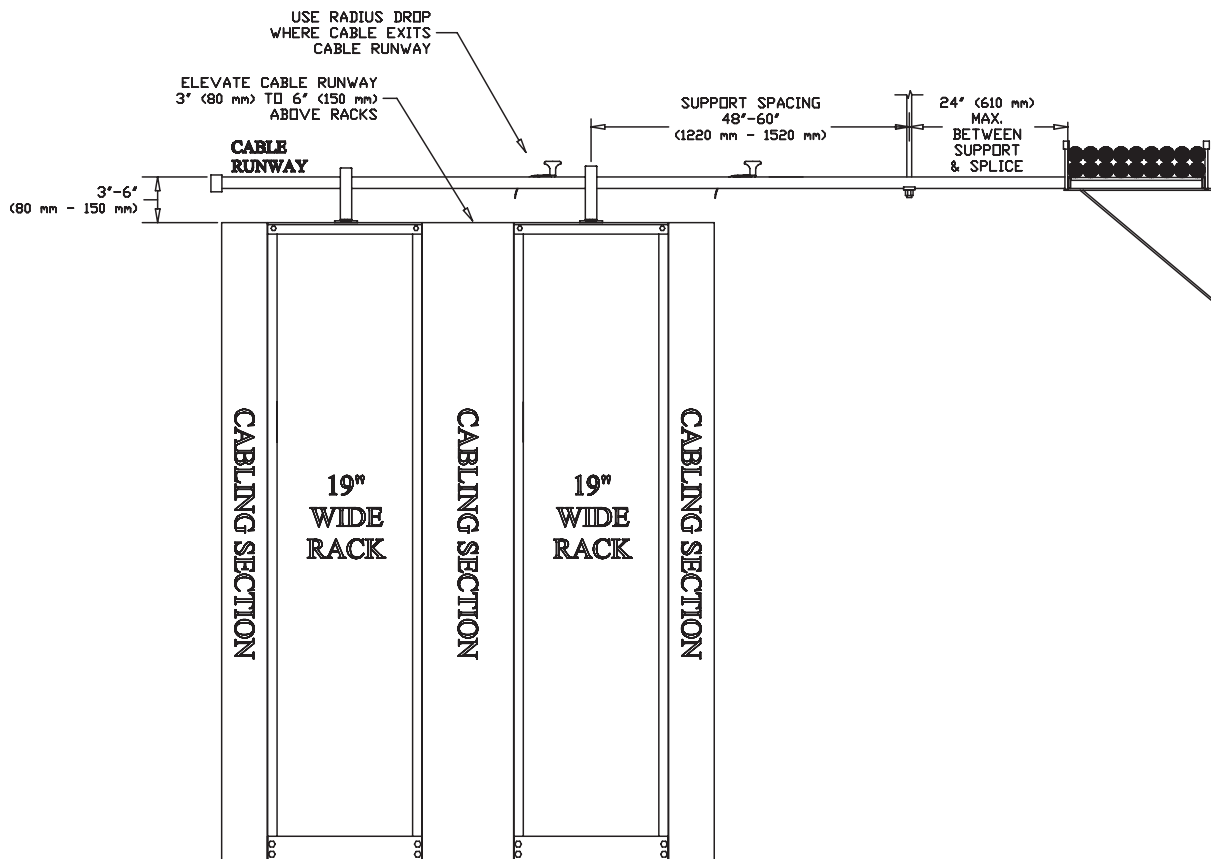
How to Select Horizontal Cable Management

If you are using flat-faced patch panels or network switches that cable from above or below, horizontal cable management will complete the support pathway for patch cords between the cabling section and the exact connection point (port) on the patch panel or switch. Alternately, horizontal management can be used to create rack-to-rack pathways for patch cords.

CPI Product Image	CPI Product Name	Key Features
	Evolution® Cable Management	Use with Evolution® Cable Management g1 Single-Sided, g2 Double-Sided and g3 Combination Vertical Cable Managers. Features a snap on cover and top and bottom cable openings for patch cords. Patch cords can pass front-to-rear through three rear openings. Single-sided versions available in 1U, 2U and 3U high.
	Velocity™ Cable Management	Use with Velocity™ Cable Management single-sided and double-sided vertical cable managers. Features a snap on cover and top and bottom cable openings for patch cords. Cable can pass front-to-rear through two rear openings. Single-sided versions available in 1U, 2U and 3U high.
	UHCM Universal Horizontal Cable Manager	UHCM is designed for use with CCS and MCS vertical cabling sections. It has a snap-on cover and features top and bottom cable openings for patch cords. Patch cords can pass from front-to-rear through a rear opening. Single and double-sided versions available in 1U, 2U and 3U high.
	UHCM - Deep Universal Horizontal Cable Manager with Deep Channel	UHCM - Deep is designed for use with double-sided MCS vertical cabling sections when the cabling sections are center-mounted on 3"D (80 mm) racks. It has a snap-on cover and features top and bottom cable openings for patch cords. Patch cords can pass through a rear opening. Single-sided only versions in 1U, 2U and 3U high.
	19" HWMP 19" Horiztonal Wire Mangemement Panel	Designed for use with VCS vertical cabling sections. Open ring-style managers with 1.5" (38 mm) standoff from from the rack. Includes cable spools to control cables as they exit the vertical manager. Cover available as an accessory. Single-sided versions only in 1U and 2U high.
	RCM Rack Cabling Managers	Small ring-style managers attach to a flush rack-mount panel. Only 1.5"D (38 mm). Excellent for use within cabinets and enclosures. Single-sided version only in 1U and 2U high.
	LHRP Large Horizontal Ring Panel	Large 6"D (150 mm) manager that attaches to a flush rack-mount panel. Use above or below large network switches that have vertical modules. Single-sided only version, 2U high.
	JT-3D JT-6D Jumper Trays	Use open trays to create rack-to-rack pathways for patch cords. Also used below switches or fiber patch panels to catch patch or jumper cords. Two depths - 3" or 6" (80 mm or 150 mm). Single-sided only versions, 2U high.

Select a style of horizontal cable management that complements the cabling section (vertical manager). Generally, it is good practice to plan 1U of horizontal cable management for every 2U of connectivity. Cable fill should equal at minimum, half of the ports supported by the cable manager. This method assumes that patch cords enter from both sides of the rack. Capacity should equal port density when cables enter from one side of the rack only. See the cable fill comparison table on the next page.

The following example shows a high-density design with 2U horizontal managers used in between 2U patch panels. Each horizontal manager supports the (48 port) patch panel located above and below it. Note that patch cords will enter from both sides of the rack. Cable Fill for the horizontal manager. must equal or exceed 48 cables - half the ports supported by the horizontal manager. Jumper trays provide a rack-to-rack pathway for patch cords.
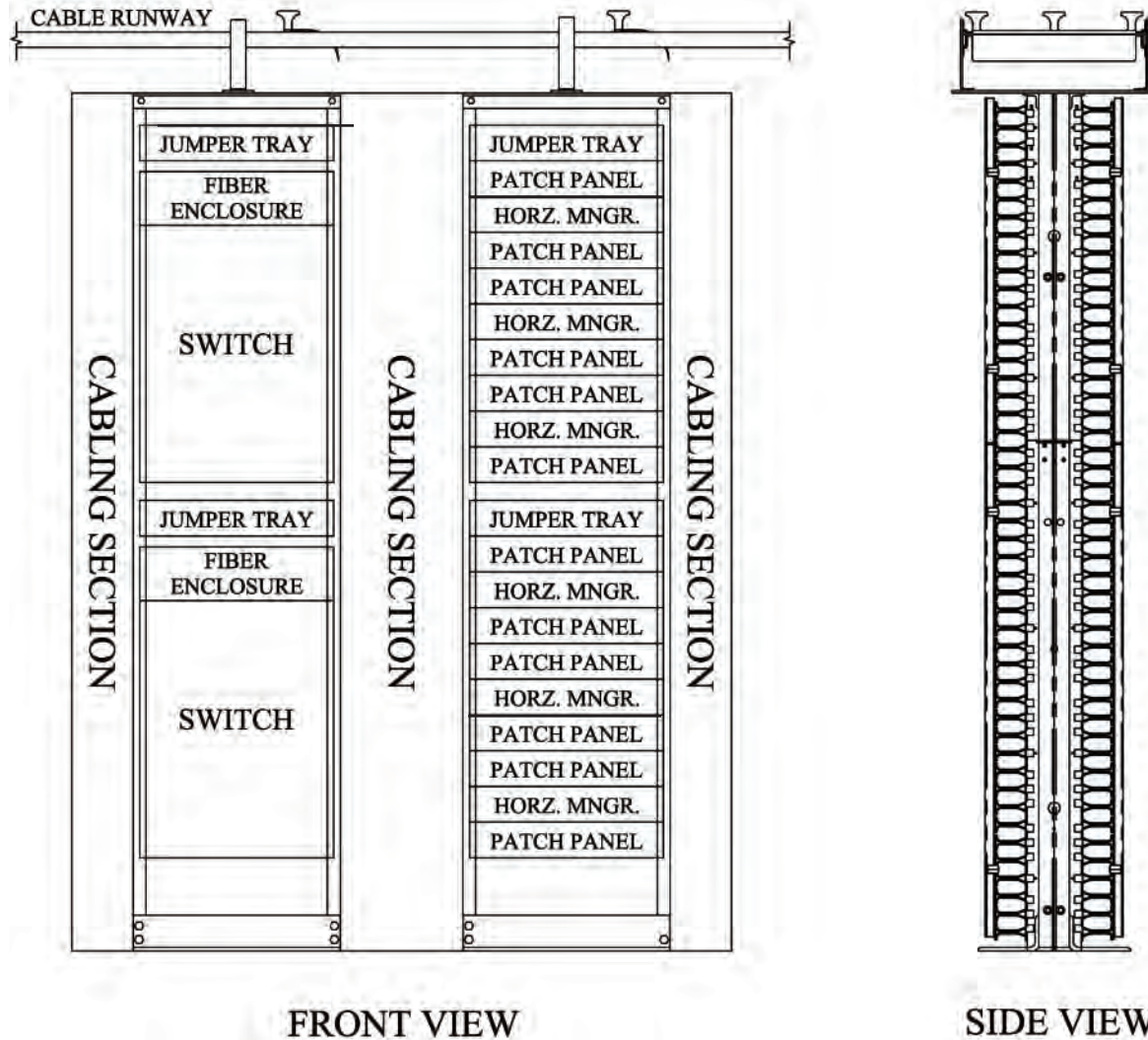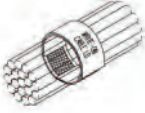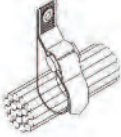

FRONT VIEW   SIDE VIEW

CPI Horizontal Cable Manager Cable Fill Comparison Table								
Style	Cat 5e* - 50% fill			Cat 6* - 50% fill			Cat 6a* - 50% fill		
	1U	2U	3U	1U	2U	3U	1U	2U	3U
Evolution®	44	137	225	28	86	142	19	60	100
Velocity™	23	78	133	14	49	84	10	34	58
UHCM	31	84	141	19	53	89	13	37	62
UHCM-Deep	41	112	188	26	71	119	18	50	83
19" HWMP	26	61	-	16	38	-	11	27	-
RCM	8	24	-	5	15	-	3	10	-
LHRP	-	135	-	-	85	-	-	60	-
JT-3D	-	50	-	-	31	-	-	22	-
JT-6D	-	135	-	-	85	-	-	60	-

Note: All cable fills are loose fill estimates based on .20" (5 mm) outside diameter (OD) Cat 5e, .25" (6 mm) OD Cat 6 and .30" (8 mm) OD Cat 6a 4-pair UTP Cable. Different cable types, sizes and fill ratios will result in different fill values. Refer to the CPI Cable Fill Table (www.chatsworth.com/cablefill) for more details.

CHATSWORTH PRODUCTS, INC.

Cable Management Solutions for Rack Systems

Bundling Cables

Bundle cables with a wide reusable strap. CPI Saf-T-Grip® Reusable Cable Management Straps are 3/4"W (19 mm) and have a hook and loop closure. This allows loose bundling of cables to prevent deformation of the cable jackets. It is also easy to add or remove cables from the bundle.

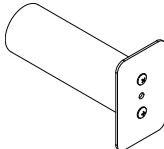| CPI Product Image	CPI Product Name	Key Features
	Open Loop Series, Saf-T-Grip® Reusable Cable Management Straps	Basic strap wraps around the cable and secures the bundle. Available in 6", 9" or 12"L (150 m, 230 mm or 300 mm) for 2", 3" or 4" (50 mm, 80 mm or 100 mm) diameter cable bundles.
	End Grommet Buckle Series, Saf-T-Grip® Reusable Cable Management Straps	Cinching strap wraps through end buckle and secures the bundle. Grommet on end tab allows strap/bundle to be secured to rack or wall. Available in 6", 9" or 12"L (150 m, 230 mm or 300 mm) for 2", 3" or 4" (50 mm, 80 mm or 100 mm) diameter cable bundles.
	Center Grommet Buckle Series, Saf-T-Grip® Reusable Cable Management Straps	Cinching strap wraps through end buckle and secures the bundle. Grommet in between buckle and end of strap allows bundle to be secured to rack or wall. Available in 6", 9" or 12"L (150 m, 230 mm or 300 mm) for 2", 3" or 4" (50 mm, 80 mm or 100 mm) diameter cable bundles.

The cable fill table below lists maximum fills for each size of Saf-T-Grip® Cable Management Strap.

CPI Saf-T-Grip® Cable Fills				
Strap Length	Bundle Diameter	Max. Fill		
		Cat 5e*	Cat 6*	Cat 6a*
6" (150 mm)	2" (50 mm)	50	31	22
9" (230 mm)	3" (80 mm)	112	71	50
12" (300 mm)	4" (100 mm)	201	127	89

Note: All cable fills are estimates based on .20" (5 mm) outside diameter (OD) Cat 5e, .25" (6 mm) OD Cat 6 and .30" (8 mm) OD Cat 6a 4-pair UTP Cable. Different cable types, sizes and fill ratios will result in different fill values. Refer to the CPI Cable Fill Table (www.chatsworth.com/cablefill) for more details.

Cable Spools

Cable spools help control patch cord slack within cabling sections. Patch cords are often purchased at standard lengths that may exceed the distance between ports. The slack should be controlled with bend radius requirements in mind. Use cable spools to make 180° turns. Drape patch cords over cable spools to take up slack.

CPI Product Image	CPI Product Name	Key Features
	Cable Distribution Spool for Double-Sided Cabling Section	Snap-in Cable Spools for use with double-sided VCS Vertical Cabling Section, CCS Combination Cabling Section, MCS Master Cabling Section and Evolution Cable Management.
	Cable Spool Kit	Cable Spool Kit for use in 6"W (152 mm) or wider Velocity™ Cable Management vertical cable managers.

Example Solutions — A Typical Horizontal Cross-Connect

The typical cable management solution supports a mix of fiber enclosures, patch panels and network switches. There may also be voice switches, media converters and other termination hardware.

The example below of a typical horizontal cross connect shows 576 user connections on 2U x 48 port patch panels which are on the rack on the right. 2U horizontal managers are used in between each set of patch panels. Two 20U 9-slot modular switches provide data and IP telephony connections through a fiber backbone on the rack on the left. Jumper trays are used at the top and middle of both racks to create a side-to-side pathway. This configuration supports 288 users with a separate data and voice connection to each workspace. Patch cords connect the patch panels and switches. The middle cabling section should be sized for 576 cables; the side cabling section must be sized for 288 cables.



FRONT VIEW   SIDE VIEW
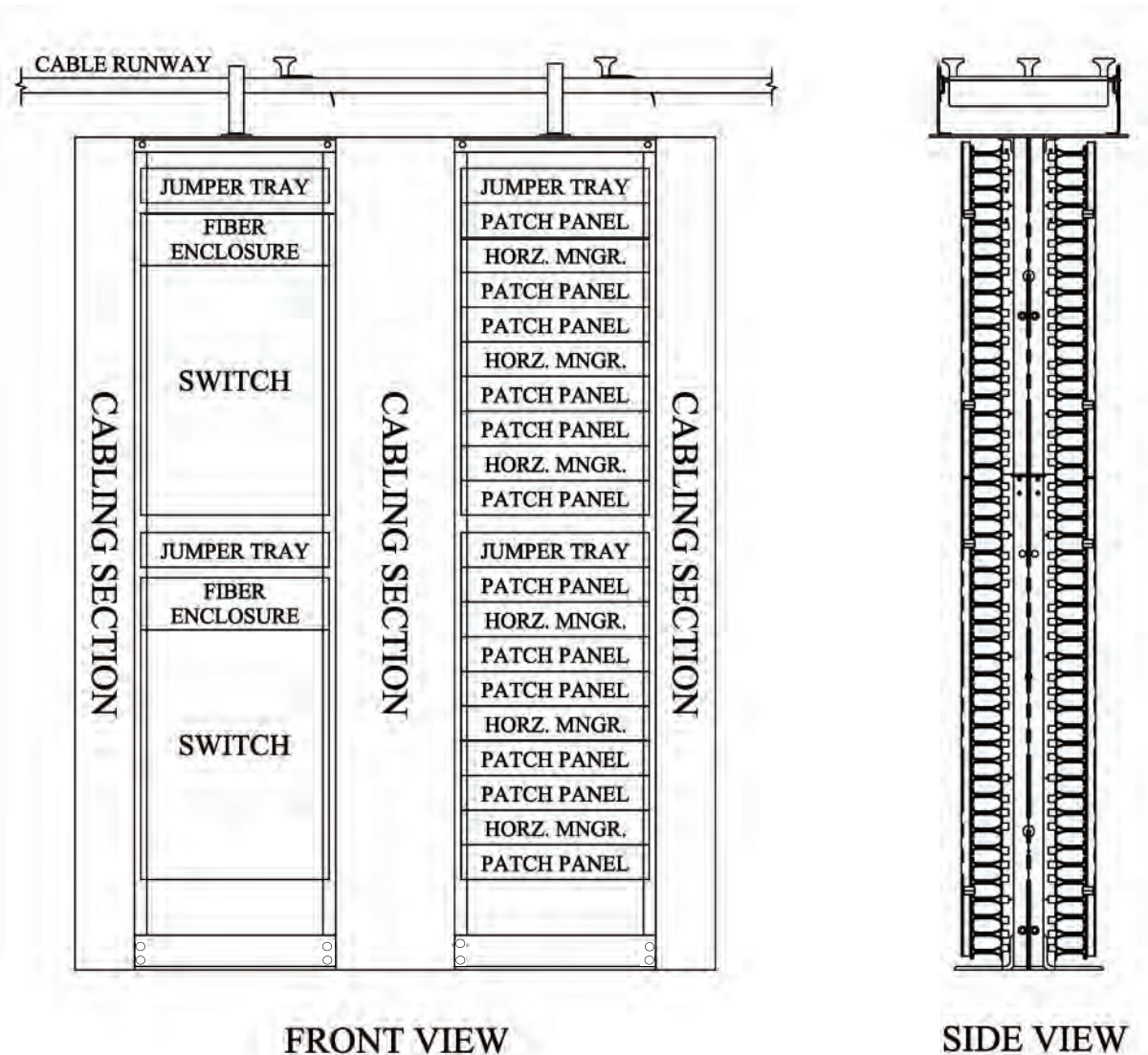
Note that a third rack with patch panels may be added at left or far right to support an additional 576 connections. This would allow two spare connections to each workspace. Also, there is one open module on each switch that could be used to provide an additional 48 connections to users or fiber in the horizontal.

Alternately, angled-face patch panels can be used without horizontal managers (as shown below). This requires deeper vertical managers along both sides of the rack.

CPI MCS-EFX, CCS-EFX, Velocity Cable Management or Evolution Cable Management have extended-fingers — openings that align with each rack-mount space. -EFX versions are 2 1/2" (64 mm) deeper than standard depth models (MCS or CCS) and are the best choice for angled-face patch panels.

FRONT VIEW

SIDE VIEW
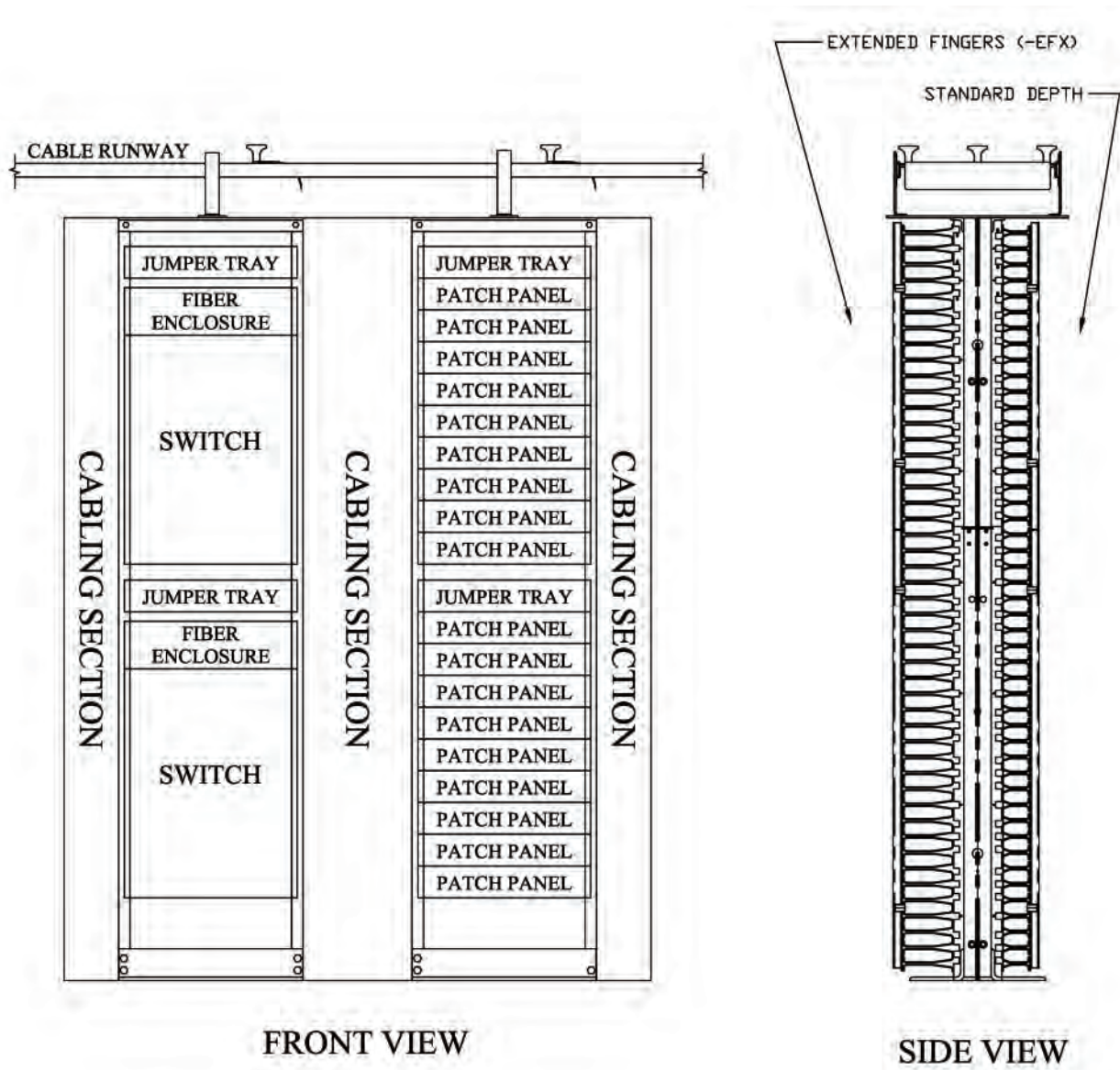
Note that this configuration provides an additional 288 connections (864 total) providing three connections per workspace for 288 users. The 568B Standard recommends a minimum of three connections per workspace. The middle cabling section should be sized for 864 cables; the side cabling section must be sized for 432 cables.

Another common arrangement for equipment is to have switches and patch panels mixed on the same rack (as shown below). This configuration is usually done with angled-face patch panels using deeper vertical managers (extended fingers) and omitting the horizontal managers for higher port densities per rack.

FRONT VIEW

SIDE VIEW
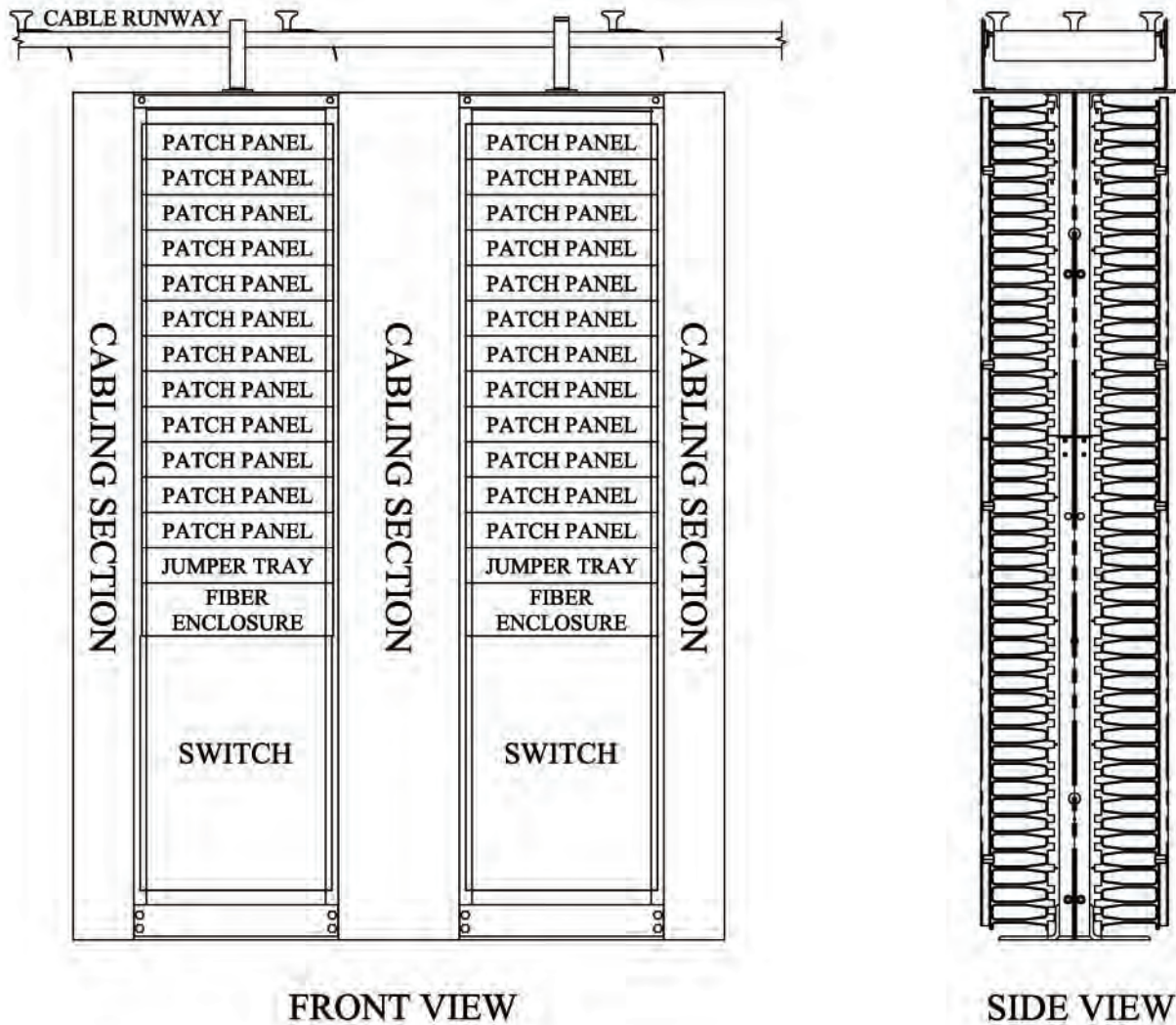
Note that this configuration provides 1152 connections (576 per rack) providing four connections per workspace for 288 users. The middle cabling section must be sized for 576 cables; the side cabling sections must be sized for 288 cables.

Conclusion

CPI Cable Management Solutions support and protect cables to help maintain cable performance.

For the best cable performance, specify continuous support for cable including vertical and horizontal cable managers and overhead cable runway. Whenever cable changes direction, specify support that creates a wide turn for cable to follow. Bundle cables with wide reusable straps and use cable spools to control patch cord slack within cable managers.

Also, specify cable managers that are large enough to maintain cable bend radius when cables enter/exit the managers. Using 50% fill as selection criteria for vertical and horizontal managers is a simple way to do this.

CPI provides a comprehensive line of Cable Management Solutions and will help you determine the best solution for your network. Contact CPI Technical Support (800-834-4969) for configuration assistance. You can also download CPI drawing blocks for use in your drawings from the CPI Website (www.chatsworth.com/designtools).