Enclosure Selection

This example is provided to assist you in sizing an enclosure for your Bulletin 2094 drive system. The example system consists of these components:

- 6-axis Bulletin 2094 servo drive system
- Line Interface Module (LIM)
- ControlLogix® chassis and modules (controller)

Size the Bulletin 2094 servo drive and LIM module and use the results to predict the amount of heat dissipated into the enclosure. You also need heat dissipation data from other equipment inside the enclosure (such as the ControlLogix controller). Once the total amount of heat dissipation (in watts) is known, you can calculate the minimum enclosure size.

Table 11 - Bulletin 2094 System Heat Dissipation Example

Enclosure Component	Description		Loading (1)	Heat Dissipation (1) watts
2094-BC02-M02-M	Integrated axis module (IAM), 400/460V	15 kW (converter section)	20%	44
		15 A (inverter section)	40%	72
2094-BM02-M	Axis module (AM), 400/460V, 15 A		60%	93
2094-BM02-M	Axis module (AM), 400/460V, 15 A		60%	93
2094-BM01-M	Axis module (AM), 400/460V, 9 A		40%	73
2094-BM01-M	Axis module (AM), 400/460V, 9 A		40%	73
2094-BM01-M	Axis module (AM), 400/460V, 9 A		20%	57
2094-BL25S	Line interface module (LIM), 400/460V, 25 A; 24V DC 20 A		100%	43
2094-PRS6	Power rail, 460V, 6 axis		–	0
2090-XB33-32	Resistive brake module (RBM), 33 A, 32 Ω		–	30
Total Kinetix 6200 and Kinetix 6500 system wattage				578

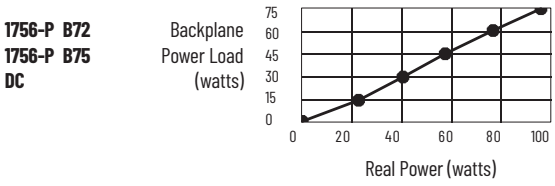
(1) To determine heat dissipation specifications for your drive system components, refer to Power Dissipation Specifications on page 34.

Table 12 - ControlLogix System Heat Dissipation Example

Enclosure Component	Description	Backplane Power Load (1) watts	Heat Dissipation (1) watts
1756-M08SE	8-axis Sercos interface module	3.2	0
1756-L5563	L63 ControlLogix processor	4.5	0
1756-IB16D	16 -point input module	0.84	5.8
1756-OB16D	16 -point output module	4.64	3.3
1756-ENxTx	EtherNet/IP communication module	4.0	0
Backplane total		17.18 (2)	–
1756-PB72	24V DC ControlLogix power supply	–	25 (2)
1756-A7	7-slot mounting chassis	–	–
Total ControlLogix system wattage			34.1

(1) For ControlLogix module specifications, refer to the ControlLogix Selection Guide, publication 1756-SG001.
(2) Real power heat dissipation is determined by applying the backplane power load (17.18W) to the graph below.

Figure 9 - ControlLogix Real Power



For backplane power loading requirements of other ControlLogix power supplies, refer to the ControlLogix Selection Guide, publication 1756-SG001.

In this example, the amount of power dissipated inside the cabinet is the sum of the Bulletin 2094 system value (578 W) and the ControlLogix system value (34 W) for a total of 612 W.

With no active method of heat dissipation (such as fans or air conditioning) either of these approximate equations can be used.

Metric	Standard English
$A = \frac{0.38Q}{1.8T - 1.1}$	$A = \frac{4.08Q}{T - 1.1}$
Where T is temperature difference between inside air and outside ambient (°C), Q is heat generated in enclosure (Watts), and A is enclosure surface area (m^2). The exterior surface of all six sides of an enclosure is calculated as:	Where T is temperature difference between inside air and outside ambient (°F), Q is heat generated in enclosure (Watts), and A is enclosure surface area (ft^2). The exterior surface of all six sides of an enclosure is calculated as:
A = 2dw + 2dh + 2wh	A = (2dw + 2dh + 2wh) / 144
Where d (depth), w (width), and h (height) are in meters.	Where d (depth), w (width), and h (height) are in inches.

Total system watts dissipated (Q) was calculated at 612 W. The maximum ambient rating of the Bulletin 2094 system is 50 °C (122 °F) and if the maximum environmental temperature is 30 °C (86 °F), then T=20 in the equation below.

$$A = \frac{0.38\,(612)}{1.8\,(20) - 1.1} = 6.66\ m^2$$

In this example, the enclosure must have an exterior surface of 6.66 m^2. If any portion of the enclosure is not able to transfer heat, do not include that portion in the calculation.

Because the minimum cabinet depth to house the 460V drive (selected for this example) is 302 mm (11.9 in.), then the cabinet needs to be approximately 2500 mm (high) x 950 mm (wide) x 302 mm (deep).

$2 \times (0.3 \times 0.95) + 2 \times (0.3 \times 2.5) + 2 \times (0.95 \times 2.5) = 6.82\ m^2$

Because this cabinet size is considerably larger than what is necessary to house the system components, consider some means of cooling in a smaller cabinet to be more efficient. Contact your cabinet manufacturer for options available to cool your cabinet.

Table 13 - Power Dissipation Specifications

Bulletin 2094 Drive Modules [1]	Usage as % of Rated Power Output (watts)				
	20%	**40%**	**60%**	**80%**	**100%**
IAM (converter) power module [2]					
2094-BC01-MP5-M	18	21	25	29	34
2094-BC01-M01-M					33
2094-BC02-M02-M	36	44	54	64	75
2094-BC04-M03-M	50	67	87	110	135
2094-BC07-M05-M	71	101	137	179	226
IAM (inverter) module or AM power module [2]					
2094-BC01-MP5-S or 2094-BMP5-M	46	54	61	69	77
2094-BC01-M01-S or 2094-BM01-M	57	73	90	108	126
2094-BC02-M02-S or 2094-BM02-M	53	72	93	116	142
2094-BC04-M03-S or 2094-BM03-M	94	130	169	211	255
2094-BC07-M05-S or 2094-BM05-M	121	183	252	326	407
Shunt module - 2094-BSP2	68	121	174	227	280
IPIM module - 2094-SEPM-B24-S	To calculate power dissipation for IPIM modules on your 2094 power rail, refer to the Kinetix 6000M Integrated Drive-Motor User Manual, publication 2094-UM003.				

(1) Power dissipation for the Bulletin 2094 control modules, catalog numbers 2094-SE02F-M00-S*x* and 2094-EN02D-M01-S*x*, is included in the IAM and AM power module specifications.
(2) Internal shunt power is not included in the calculations and must be added based on utilization.

Minimum Clearance Requirements

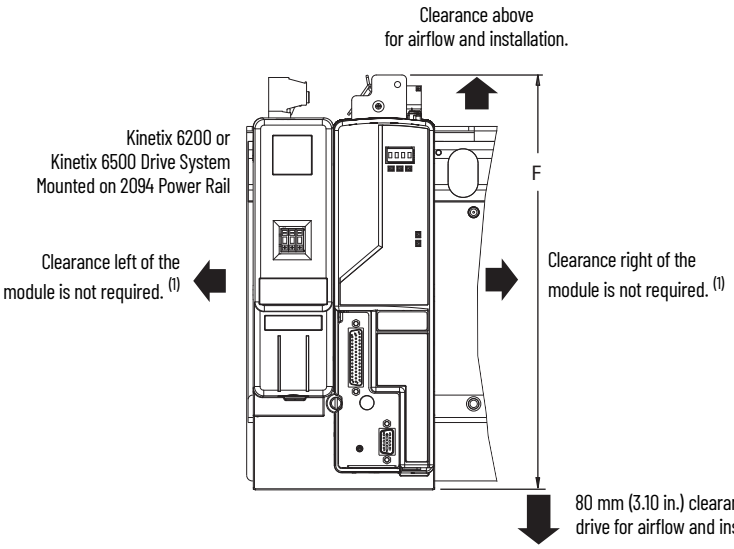
This section provides information to assist you in sizing your cabinet and positioning your Bulletin 2094 system components.

IMPORTANT Mount the module in an upright position. Do not mount the module on its side.

Figure 10 illustrates minimum clearance requirements for proper airflow and installation:

- Additional clearance is required for the cables and wires connected to the top and front of the drive.
- Additional clearance left and right of the power rail is required when the drive is mounted adjacent to noise sensitive equipment or clean wireways.

Figure 10 - Minimum Clearance Requirements



Drive Cat. No.	F
2094-BC01-Mxx-M 2094-BC02-M02-M	285 mm (11.2) in.
2094-BMP5-M, 2094-BM01-M, 2094-BM02-M	
2094-SEPM-B24-S 2094-BSP2	287 mm (11.3) in.
2094-BC04-M03-M 2094-BM03-M	375 mm (14.7) in.
2094-BC07-M05-M 2094-BM05-M	

Refer to Power Dissipation Specifications on page 34, and Kinetix Servo Drive Specifications Technical Data, publication KNX-TD003, for Kinetix 6000 drive dimensions.

(1) The power rail (slim), catalog number 2094-PRSx, extends left and right of the first and last module 5.0 mm (0.20 in.). The Bulletin 2094-PRx power rail extends approximately 25.4 mm (1.0 in.) left of the IAM module and right of the last module mounted on the rail.

Table 14 - Minimum Cabinet Depth

Drive Cat. No.	Cabinet Depth, min (1)
2094-BC01-Mxx-M, 2094-BC02-M02-M, 2094-BMP5-M, 2094-BM01-M, 2094-BM02-M	302 mm (11.9 in.)
2094-BSP2	272 mm (10.7 in.)
2094-BC04-M03-M, 2094-BC07-M05-M, 2094-BM03-M, 2094-BM05-M	302 mm (11.9 in.)
2094-SEPM-B24-S	263 mm (10.3 in.)

(1) Minimum cabinet depth is based on the use of 2090-K6CK-*xxxx* low-profile connector kits. Other means of making feedback connections can require additional clearance.

Electrical Noise Reduction

This section outlines best practices that minimize the possibility of noise-related failures as they apply specifically to Kinetix 6200 and Kinetix 6500 system installations. For more information on the concept of high-frequency (HF) bonding, the ground plane principle, and electrical noise reduction, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Bond Modules

Bonding is the practice of connecting metal chassis, assemblies, frames, shields, and enclosures to reduce the effects of electromagnetic interference (EMI).

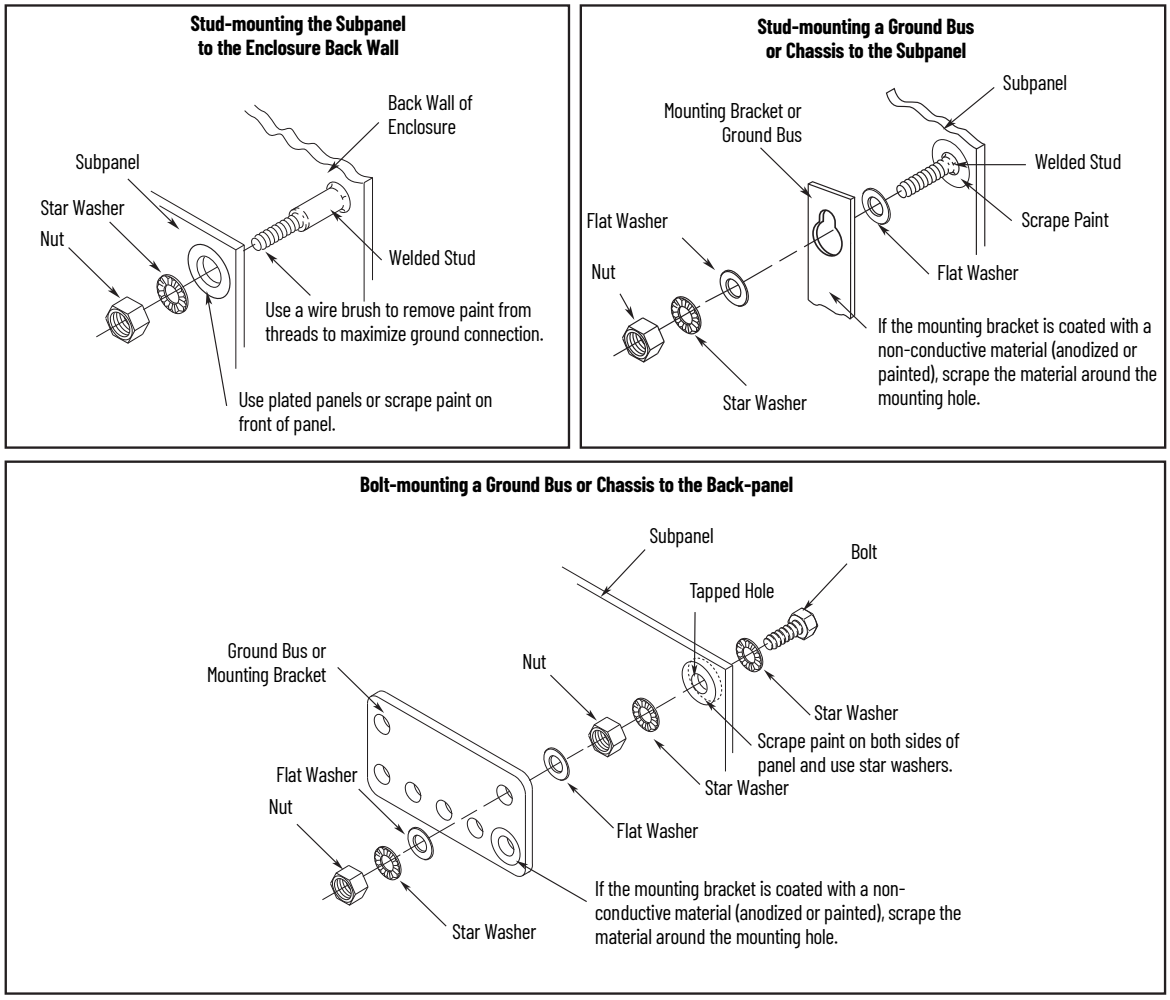
Unless specified, most paints are not conductive and act as insulators. To achieve a good bond between power rail and the subpanel, surfaces need to be paint-free or plated. Bonding metal surfaces creates a low-impedance return path for high-frequency energy.

IMPORTANT To improve the bond between the power rail and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

Improper bonding of metal surfaces blocks the direct return path and allows high-frequency energy to travel elsewhere in the cabinet. Excessive high-frequency energy can affect the operation of other microprocessor-controlled equipment.

These illustrations show details of recommended bonding practices for painted panels, enclosures, and mounting brackets.

Figure 11 - Recommended Bonding Practices for Painted Panels

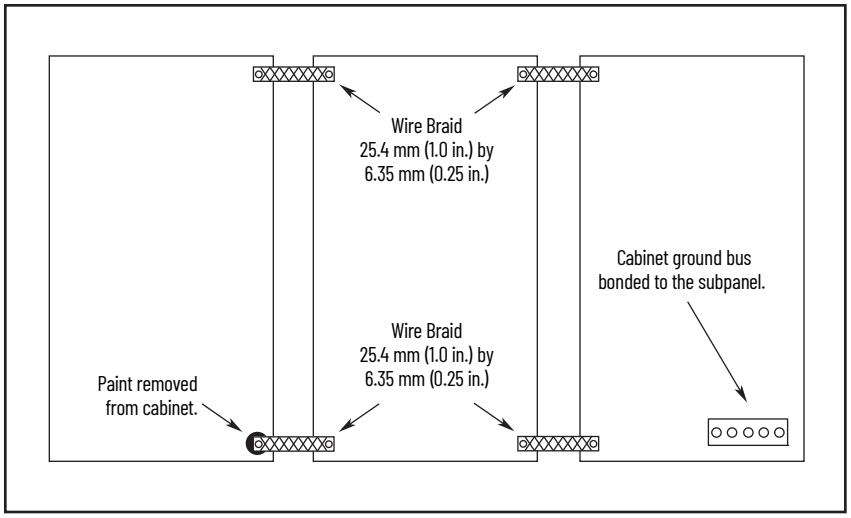


Bond Multiple Subpanels

Bonding multiple subpanels creates a common low impedance exit path for the high frequency energy inside the cabinet. If subpanels are not bonded together, and do not share a common low impedance path, the difference in impedance can affect networks and other devices that span multiple panels:

- Bond the top and bottom of each subpanel to the cabinet by using 25.4 mm (1.0 in.) by 6.35 mm (0.25 in.) wire braid. As a rule, the wider and shorter the braid is, the better the bond.
- Scrape the paint from around each fastener to maximize metal-to-metal contact.

Figure 12 - Multiple Subpanels and Cabinet Recommendations

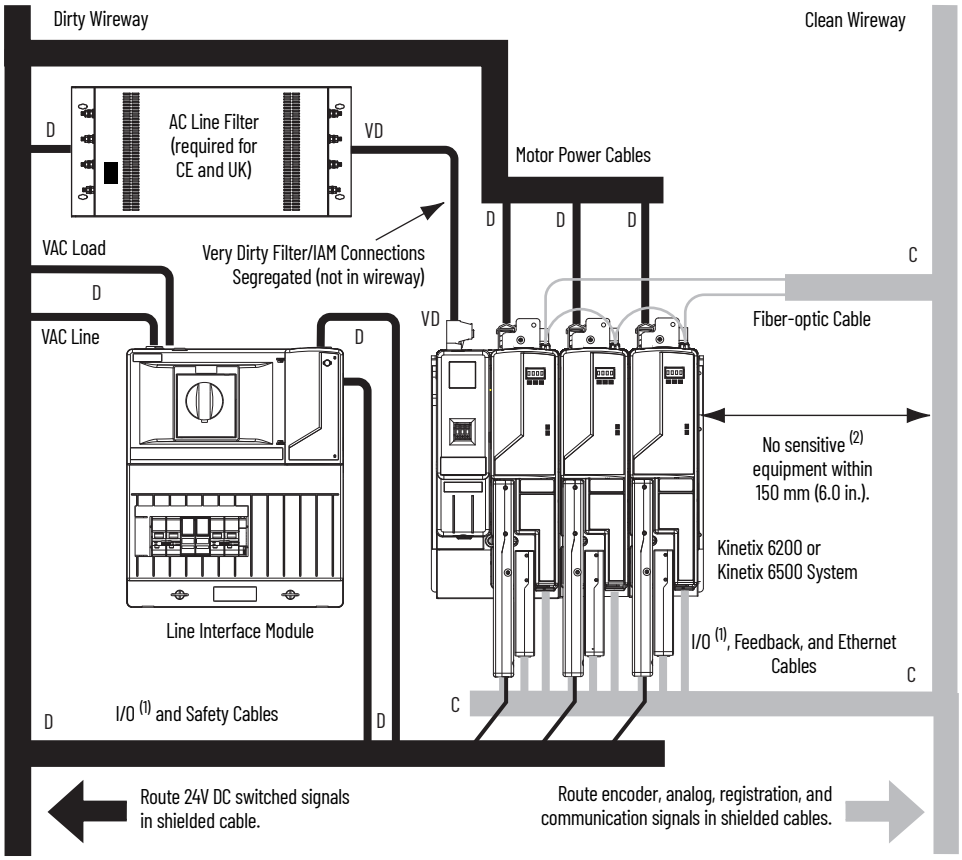


Establish Noise Zones

Observe these guidelines when the 2094-BL*xx*S or 2094-XL75S-C*x* LIM module is used in the Bulletin 2094 system and mounted left of the IAM module with the AC (EMC) line filter mounted above the LIM module:

- The clean zone (C) is to the right and beneath the Bulletin 2094 system (gray wireway).
- The dirty zone (D) is to the left and above the Bulletin 2094 system, and above and below the LIM module (black wireway).
- The very dirty zone (VD) is from the filter output to IAM module. Shielded cable is required on the EMC filter (load side) and the braided shield attached to the clamp provided.
- The Sercos fiber-optic cables are immune to electrical noise, but due to their delicate nature, route them in the clean zone. Ethernet cables are noise sensitive and belong in the clean zone.

Figure 13 - Noise Zones (LIM mounted left of IAM module)

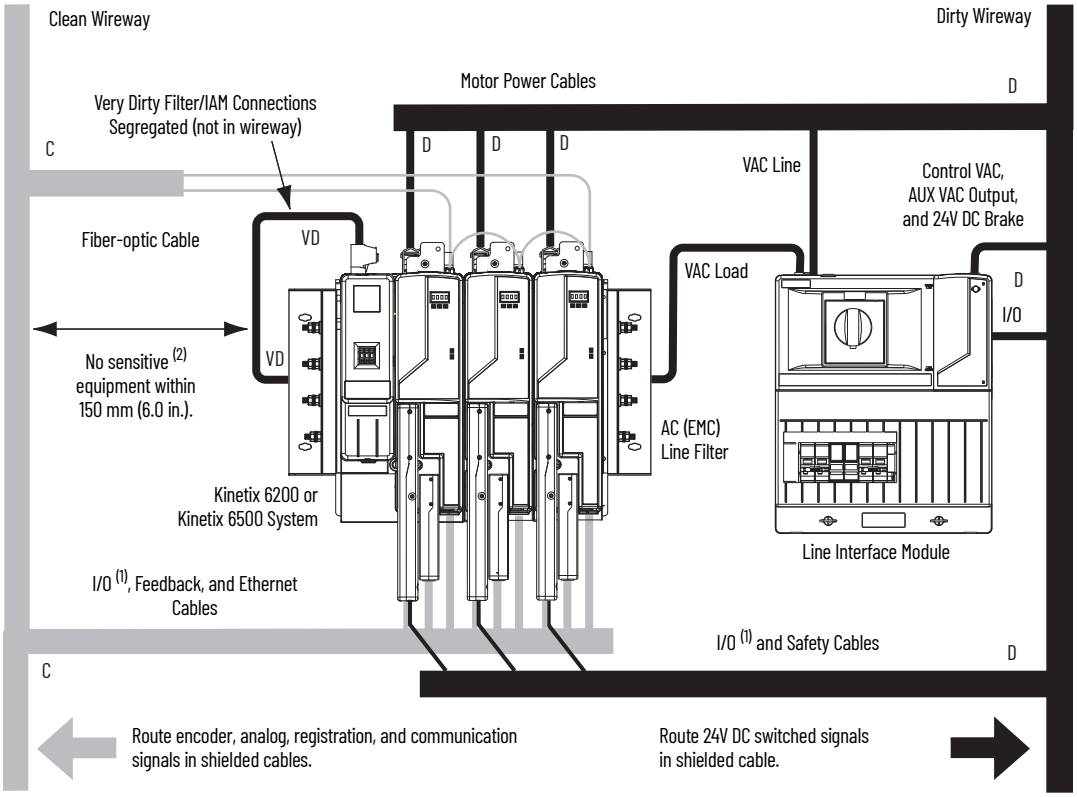


(1) If drive system I/O cable contains (dirty) relay wires, route cable with LIM module I/O cable in dirty wireway.
(2) When space does not permit the 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Observe these guidelines when the 2094-BL*xx*S or 2094-XL75S-C*x* LIM module is used in the Bulletin 2094 system and mounted right of the IAM module with the AC (EMC) line filter mounted behind the IAM module:

- The clean zone (C) is to the left and beneath the Bulletin 2094 system (gray wireway).
- The dirty zone (D) is to the right and above the Bulletin 2094 system, and above and below the LIM module (black wireway).
- The very dirty zone (VD) is from the filter output to IAM module. Shielded cable is required on the EMC filter (load side) and the braided shield attached to the clamp provided.
- The Sercos fiber-optic cables are immune to electrical noise, but due to their delicate nature, route them in the clean zone. Ethernet cables are noise sensitive and belong in the clean zone.

Figure 14 - Noise Zones (LIM with EMC filter behind IAM module)

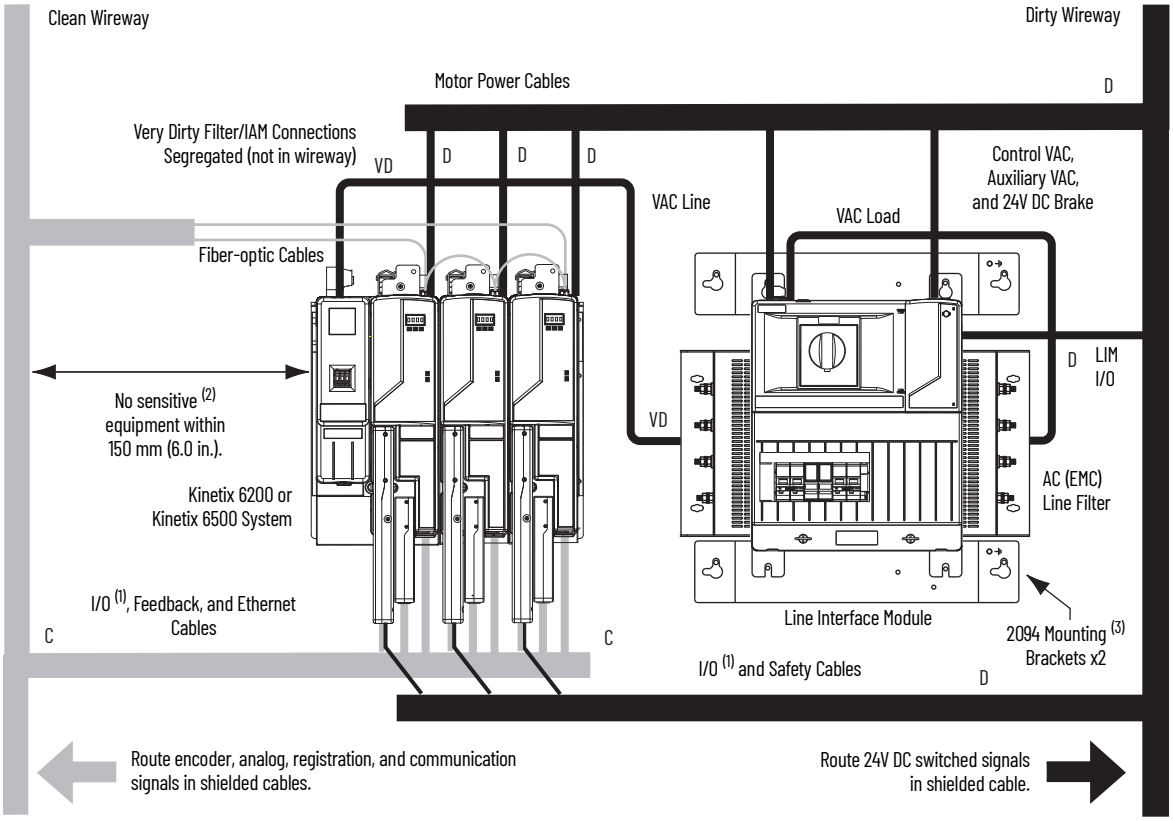


(1) If drive system I/O cable contains (dirty) relay wires, route cable with LIM module I/O cable in dirty wireway.
(2) When space does not permit the 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Observe these guidelines when the 2094-BL*xx*S or 2094-XL75S-C*x* LIM module is used in the Bulletin 2094 system and mounted right of the drive with the AC (EMC) line filter mounted behind the LIM module:

- The clean zone (C) is to the left and beneath the Bulletin 2094 system (gray wireway).
- The dirty zone (D) is to the right and above the Bulletin 2094 system, and above and below the LIM module (black wireway).
- The very dirty zone (VD) is from the filter output to drive. Shielded cable is required on the EMC filter (load side) and the braided shield attached to the clamp (when provided).
- The Sercos fiber-optic cables are immune to electrical noise, but due to their delicate nature, route them in the clean zone. Ethernet cables are noise sensitive and belong in the clean zone.

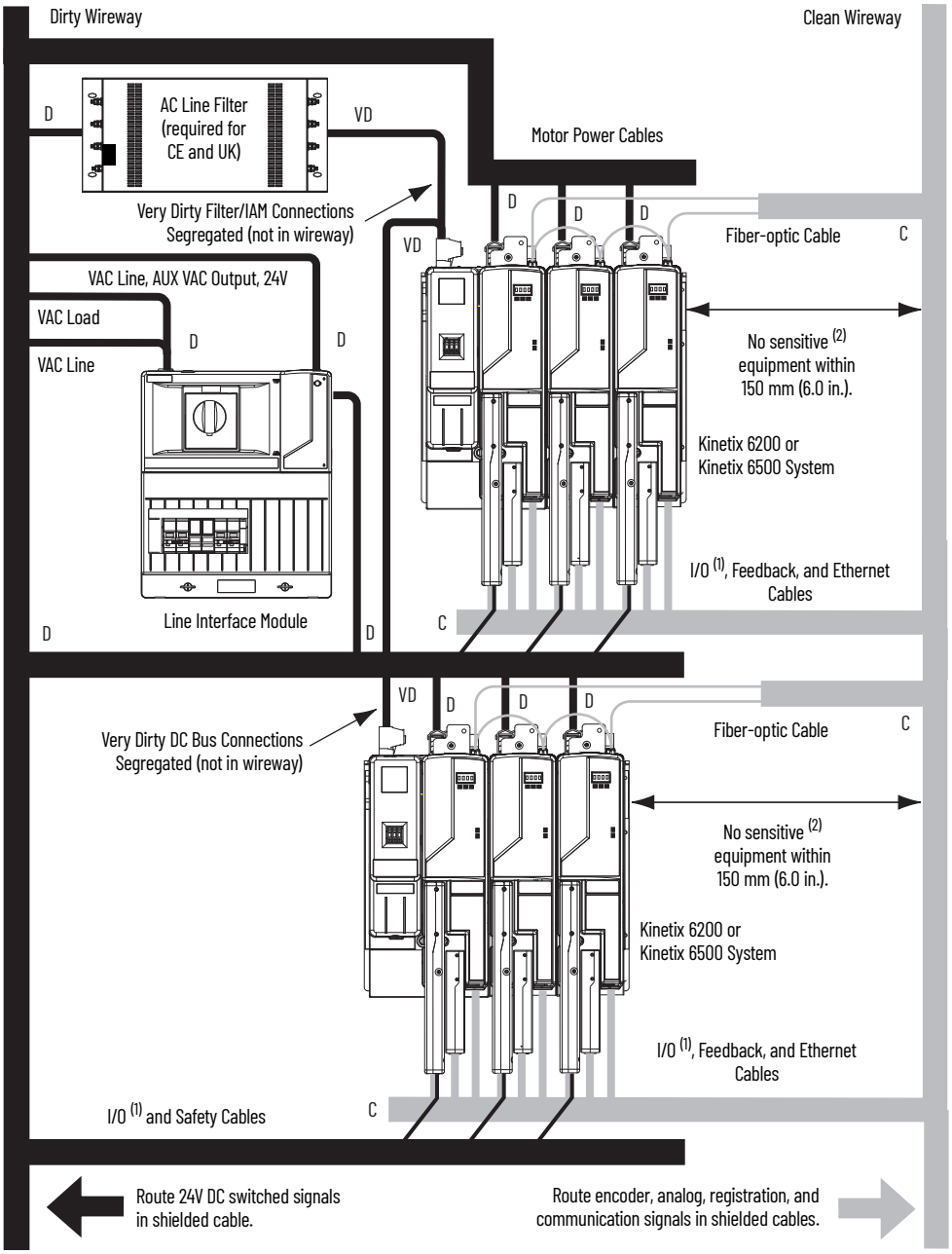
Figure 15 - Noise Zones (EMC filter behind LIM module)



(1) If drive system I/O cable contains (dirty) relay wires, route cable with LIM module I/O cable in dirty wireway.
(2) When space does not permit the 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.
(3) Only the 2094-AL*xx*S and 2094-XL75S-C*x* LIM modules are compatible with the 2094 mounting brackets. The 2094-BL*xx*S, 2094-AL09, and 2094-BL02 LIM modules are not compatible.

Keep the DC common-bus cable (very dirty) segregated from all other cables (not in a wireway) when the 2094-BL*xx*S or 2094-XL75S-C*x* LIM module is used in a DC common-bus configuration and the follower IAM module is mounted below the leader IAM module.

Figure 16 - Noise Zones (DC common bus)



(1) If drive system I/O cable contains (dirty) relay wires, route cable with LIM module I/O cable in dirty wireway.

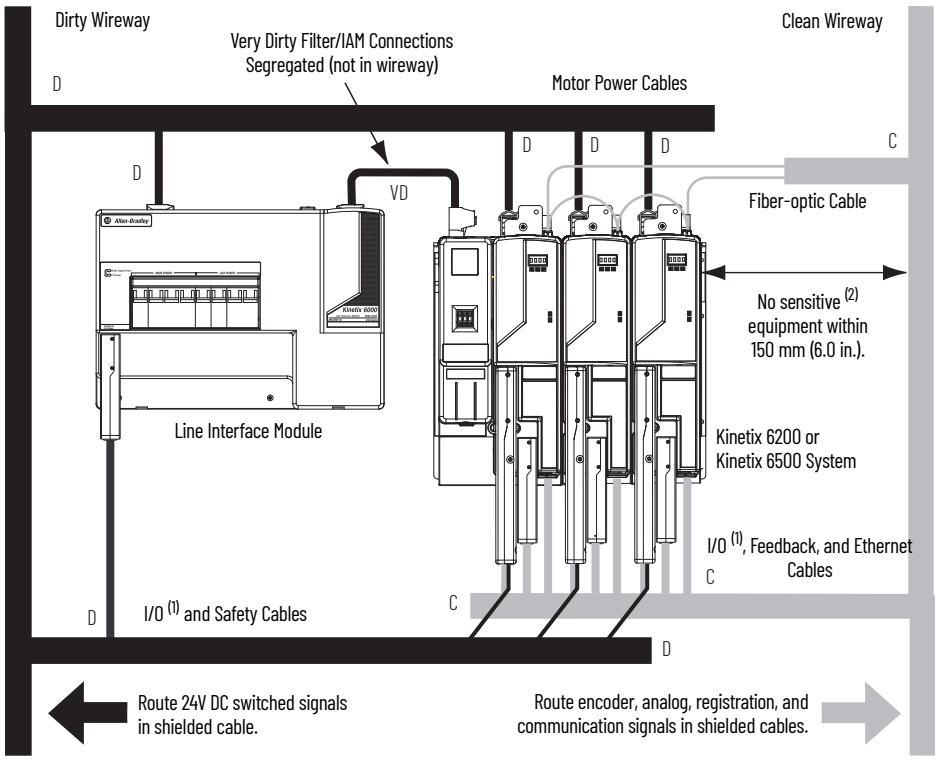
(2) When space does not permit the 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Observe these guidelines when the 2094-BL02 LIM module is used in the Bulletin 2094 system and mounted left of the IAM module:

- The clean zone (C) is to the right and beneath the Bulletin 2094 system (gray wireway).
- The dirty zone (D) is to the left and above the Bulletin 2094 system, and above and below the LIM module (black wireway).
- The very dirty zone (VD) is limited to where the LIM module VAC output jumpers over to the IAM module. Shielded cable is required only if the very dirty cables enter a wireway.
- The Sercos fiber-optic cables are immune to electrical noise, but due to their delicate nature, route them in the clean zone. Ethernet cables are noise sensitive and belong in the clean zone.

This layout is preferred due to the reduced size of the very dirty zone.

Figure 17 - Noise Zones (LIM mounted left of IAM module)

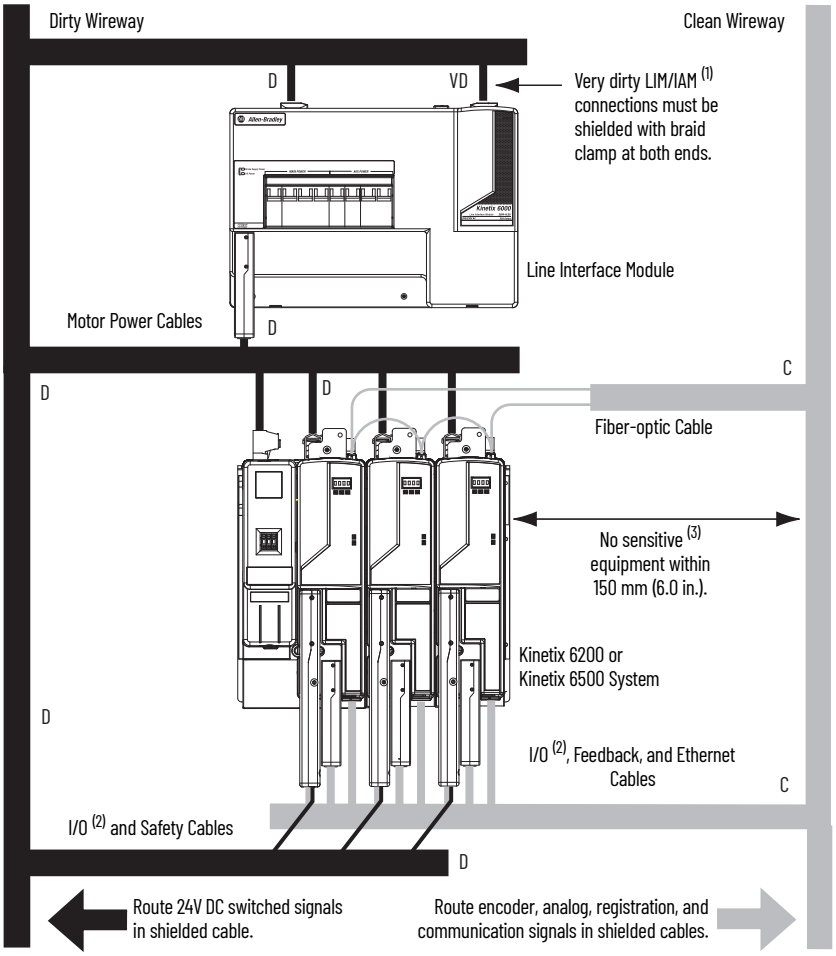


(1) If drive system I/O cable contains (dirty) relay wires, route cable with LIM module I/O cable in dirty wireway.
(2) When space does not permit the 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Observe these guidelines when the 2094-BL02 LIM module is used in the Bulletin 2094 system and mounted above the IAM module:

- The clean zone (C) is to the right and beneath the Bulletin 2094 system (gray wireway).
- The dirty zone (D) is to the left and above the Bulletin 2094 system, and above and below the LIM module (black wireway).
- The LIM VAC output is very dirty (VD). Use shielded cable with a braid clamp attached at both ends of the cable to reduce the rating to dirty (D).
- The Sercos fiber-optic cables are immune to electrical noise, but due to their delicate nature, route them in the clean zone. Ethernet cables are noise sensitive and belong in the clean zone.

Figure 18 - Noise Zones (LIM mounted above IAM module)



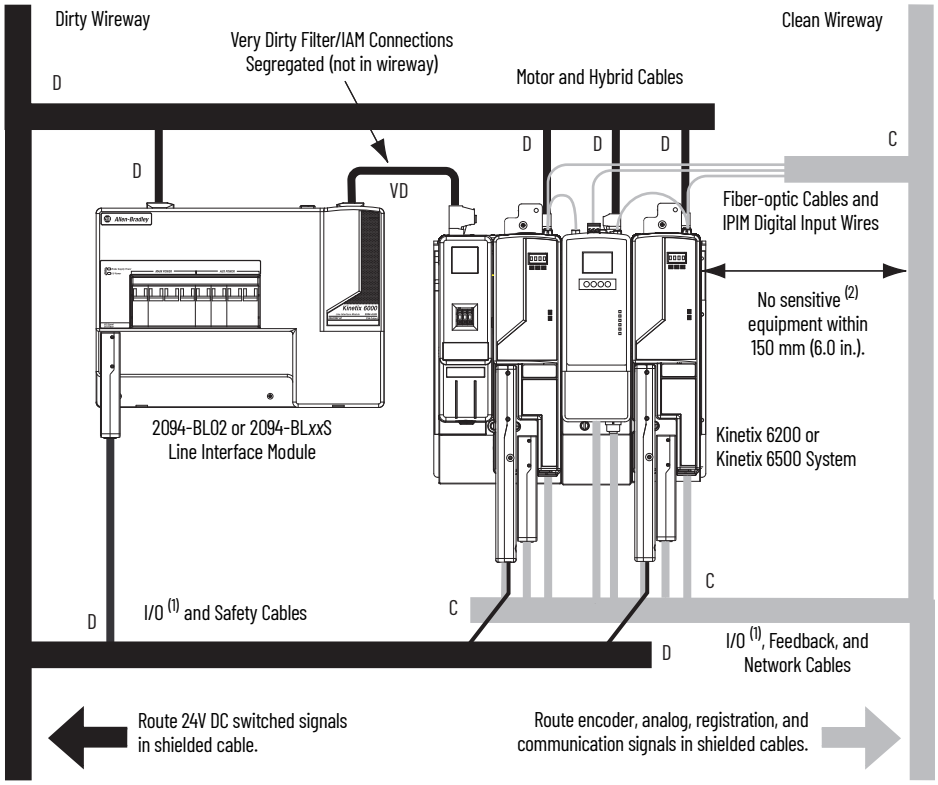
(1) For examples of shield clamp attachment, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.
(2) If drive system I/O cable contains (dirty) relay wires, route cable in dirty wireway.
(3) When space does not permit the 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Observe these guidelines when your system includes the 2094-SEPM-B24-S IPIM module. In this example, a 2094-BL02 LIM module is used in the Bulletin 2094 system and mounted left of the IAM module:

- Establish clean (C) and dirty zones (D) similar to other Bulletin 2094 drive systems.
- The Sercos fiber-optic cables are immune to electrical noise, but due to their delicate nature, route them in the clean zone.
- IPIM digital input wires are noise sensitive and belong with the fiber-optic cables in the clean zone.
- Ethernet cables are noise sensitive and belong in the clean zone, however, they are connected only when programming the IPIM module.
- IDM network cables, although noise sensitive by nature, are shielded and can be routed with the hybrid cables outside of the enclosure.
- The Bulletin 2090 hybrid cable is dirty and belongs in the dirty zone.

This layout is preferred due to the reduced size of the very dirty zone.

Figure 19 - Noise Zones (Bulletin 2094 power rail with IPIM module)



(1) If drive system I/O cable contains (dirty) relay wires, route cable with LIM module I/O cable in dirty wireway.
(2) When space does not permit the 150 mm (6.0 in.) segregation, use a grounded steel shield instead. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.