UNIM012

Knowledge Base Document
Technical Support Department, U79, Newtown

Title: Unidrive M600 to M800 DC Bus Paralleling Applications

Document Category:	Application related	**Product Category:**	Unidrive M
Credits		**Circulation:**	Public

Revision History

Revision	Date	Revising Author	Authorised By	Comments
1.0	06/12/2013	Daniel Schmidt	Rob Francis	Initial Version
1.1	12/02/2014	Rob Francis		Minor corrections
1.2	15/05/2014	Shashikant Patil		Mounting footprint added, parallel DC braking resistance and power rating tables added
1.3	8/07/2014	Phil Knight		UL page added

Summary of Contents

This document is designed as a guide for fusing and connecting the 200V and 400V Unidrive M600 to M800 drives for various common DC bus (paralleled) applications.

Introduction

Connecting the DC links of several drives together allows regenerated/braking energy from one drive to be re-used by another motoring drive. This improves the efficiency of the system since the regenerated energy is not wasted through the heating of braking resistors, and the motoring drive draws substantially less power from the mains. This can be particularly advantageous in a push-pull configuration where one or more drives may be 'holding back' a line to provide tension. Paralleling of the DC bus is often applied in high performance servo drive applications where a substantial amount of energy is used in accelerating and braking motors/machines.

As well as offering advantages in terms of simplifying energy management, a common DC bus system also has the potential to simplify the mains connections and protection. In some cases only a single-mains branch protected feed is needed.

Summary for using DC paralleling:

- Allows drives of different ratings and frame sizes to be connected together
- Reduction of energy losses (heat loss from braking resistors)
- Reduction in cabinet/panel size
- Reduction of input stage systems cost (reduced AC input cabling, AC input fuses, contactors etc.)
- System controlled power down on mains loss.

There are disadvantages when paralleling the DC bus however, and care needs to be taken in the implementation of such a system. Connecting the DC bus of multiple drives together entails the direct connection of each drive’s DC capacitors. These capacitors store substantial amounts of energy, and in the event of a fault, all the stored energy from all of the drives will be fed into the fault. Depending on the system configuration, protection can be provided through the strategic use of supplemental fusing between the drives; however, individual DC fusing is not always required for every application.

For a UL approved system, please refer to the UL Information section of this document.

Contents

Safety Instructions

WARNING! All electrical installation and maintenance work on drives should be carried out by qualified electricians who are familiar with the requirements for safety and EMC. The electrician is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used.

Never work on a drive while input power is still applied. After locking out and tagging out the input power, wait for 10 minutes for capacitors to discharge before you start working on the drive. Even when input power is disconnected from the system, externally supplied control circuits may still carry dangerous voltages. Always confirm that no voltage is still present, both at the input terminals of the converter and at the DC common bus terminals.

A rotating permanent magnet motor can generate dangerous voltages. Lock the motor shaft mechanically before connecting a permanent magnet motor to a drive, or before doing any work on a drive system that is connected to a permanent magnet motor.

IMPORTANT! Drive systems utilizing a common bus topology must be mounted in an enclosure which prevents access except by trained and authorized personnel, and which prevents the ingress of contamination. It is designed for use in an environment classified as pollution degree 2 in accordance with IEC 60664-1. This means that only dry, non-conducting contamination is acceptable.

Please refer to the user guide for each of the drives used in a common bus topology for additional safety requirements.

Discussion

Fusing Policy

Fuses are always required on AC connections, and must be of IEC class gG or gR, or of UL class J. Refer to *Appendix – Branch Fuse Selection* for the recommended AC fuses for size3 – size6 drives; For size7 – size11 drives, please refer to the drive's user guide for the recommended AC fuses.

For applications where supplemental DC fuses are used, ensure that the fuses are placed on both the "+" and "-" cables that go between the drive and the common DC bus. Also, the supplemental DC fuse must have a current rating that is less than or equal to the branch fuse rating. The two types of fuses can have the same current rating, as the supplemental [semiconductor] fuses are a faster acting fuse than the "upstream" IEC/UL class branch protection. Refer to *Appendix – Supplemental Fuse List* for the recommended DC fuses.

Figures within this document show the fuses next to the drive(s) they "belong" to; however, in application, the fuses should actually be placed as physically close to their source of power as possible. This will serve as to protect the cabling.

To dispel any misconceptions, fuses are used on all power electronic devices to limit the available energy as to protect persons and property, and not to necessarily "save the drive" during the most severe of failures.

Cable Protection

The AC mains fuses protect the AC supply cables. Whereas the DC supply fuses are high-speed semiconductor fuses, which protect the drives during severe fault conditions. The DC fuses offer limited protection to the DC supply cables during a less severe fault. The AC supply fuses will protect the DC supply cables against such overloads, if the DC supply cables are rated for (the AC fuse rating x 1.25). For situations where this is not possible, additional protection for the DC cables should be considered.

The responsibility falls on the user to ensure that the input cables and output/motor cables used in their common bus system adhere to local and national regulations. Specifically, if a cable is fused, the current carrying capacity of the cable must be equal to or greater than the fuse's amperage rating. Therefore, cable sizing recommendations will not appear within this document, as the size of the cable depends on many factors such as the cable/jacket type, its temperature rating, the number of cables used in parallel, and whether or not the cable(s) are located within conduit.

Brake Resistors

The Unidrive M drives are designed to allow brake sharing through one or more brake resistors, from one or more drives. Please refer to the parameter *Braking IGBT Lower Threshold* (06.073) in the Parameter Reference Guide for additional details.

Paralleling Methods

The first step is to determine the power profile of the whole system. A local application engineer can assist with this process. Once this fundamental information has been determined, a rational decision can be made about which paralleling scheme, and cabling/fusing connection is most suitable for your application.

There are several topologies for connecting drives together as to create a shared/common DC bus. The following two basic paralleling schemes are considered within this report:

1) Drives are connected to the DC bus via supplemental fuses.
2) Drives are connected to the DC bus without fusing.

Soft Start Circuitry

Unidrive M size3 – size6 drives are designed with an uncontrolled rectifier and a soft-start resistor. The "+" and "-" DC bus terminals are internally connected to the output of the rectifier, and connected before each internal soft start circuit (as shown in *Figure 1a*). In a common DC bus system this means that each of these drives' have their own internal soft-start circuitry, and therefore require no external soft-start components. Moreover, this means that the converter's soft-start circuitry only has to pre-charge the converter's bus capacitors, and not the rest of the drives that are attached via the common DC bus. This holds true for all Unidrive M size3 – size6 drives regardless of whether the drive is being supplied by an AC or DC source.

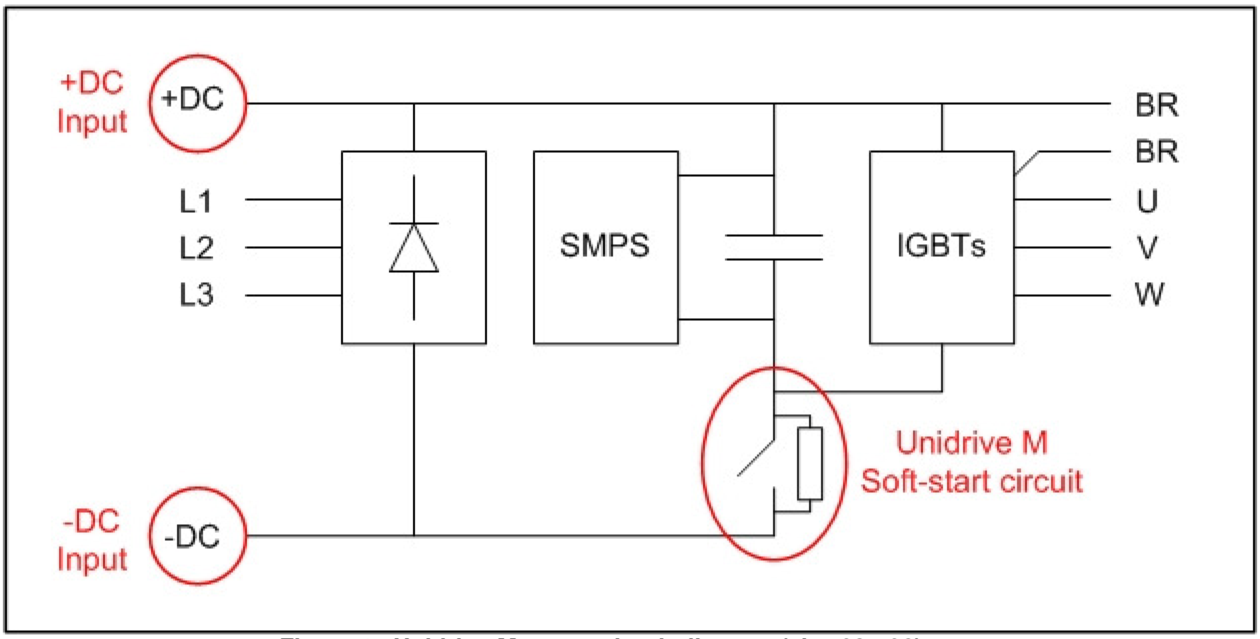

Figure 1a Unidrive-M power circuit diagram (size 03 - 06)

Unidrive M size7 – size11 drives are designed with a controlled rectifier (and no internal soft-start resistor). The "+" and "-" DC bus terminals are internally connected to the output of the controlled rectifier, and connected directly to each drive's bus capacitors (as shown in *Figure 1b*). In a common DC bus system, this means that each Unidrive M converter is capable of soft-starting energy from an AC supply, and then sharing this soft-start energy with inverters on the common DC bus. However, care must be taken when using a converter that has some form of uncontrolled rectifier, as such a converter offers no soft-start protection when powering up a DC bus; external soft-start circuitry will be required to limit inrush energy into the inverters. Please refer to the converter's user manual regarding its inrush capabilities.

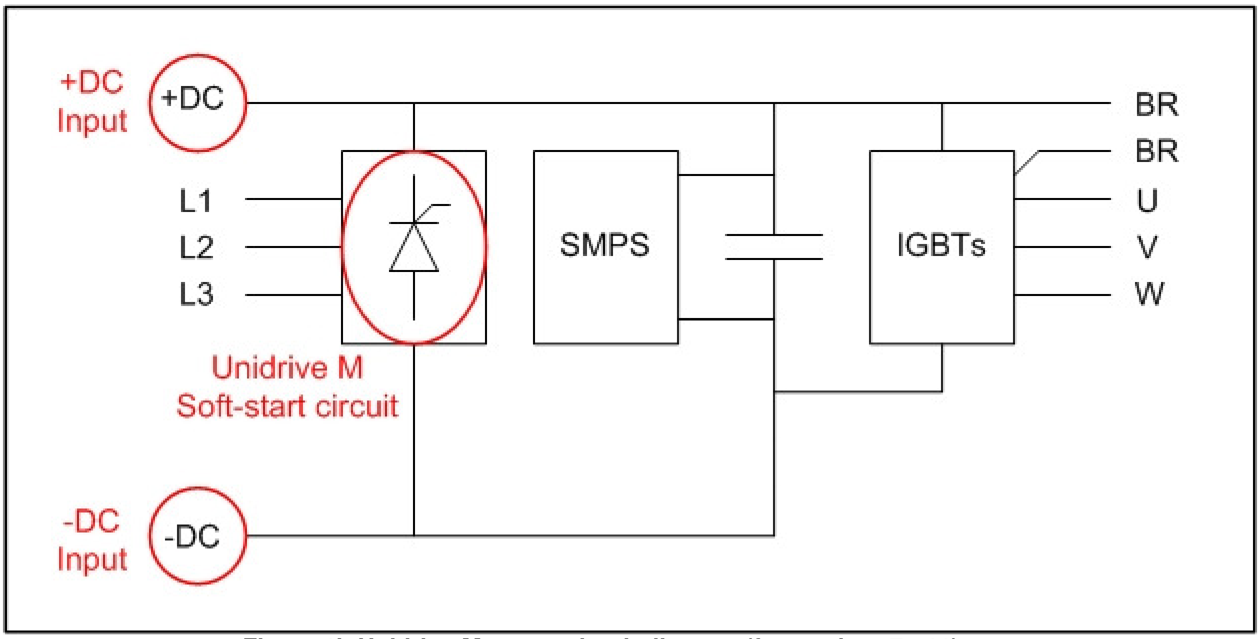

Figure 1b Unidrive-M power circuit diagram (frame sizes 7 - 11)

Typically the soft start circuitry is "activated" under two circumstances: 1) during a "normal" AC mains power-up sequence. 2) if the DC bus voltage drops below the predetermined *Undervoltage Threshold* level. And in general, the *Undervoltage Threshold* level is only reached during a "normal" power-down sequence, or during a severe utility brownout or a utility blackout condition. The Unidrive M drives are designed to withstand even the most severe of utility disturbances. However, in regions that have a less stable electrical utility grid, a less severe utility brownout condition can actually be more of a system annoyance than a more severe brownout condition would be. First, let's define a "critical brownout" to be where the utility voltage sags to just above the trigger point of an *Undervoltage Threshold* trip, and then where the utility voltage instantly jumps back up to its maximum line voltage (i.e. nominal line voltage + maximum utility tolerance). This critical brown out would not cause the soft start circuitry to re-engage, and would subsequently surge a substantial magnitude of current back into all of the DC bus capacitors. So as the total DC bus capacitance increases beyond a single frame block, there is an increasing probability that a critical brownout could cause the branch fuses to spuriously open. Therefore, to reduce this annoyance potential in areas with less-than-reliable utilities, a common bus system comprised of multiple instances of *Figure 5a* & *5b* should be favoured over a common bus systems illustrated in *Figure 6a*, *6b*, or *6c*. Alternatively, an "oversized" converter would help mitigate this issue. However, in more reliable regions, the probability of these critical brownouts are small, and so any common bus topology within this document should be considered reliable.

System Configurations

1.0 DC paralleling of individually fused drives.

In this scheme, a converter takes an AC voltage and changes it into a DC voltage. Motor drives, also known as inverters, can then be connected to this “parent” DC bus through supplemental fusing. The converter must be tied to the AC mains through its own branch protection, which will be specified in the converter’s user manual. The limiting factor on the number of drives that can be attached to a common DC bus in this manner is the power rating of the converter. Analysis of the motion profile for the whole system will dictate the size of the converter required.

The system shown in *Figure 2* is comprised of a Mentor converter, and an unspecified number of individually-fused Unidrive M inverters. In this configuration, the Mentor drive is purely used as a DC power supply, and is not able to drive a motor in this mode. Due to the power ratings of the Mentor drives, this configuration can only be used with Unidrive M size3 – size6 inverters.

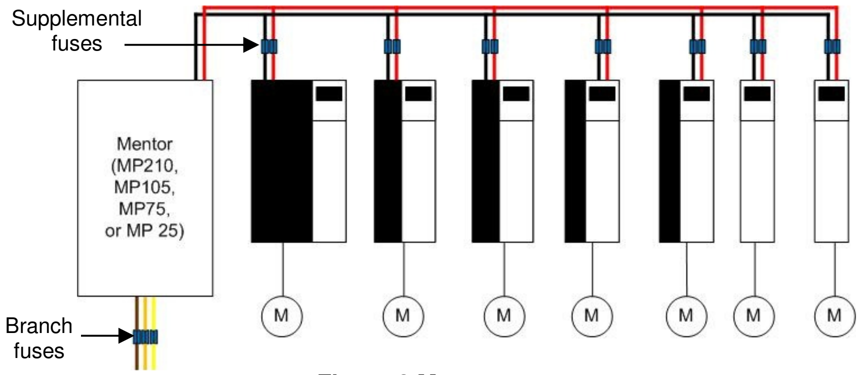

Figure 2 Mentor converter

When using the Mentor drive as a converter, there are limitations on the DC “parent bus” voltage, regardless of whether or not the Mentor drive is used to regenerate energy back onto the AC mains. Please refer to ‘*MMP001 Knowledge Base Document - Regeneration with Mentor MP’* for more details. With regards to the DC bus voltage, the limitations are:

- 280 – 340V_{DC} for the 200/240V drives
- 540 – 630V_{DC} for the 400/480V drives

Alternatively, as shown in *Figure 3a*, a Unidrive M size3 – size11 drive can be used for a converter. Then any other Unidrive M drives can be connected to the "parent" DC bus via supplemental DC fuses. However, the largest rated Unidrive M drive within this system must act as the converter, and be connected to the AC mains via branch circuit protection. Furthermore, the total power that can be used by this system configuration is dictated by the branch protection of the converter. For these reasons it is most advisable to "oversize" the Unidrive M converter. Unlike a Mentor converter as seen in *Figure 2*, the Unidrive M converter can drive its own suitably rated motor even while supplying a common DC bus to the rest of the system. Refer to *Appendix - Branch Fuse Selection* when selecting the appropriate branch protection for the Unidrive M converter; refer to user manuals for non-Unidrive M converters. Refer to *Appendix - Drive Rating Information* when selecting the supplemental DC fuse for each inverter drive (see columns *700V_{DC} supplemental fuse (minimum rating)* & *700V_{DC} supplemental fuse (maximum rating)*). Supplemental fuse selection will be discussed further in the section for *Building a System*.

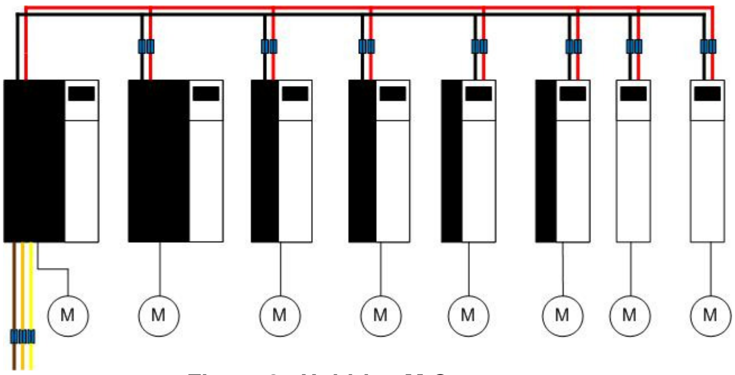

Figure 3a Unidrive-M Converter

In general, the Unidrive M converter does not need its own supplemental fuse when creating the parent DC bus, as illustrated in *Figure 3a*, as the inverter's supplemental fuse(s) also limits the "backflow" to the converter. However, if the supplemental fuse amperages summed up from all of the inverters ends up exceeding the maximum supplemental fuse rating for the converter as found in *Appendix – Drive Rating Information*, then the converter will need its own fuse, as shown in *Figure 3b*. Always select the maximum rated supplemental fuse when a supplemental fuse is required for the converter. An example of this procedure is given in *Appendix – Building a System - Example 2*.

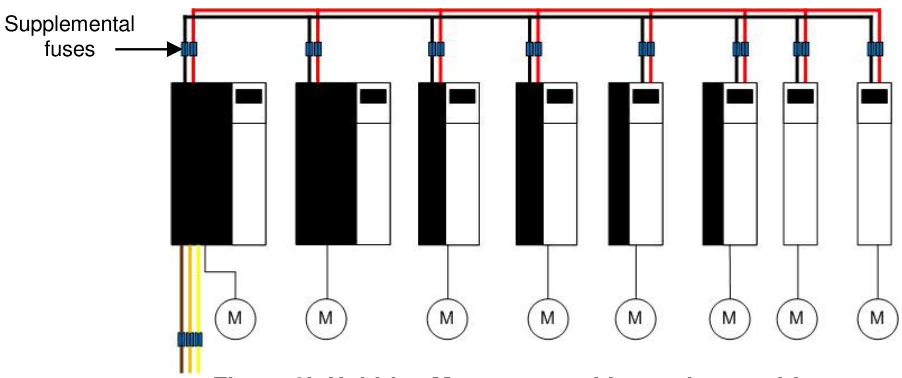

Figure 3b Unidrive-M converter with supplemental fuses

The converter can also be substituted with an external rectifier stack, as shown below in *Figure 4a* and *Figure 4b*. However, the customer assumes liability with regards to the quality and reliability of this alternative converter. Please refer to the rectifier's user guide for any additional fusing/protection requirements.

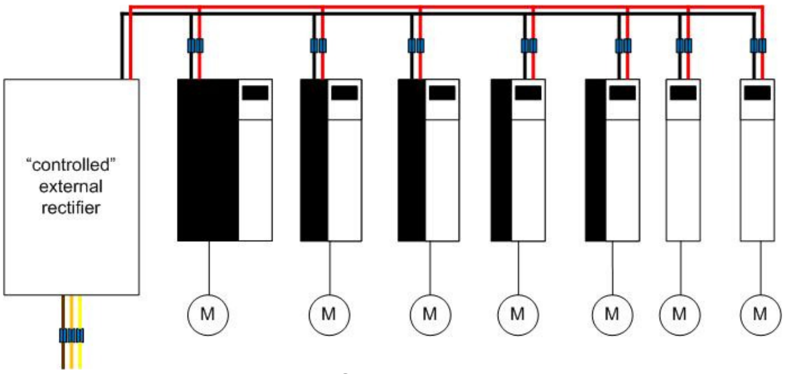

Figure 4a Controlled Rectifier

The limiting factor on the number of drives that can be attached to an external rectifier in this manner would be one of the following. 1) The converter is not rated to supply enough power for the motion profile required of the drive system. 2) The converter has its own soft start circuitry inrush energy limitations that must not be exceeded. Therefore, care must be taken to ensure that the converter is sufficiently rated to power the Unidrive M drives that are attached to its "common bus" DC output.

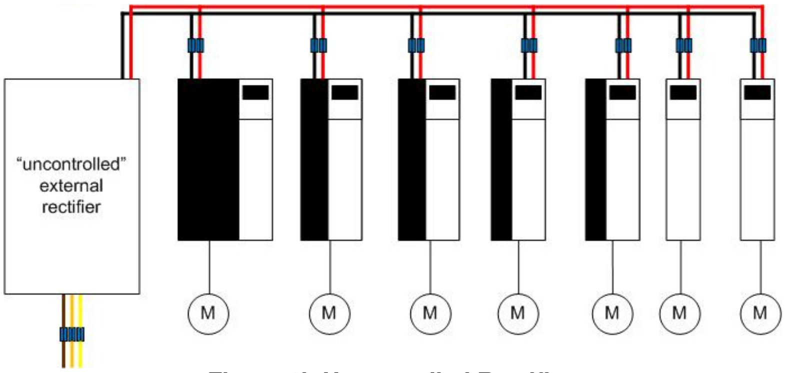

Figure 4b Uncontrolled Rectifier

When using an uncontrolled rectifier stack, please refer to the section for *Soft Start Circuitry*, as Unidrive M drives size7 – size11 will require the use of user supplied soft start circuitry in this topology.

2.0 DC paralleling of multiple "unfused" drives.

In this type of system configuration, only Unidrive M drives sizes3 – size6 can be connected together to create a block of drives which share a "local" unfused DC bus between the drives. Bus bar connection kits are available for simple and space saving connections between drives; refer to *Appendix – Paralleling busbar data*. Note that each frame block can be comprised of drives within different frame sizes, and of different power ratings. Obviously, drives of different voltage ratings cannot be mixed on the same common bus. Furthermore, the drive with the largest power rating must always be the converter drive.

2.1 Unfused "local" DC Bus:

Below, *Figure 5a* and *Figure 5b*, show blocks of Unidrive M drives powered via AC mains using branch circuit protection. Refer to *Appendix - Branch Circuit Fuse Selection* when selecting the appropriate branch protection for the converter. Notice that no supplemental DC fuses are required for this type of configuration. The maximum number of drives that can be paralleled together to create a frame block depends on the *maximum frame block capacitance* that each Unidrive M frame size can support "unfused" on its DC bus; Refer to *Appendix – Drive Rating Information* under the *maximum frame block capacitance* columns for these limits. Sizing examples are provided in *Appendix – Building a System*.

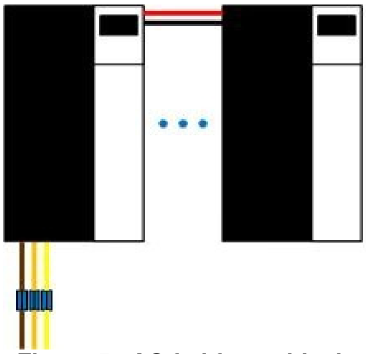

Figure 5a AC fed frame block

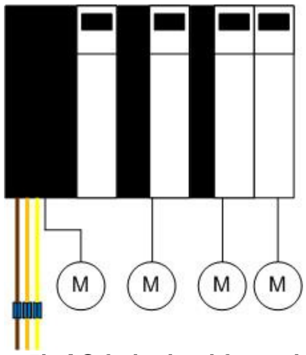

Figure 5b AC fed mixed frame block

The user must remember that the power "losses" of their system cannot exceed the current capabilities of their fuses. This means that the current going into all "motoring" drives, MINUS the current coming out of all "regenerating" drives, is the value that cannot exceed the current rating of the fuses. For systems designed around a serial-motion profile, this is rarely an issue; for systems designed around a parallel-motion profile, their motion profile must be analyzed thoroughly.

When creating a frame block with drives of multiple frame sizes, as shown in *Figure 5b*, the smallest rated drive dictates the maximum frame block capacitance allowed. To be clear, the maximum frame block capacitance is calculated by adding up the individual drive capacitance for all drives within the same frame block. Individual drive capacitance can be found in *Appendix – Drive Rating Information*.

NOTE: There is subtly that needs to be observed when using bus bar kits between drives of varying frame sizes, as to avoid the scenario where the current rating of a smaller drive's paralleling bus bars is exceeded. The drives need to be arranged so that either all of the larger rated drives are on one side of the frame block and all of the smaller rated drives are on the other side, or arranged where the larger drives are all in the middle of the frame block and the smaller rated drives are placed on either sides of the larger drives. To be explicit, smaller rated drives cannot be placed in the middle of a frame block with larger rated drives placed on both sides of the smaller rated drives. Explained differently, the frame block cannot be arranged where the common bus energy is allowed to flow from a larger rated drive, through the paralleling bus bars of a smaller rated drive, and back into another larger rated drive. The amperage limitations on the paralleling bus bars can be found in *Appendix – Paralleling Bus Bar Data*.

2.2 Fused "parent" DC Bus:

If more drives are required for an application than a single frame block will allow, then multiple frame blocks can be connected together to the "parent" DC bus through supplemental fuses, as seen in *Figure 6a*, *Figure 6b*, and *Figure 6c*. Note that each drive size3 – size11 is designed to be used as a converter, and allows for an unspecified number of frame blocks of drives to be connected to its parent DC bus. Refer to *Appendix - Branch Circuit Fuse Selection* when selecting the appropriate branch protection for the converter; Refer to *Appendix - Approved Supplemental DC Fuses* when selecting the supplemental DC fuse to connect each frame block to the "parent" DC bus.

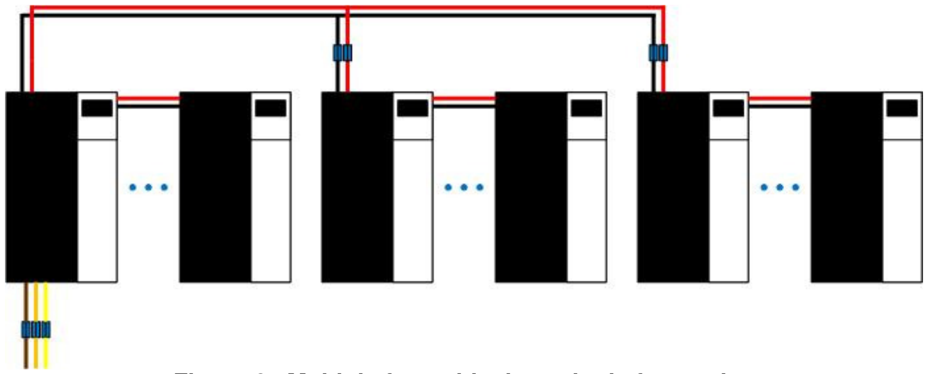

Figure 6a Multiple frame blocks – single frame size

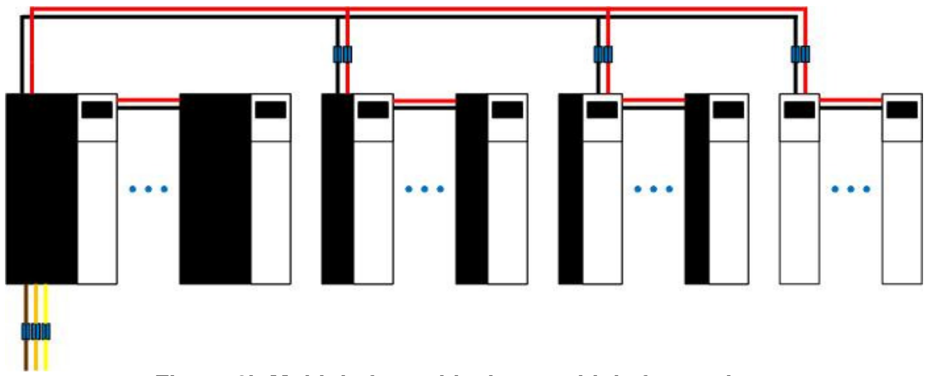

Figure 6b Multiple frame blocks – multiple frame sizes

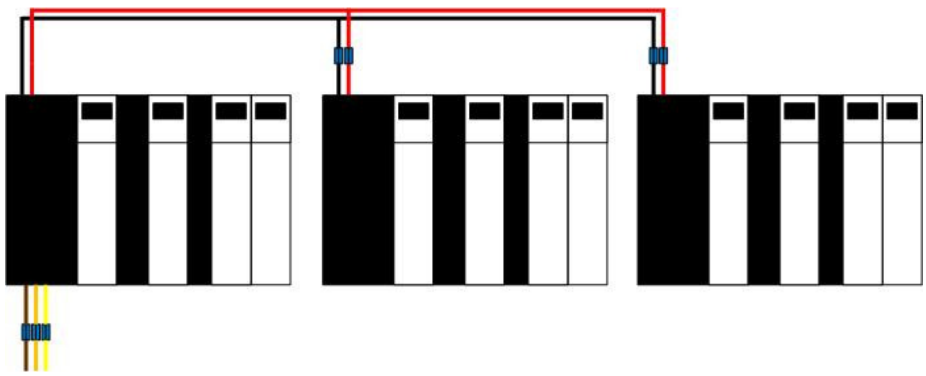

Figure 6c Multiple frame blocks – mixed drives

Again, keep in mind that the largest rated Unidrive M drive in the entire system MUST be the converter, and must be properly sized to provide enough power to satisfy the motion profile of the whole system. As mentioned previously, the total power that can be used by the whole system is dictated by the converter's branch protection. For these reasons, it is most advisable to "oversize" the converter… and especially if a process contains parallel-style motions. The total power available within a given frame block is dictated by each frame block's supplemental fuse.

There are two things to consider when selecting a supplemental fuse for each frame block.

1) The largest rated drive within the frame block has a minimum fuse rating requirement.
2) The smallest rated drive within the frame block has a maximum fuse rating limitation.

Therefore, the supplemental fuses used on a given frame block must fall within this range of acceptable fuse ratings. To optimize the supplemental fuse on a frame block for a given frame size, *Figure 6b* should be used as this eliminates the situation where a smaller drive limits what a supplemental fuse can be.

Again, the Unidrive M converter does not generally need its own supplemental fuse when creating the parent DC bus, unless the supplemental fuse amperages summed up from all of the inverters exceeds the maximum supplemental fuse rating for the converter as found in *Appendix – Drive Rating Information*, then the converter will need its own fuse. Always select the maximum rated supplemental fuse when a supplemental fuse is required for the converter. An example of this procedure is given in *Appendix – Building a System - Example 2*.

Building a System

Rules

- The largest drive within the system must be the converter
    - Converter connects to the AC mains via branch circuit protection
    - Converter dictates the total energy available to the system
    - Converter creates the "parent" DC bus
- The smallest rated drive in each frame block dictates the maximum total capacitance that can be unfused within that frame block.
    - A frame block can be made up of drives with different ratings and even different frame sizes (for size3 – size6)
    - Drives that can't "fit" within the same frame block must be placed in additional frame blocks
    - Additional frame blocks can be connected to the "parent" DC bus via supplemental DC fuses
- Supplemental DC fuses are dictated by the smallest rated drive within each additional frame block
    - The supplemental fuses dictate the total energy available to the frame block
    - Each drive has a minimum and maximum allowable amperage rating for its supplemental fuse selection
    - Check to see if the converter needs its own supplemental fuse
    - Verify that supplemental fuse rating does not exceed 250% of summed DC input current for all inverters in a given frame block
- Mounting footprints for connecting different drives using DC paralleling bus bars
    - Drive mounting hole and footprint information for the different drives sizes are shown in *Appendix - Drive Mounting Hole and Footprint Information*.
        - Refer to Figure 14 to Figure 17 for mounting hole footprint of different drive size combinations
    - When used in a mixed frame group the Unidrive M Size6 should always be placed on extreme right hand side.

Example #1

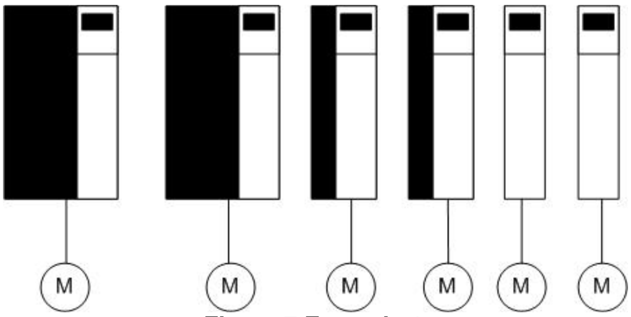

Figure 7 Example 1

List all of the drives that need to be included in your system…

Drives:

- Unidrive M size3 – Mxxx-034 00045
- Unidrive M size3 – Mxxx-034 00078
- Unidrive M size4 – Mxxx-044 00150
- Unidrive M size4 – Mxxx-044 00172
- Unidrive M size6 – Mxxx-064 00350
- Unidrive M size6 – Mxxx-064 00470

Write down the capacitance values for the individual drives found within *Appendix – Drive Rating Information*.

Capacitance:

- Unidrive M size3 – Mxxx-034 00045 – 220µF
- Unidrive M size3 – Mxxx-034 00078 – 390µF
- Unidrive M size4 – Mxxx-044 00150 – 660µF
- Unidrive M size4 – Mxxx-044 00172 – 660µF
- Unidrive M size6 – Mxxx-064 00350 – 1500µF
- Unidrive M size6 – Mxxx-064 00470 – 1500µF

Check to see if all of the drives can be in the same frame block; sum up the combined bus capacitance.

2 x 1500µF + 2 x 660µF + 390µF + 220 µF = 4930 µF Total

According to *Appendix – Drive Rating Information*, under size3 and size4, 4930µF is larger than is allowed as the maximum frame block capacitance on these drives; you will have to create multiple frame blocks for all of these drives to be in your system. You can be creative at this point and pair up drives as best suits your motion profile… Perhaps the size4 drives are set up in a push-pull configuration, so we don't want to separate those drives… Does your motion profile require both of the size6 drives to "motor" at the same time…? Take a look at some of the combinations that you can choose:

System A:

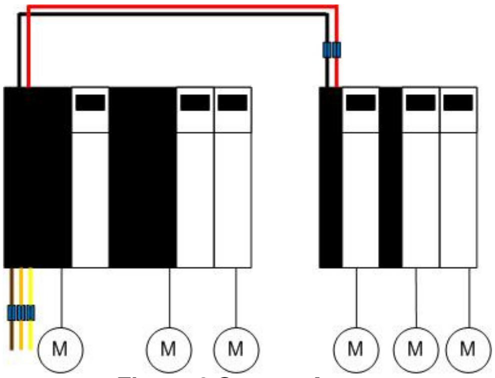

Figure 8 System A

- Frame block #1 (i.e. converter frame block)
  - Unidrive M size6 – Mxxx-064 00470 – 1500µF
  - Unidrive M size6 – Mxxx-064 00350 – 1500µF
  - Unidrive M size3 – Mxxx-034 00078 – 390µF
  - Total frame block capacitance = 3390µF (which is less than the 3510µF maximum for size3)
- Frame block #2 (i.e. inverter frame block)
  - Unidrive M size4 – Mxxx-044 00150 – 660µF
  - Unidrive M size4 – Mxxx-044 00172 – 660µF
  - Unidrive M size3 – Mxxx-034 00045 – 220µF
  - Total frame block capacitance = 1540µF (which is less than the 3510µF maximum for size3)

The Unidrive M size6 – Mxxx-064 00470 is the largest drive in this system, so it must be wired up as the converter. Because you are connecting smaller unfused frame sizes to the size6 drive, *Appendix – Branch Fuse Selection* dictates that a high speed 60A fuse is required as the AC mains branch circuit protection.

The supplemental fuse required on the second frame block is dictated by the smallest drive within this frame block. With two size4 drives and a size3 drive all motoring at the same time, you could use a 60A fuse ($27.3A_{DC}$ + $21.1A_{DC}$ + $10.3A_{DC}$ rounded up). But because the size3 drive only needs a $12A_{DC}$ fuse at minimum according to *Appendix – Drive Rating Information*, and the pair of size4 drives in a push-pull configuration isn't going to consume that much current from the parent DC bus, you can get by with a $30A_{DC}$ supplemental fuse for this example. In case you're wondering why the $30A_{DC}$ fuse was chosen, it's because this would allow for each drive to run (one at a time) at full power during commissioning if needed. Now that a $30A_{DC}$ fuse has been selected for this frame block from the *Appendix – Supplemental Fuse List*, you can select the appropriate cable to bring the parent common bus over from the converter to this second frame block.

The last thing to check is whether or not the converter needs its own supplemental DC fuses when sourcing to the parent bus; Add up the supplemental fuse current ratings on all inverter frame blocks:

Current ratings:

- Frame block #2 – $30A_{DC}$
- Total inverter frame block ampacity is $30A_{DC}$, which is less than the $160A_{DC}$ rating for a size 6 drive connecting to a parent DC bus. Therefore the converter does not need its own supplemental fuse.

System B:

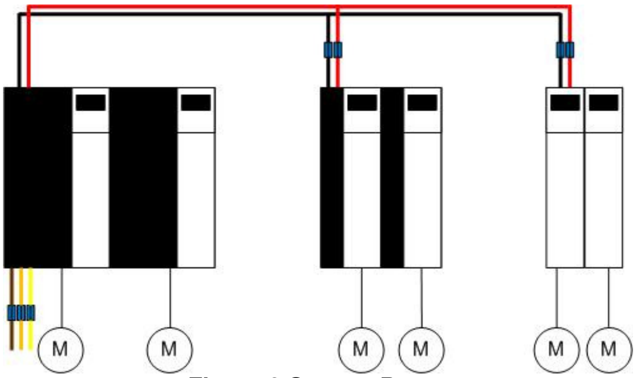

Figure 9 System B

- Frame block #1 (i.e. converter frame block)
  - Unidrive M size6 – Mxxx-064 00470 – 1500µF
  - Unidrive M size6 – Mxxx-064 00350 – 1500µF
  - Total frame block capacitance = 3000µF (which is less than the 7500µF maximum for size6)
- Frame block #2 (i.e. inverter frame block)
  - Unidrive M size4 – Mxxx-044 00150 – 660µF
  - Unidrive M size4 – Mxxx-044 00172 – 660µF
  - Total frame block capacitance = 1540µF (which is less than the 4140µF maximum for size4)
- Frame block #3 (i.e. inverter frame block)
  - Unidrive M size3 – Mxxx-034 00045 – 220µF
  - Unidrive M size3 – Mxxx-034 00078 – 390µF
  - Total frame block capacitance = 1540µF (which is less than the 3510µF maximum for size3)

The Unidrive M size6 – Mxxx-064 00470 is the largest drive in this system, so it must be wired up as the converter. Because you are not connecting smaller unfused frame sizes to the size6 drive, *Appendix – Branch Fuse Selection* shows that a slow speed 60A fuse can be used as the AC mains branch circuit protection. However, one can always use a faster speed fuse in place of a slower speed fuse; the converse is NEVER permissible!

The supplemental fuse required on the second frame block is dictated by the smallest drive within this frame block. With the two size4 drives motoring at the same time, you could use a 50A fuse (27.3A_{DC} + 21.1A_{DC} rounded up). Since we're saying that the pair of these drives are in a push-pull configuration, they aren't going to consume that much current from the parent DC bus and so you can get by with a 30A_{DC} supplemental fuse for this example.

The supplemental fuse required on the third frame block is dictated by the smallest drive within this frame block. With two size3 drives motoring at the same time, you can use a 30A fuse (14.5A_{DC} + 10.3A_{DC} rounded up).

The last thing to check is whether or not the converter needs its own supplemental DC fuses when sourcing to the parent bus; Add up the supplemental fuse current ratings on all inverter frame blocks:

Current ratings:

- Frame block #2 – 30A_{DC}
- Frame block #3 – 30A_{DC}
- Total inverter frame block ampacity is 60A_{DC}, which is less than the 160A_{DC} rating for a size 6 drive connecting to a parent DC bus. Therefore the converter does not need its own supplemental fuse.

System C:

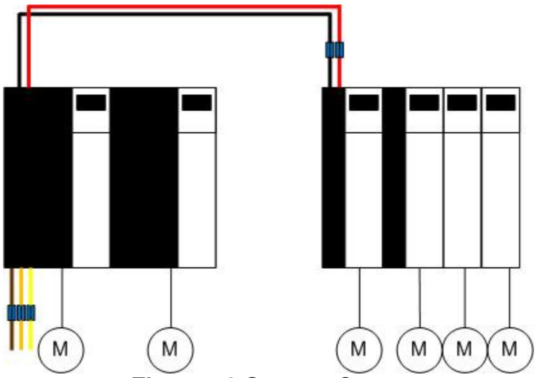

Figure 10 System C

- Frame block #1 (i.e. converter frame block)
  - Unidrive M size6 – Mxxx-064 00470 – 1500µF
  - Unidrive M size6 – Mxxx-064 00350 – 1500µF
  - Total frame block capacitance = 3000µF (which is less than the 7500µF maximum for size3)
- Frame block #2 (i.e. inverter frame block)
  - Unidrive M size4 – Mxxx-044 00150 – 660µF
  - Unidrive M size4 – Mxxx-044 00172 – 660µF
  - Unidrive M size3 – Mxxx-034 00078 – 390µF
  - Unidrive M size3 – Mxxx-034 00045 – 220µF
  - Total frame block capacitance = 1930µF (which is less than the 3510µF maximum for size3)

The Unidrive M size6 – Mxxx-064 00470 is the largest drive in this system, so it must be wired up as the converter. Because you are not connecting smaller unfused frame sizes to the size6 drive, *Appendix – Branch Fuse Selection* shows that a slow speed 60A fuse can be used as the AC mains branch circuit protection.

The supplemental fuse required on the second frame block is dictated by the smallest rated drive within this frame block. If all four of the drives were all motoring at the same time, you would need an 80A fuse (27.3A_{DC} + 21.1 A_{DC} + 14.5A_{DC} + 10.3A_{DC} rounded up). Clearly an 80A_{DC} requirement on this frame block would require that a larger rated converter is used. Since we're saying that the pair of size4 drives are in a push-pull configuration, they aren't going to consume that much current from the parent DC bus and so we can get by again with a 30A_{DC} supplemental fuse for this example. The 30A_{DC} fuse was chosen for the following reasons: 1) this would allow for each drive to run (one at a time) at full power during commissioning if needed. 2) both size3 drives can motor simultaneously, along with the push-pull pair of size4 drives running at 80% motor efficiency or better.

The last thing to check is whether or not the converter needs its own supplemental DC fuses when sourcing to the parent bus; Add up the supplemental fuse current ratings on all inverter frame blocks:

Current ratings:

- Frame block #2 – 30A_{DC}
- Total inverter frame block ampacity is 30A_{DC}, which is less than the 160A_{DC} rating for a size 6 drive connecting to a parent DC bus. Therefore the converter does not need its own supplemental fuse.

System D:

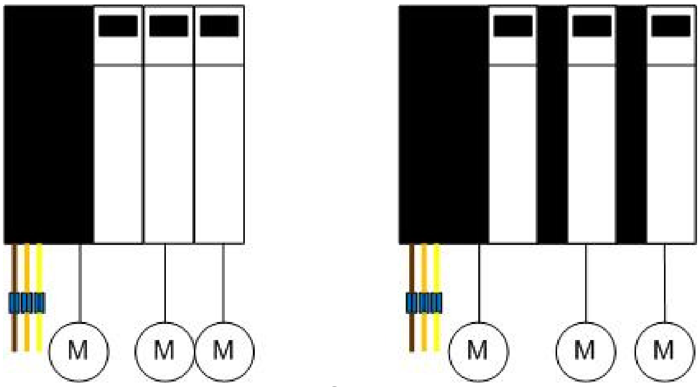

Figure 11 System D

- Frame block #1 (i.e. converter frame block)
  - Unidrive M size6 – Mxxx-064 00470 – 1500µF
  - Unidrive M size3 – Mxxx-034 00078 – 390µF
  - Unidrive M size3 – Mxxx-034 00045 – 220µF
  - Total frame block capacitance = 2110µF (which is less than the 3510µF maximum for size3)
- Frame block #2 (i.e. converter frame block)
  - Unidrive M size6 – Mxxx-064 00350 – 1500µF
  - Unidrive M size4 – Mxxx-044 00150 – 660µF
  - Unidrive M size4 – Mxxx-044 00172 – 660µF
  - Total frame block capacitance = 2820µF (which is less than the 4140µF maximum for size4)

If your motion profile requires either or both of the size6 drives to motor at the same time, or if your system periodically draws more than $60A_{DC}$ through the branch circuit protection, then you might want to consider a system configuration like this. Notice that the supplemental DC fuses are not being used, and that the common bus energy is no longer allowed to be shared between the two frame blocks. However, the trade-off is that more power is available to the system overall, than in the previous 3 system examples.

For the first frame block, the Unidrive M size6 – Mxxx-064 00470 is the largest drive in this system, so it must be wired up as a converter. Because you are connecting smaller unfused frame sizes to the size6 drive, *Appendix – Branch Fuse Selection* dictates that a high speed 60A fuse is required as the AC mains branch circuit protection.

For the second frame block, the Unidrive M size6 – Mxxx-064 00253 is the second largest drive in this system, so it too must be wired up as a converter. Because you are connecting smaller unfused frame sizes to the size6 drive, *Appendix – Branch Fuse Selection* dictates that a high speed 60A fuse is required as the AC mains branch circuit protection.

There is no parent DC bus in this configuration, so there is no need to check if the converter needs a supplemental DC fuses.

Example #2

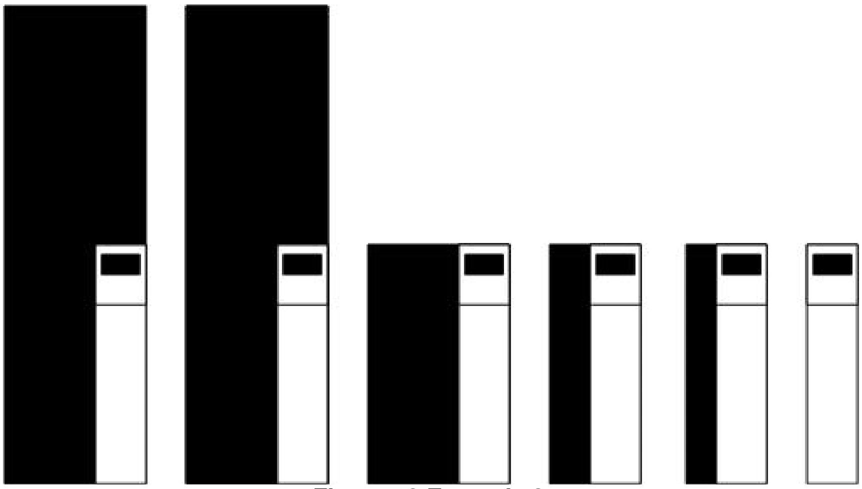

Figure 12 Example 2

List all of the drives that need to be included in your system…

Drives:

- Unidrive M size7 – Mxxx-074 00660
- Unidrive M size7 – Mxxx-074 00660
- Unidrive M size6 – Mxxx-064 00350
- Unidrive M size5 – Mxxx-054 00300
- Unidrive M size4 – Mxxx-044 00150
- Unidrive M size3 – Mxxx-034 00100

Write down the capacitance values for the individual drives found within *Appendix – Drive Rating Information*…

Capacitance:

- Unidrive M size7 – Mxxx-074 00660 – 2340 µF
- Unidrive M size7 – Mxxx-074 00660 – 2340 µF
- Unidrive M size6 – Mxxx-064 00350 – 1500 µF
- Unidrive M size5 – Mxxx-054 00300 – 780 µF
- Unidrive M size4 – Mxxx-044 00150 – 660 µF
- Unidrive M size3 – Mxxx-034 00100 – 390 µF

Unidrive M size7 – size11 can only be connected as a single drive through supplemental fuses to a common bus. Check to see if all of the size3 – size6 drives can be unfused together in the same frame block; sum up the combined bus capacitance…

1500µF + 780µF + 660µF + 390 µF = 3330 µF Total

This shows that you can have all of these smaller drives in a single frame block according to the maximum frame block capacitance limit dictated by the smallest inverter within the frame block in *Appendix – Drive Rating Information*, under size3.

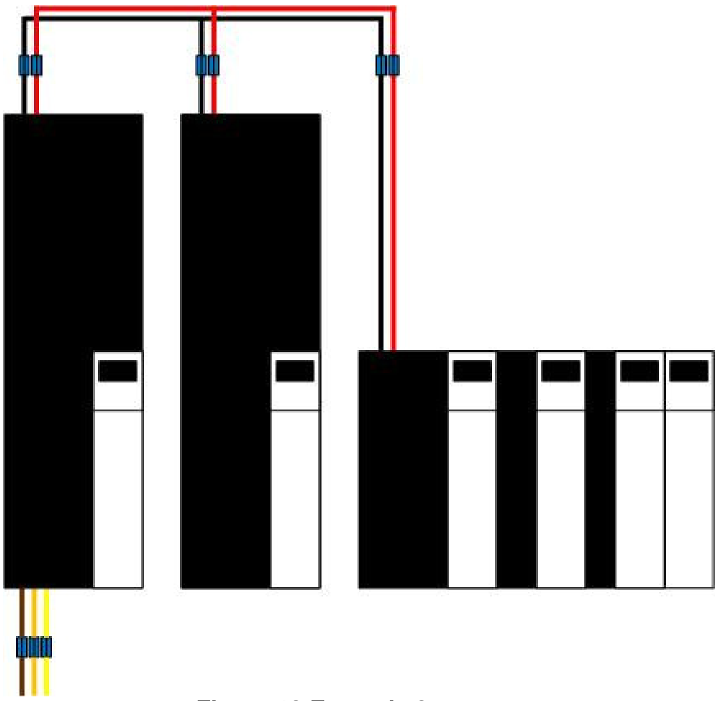

Figure 13 Example 2 system

- Frame block #1 (i.e. converter frame block)
  - Unidrive M size7 – Mxxx-074 00660 – 2340 µF
- Frame block #2 (i.e. inverter frame block)
  - Unidrive M size7 – Mxxx-074 00660 – 2340 µF
- Frame block #3 (i.e. converter frame block)
  - Unidrive M size6 – Mxxx-064 00350 – 1500 µF
  - Unidrive M size5 – Mxxx-054 00300 – 780 µF
  - Unidrive M size4 – Mxxx-044 00150 – 660 µF
  - Unidrive M size3 – Mxxx-034 00100 – 390 µF
  - Total frame block capacitance = 3330µF (which is less than the 3510µF maximum for size3)

For the first frame block, the Unidrive M size7 – Mxxx-074 00660 is one of the largest drives in this system, so it must be wired up as a converter. The user guide for the Unidrive M size7 drive will specify the amperage rating for the HSJ branch fuses.

For the second frame block, the second Unidrive M size7 – Mxxx-074 00660 is connected up to the parent DC bus through a pair of 100A$_{DC}$ supplemental fuses according to *Appendix – Drive Rating Information*, size7.

For the third frame block, the unfused of drives are connected up to the parent DC bus through a pair of 50-80A$_{DC}$ supplemental fuses depending on the motion profile of this frame block. The 50A$_{DC}$ fuse is dictated by the minimum fuse required on the size6 drive, and the 80A$_{DC}$ fuse is dictated by the maximum rated fuse for the size3 drive, according to *Appendix – Drive Rating Information*, size3 & size7. Pick the higher rated fuse if multiple drives will be motoring at the same time… so 80A$_{DC}$ in this example.

The last thing to check is whether or not the converter needs its own supplemental DC fuses when sourcing to the parent bus; Add up the supplemental fuse current ratings on all inverter frame blocks:

Current ratings:

- Frame block #2 – 100A$_{DC}$
- Frame block #3 – 80A$_{DC}$
- Total inverter frame block ampacity is 180A$_{DC}$ (100A$_{DC}$ + 80A$_{DC}$), which exceeds the 125A$_{DC}$ rating for a size7 drive connecting to a parent DC bus. Therefore the converter needs a 125A$_{DC}$ supplemental fuse (i.e. use the drive's maximum supplemental fuse rating).

The frame 7 is UL approved as a converter for a common DC bus system as in frame block #1 above but it is not UL approved as an inverter in a common DC bus system as in frame block #2 above. See the UL Information section for more information.

UL Information

General

This section gives information on UL approval of drives for group installation in common DC bus drive systems.

The UL file number is E171230.

Converters and Inverters

The models listed below may be used as Converters:

Mentor MP Range:

MP followed by 25A, 45A, 75A, 105A, 155A or 210A, followed by either 4 or 5.

Unidrive-M range:

Frame Size 7:

M700-072 00610A, M700-072 00750A, M700-072 00830A
M700-074 00660A, M700-074 00770A, M700-074 01000A

Frame Size 8:

M700-082 01160A, M700-082 01320A
M700-084 01340A, M700-084 01570A

Frame Sizes 10 Rectifiers:

RECT-10204100A
RECT-10404520A
Note: The above rectifiers cannot be used as standalone rectifiers and must by connected to one of the following inverters to form a 'converter' drive.
M700-092 01760D, M700-092 02190D, M700-102 02830D, M700-102 03000D
M700-094 02000D, M700-094 02240D, M700-104 02700D, M700-104 03200D

The models listed below may be used as Converters or Inverters:

Unidrive-M range:

Frame Size 3:

M700-032 00050A, M700-032 00066A, M700-032 00080A, M700-032 00106A
M700-034 00025A, M700-034 00031A, M700-034 00045A, M700-034 00062A
M700-034 00078A, M700-034 00100A.

Frame Size 4:

M700-042 00137A, M700-042 00158A
M700-044 00150A, M700-044 00172A

Frame Size 5:

M700-052 00250A
M700-054 00270A, M700-054 00300A

Frame Size 6:

M700-062 00330A, M700-062 00440A
M700-064 00350A, M700-064 00420A, M700-064 00470A

Note: Unidrive M models numbers beginning with M400, M600, M701, M702, M800, M810, CSD100, H300, F300 and E300 are also UL approved.

Common DC Bus Drive System with Individually Fused Inverters

Figures 2, 3a and 3b are overall views of a common DC bus drive system with individually fused inverters.

The converter is permitted to be any model listed in this section for use in common DC bus drive systems.

The inverters are permitted to be any combination of models from the Unidrive M range listed in this section for use in common DC bus drive systems.

The AC branch circuit wiring is protected by listed fuses that are field installed on the line side of the converter.

The branch fuse protection shall be provided as per the NEC and as listed in the user guide for the converter.

The DC bus wiring is protected against burnout and damage to insulation by means of supplemental fuses that are field installed in the common DC bus supply lines to each Inverter.

The supplemental fuses shall be as specified in the supplemental fuse selection tables in *Appendix - Supplemental Fuse List*.

Common DC Bus Drive System with AC fusing

Figures 5a and 5b are overall views of a common DC bus drive system with AC fusing.

The converter is permitted to be any model from the Unidrive M range listed in this section for use in common DC bus drive systems, with frame size 3, 4, 5 or 6.

The inverters are permitted to be any combination of models from the Unidrive M range listed in this section for use in common DC bus drive systems, with frame sizes 3, 4, 5 and 6.

The AC branch circuit wiring is protected by listed fuses that are field installed on the line side of the converter.

The DC bus wiring is protected against burnout and damage to insulation by the branch circuit protection.

Branch Circuit Protection

The branch circuit protection for common DC bus drive systems with AC fusing shall be as per the branch fuse selection table in *Appendix - Branch Fuse Selection*.

The permitted fuse types are as follows:

Any R/C JDDZ Class J or CC.

R/C JDDZ – HSJ series by Mersen (E2137) where indicated in the branch fuse selection table in *Appendix - Branch Fuse Selection*.

Common DC Bus Drive System with Separately Fused Inverter sections

It is advantageous to group individual Inverters together into inverter sections, with each inverter section protected by a single pair of supplemental DC fuses. See Figures 6a, 6b and 6c.

The inverters in each section may have different frame sizes in the range frame size 3 to 6.

The converter is permitted to be any model from the Unidrive M range listed in this section for use in common DC bus drive systems.

The inverters are permitted to be any combination of models from the Unidrive M range listed in this section for use in common DC bus drive systems, with frame size 3, 4, 5 or 6.

The AC branch circuit wiring is protected by listed fuses that are field installed on the line side of the converter.

The branch fuse protection shall be provided as per the NEC and the user guide for the converter.

The DC bus wiring to each inverter section is protected against burnout and damage to insulation by a pair of supplemental DC fuses installed in the common DC bus supply lines to each inverter section.

The supplemental fuses shall be as specified in the supplemental DC fuse selection tables in *Appendix - Supplemental Fuse List*.

Supplemental DC Fuse Selection Guidelines

The current rating of the supplemental DC fuses must be sufficient to carry the maximum continuous current drawn by the inverter section.

The current rating of the supplemental DC fuses may additionally need to be sufficient to carry the maximum overload current drawn by the inverter section.

In practice, each inverter and motor has its own specific load profile. The sum of the load profiles determines the minimum fuse current rating of the fuses. If the load profile is not known, then the current rating of the fuses needs to be greater than the sum of the maximum continuous currents drawn by each inverter.

The supplemental DC fuse maximum current rating and maximum i^2t rating limits are chosen so that that fuses safely protect the smallest inverter in the inverter section. The current rating and i^2t rating of the fuses must not exceed the limit in the table for the smallest Inverter.

There is a need to limit the potential i^2t that can flow from the DC bus capacitance into a fault in the smallest inverter in the Inverter Section. This limits the maximum DC bus capacitance of the inverter section.

The DC bus capacitance of the inverter section is calculated by adding together the capacitances of the individual Inverters.

The DC bus capacitance must not exceed the limit in the tables for the smallest Inverter.

Appendix 1

Paralleling Bus Bar Data

Table 1 Paralleling Bus Bar Data

Unidrive M	Max DC current through bus bar (A)	Bus bar kit Order code
Size 3	81	3470-0048
Size 4	102	3470-0061
Size 5	120	3470-0068
Size 6	128	3470-0063
Size 6 to Size 5/4/3 Adaptor	128	3470-0111

NOTE: Frame sizes 7-11 cannot be connected together via unfused bus bars; supplemental DC fuses and user supplied cables are required.

When using the Size 6 to Size 5/4/3 Adaptor Bus Bar kit, the smaller drives must be located on the left hand side of the size 6 drive.

Branch Fuse Selection

This table is used when selecting the AC mains fuse for a Unidrive M converter. From the table below: Pick the size of the converter from the left side of the table, and then follow the row over to the right until you find the column with the smallest frame size used within your frame block.

Table 2 Branch Fuse Selection

		Smallest rated drive within frame block			
		Size 3	**Size 4**	**Size 5**	**Size 6**
Size of converter	**Size 3**	LPJ / gG – 25A	-	-	-
	Size 4	HSJ / gR – 30A	LPJ / gG – 30A	-	-
	Size 5	HSJ / gR – 40A	HSJ / gR – 40A	LPJ / gG – 40A	-
	Size 6	HSJ / gR – 60A	HSJ / gR – 60A	HSJ / gR – 60A	LPJ / gG – 60A

NOTE: If frame sizes 7-11 are to be used as a converter, then refer to the drive's user guide for the required branch protection.

Drive Rating Information

Table 3 Unidrive-M size 3

<table>
<tr><th>Model</th><th>Drive Voltage</th><th>Maximum continuous input current</th><th>Maximum overload input current (10s)</th><th>$700V_{DC}$ supplemental fuse (minimum rating)</th><th>$700V_{DC}$ supplemental fuse (maximum rating)</th><th>Maximum fuse clearing i^2t allowed</th><th>Maximum allowable utility prospective fault current</th><th>Individual drive capacitance</th><th>Maximum frame block capacitance</th></tr>
<tr><td>Mxxx-032 00050</td><td rowspan="4">200/
240 V_{AC}</td><td>11.0 A_{DC}</td><td>16.7 A_{DC}</td><td>12 A_{DC}</td><td rowspan="10">80 A_{DC}</td><td rowspan="10">6.6 A^2s</td><td rowspan="10">100 kA</td><td rowspan="4">1560 µF</td><td rowspan="10">3510 µF</td></tr>
<tr><td>Mxxx-032 00066</td><td>13.3 A_{DC}</td><td>22.0 A_{DC}</td><td>15 A_{DC}</td></tr>
<tr><td>Mxxx-032 00080</td><td>18.4 A_{DC}</td><td>26.7 A_{DC}</td><td>20 A_{DC}</td></tr>
<tr><td>Mxxx-032 00106</td><td>21.2 A_{DC}</td><td>35.4 A_{DC}</td><td>25 A_{DC}</td></tr>
<tr><td>Mxxx-034 00025</td><td rowspan="6">380/
480 V_{AC}</td><td>5.7 A_{DC}</td><td>8.3 A_{DC}</td><td>6 A_{DC}</td><td rowspan="3">220 µF</td></tr>
<tr><td>Mxxx-034 00031</td><td>7.5 A_{DC}</td><td>10.3 A_{DC}</td><td>8 A_{DC}</td></tr>
<tr><td>Mxxx-034 00045</td><td>10.3 A_{DC}</td><td>15.0 A_{DC}</td><td>12 A_{DC}</td></tr>
<tr><td>Mxxx-034 00062</td><td>14.0 A_{DC}</td><td>22.6 A_{DC}</td><td>15 A_{DC}</td><td rowspan="3">390 µF</td></tr>
<tr><td>Mxxx-034 00078</td><td>14.5 A_{DC}</td><td>21.8 A_{DC}</td><td>15 A_{DC}</td></tr>
<tr><td>Mxxx-034 00100</td><td>17.2 A_{DC}</td><td>27.9 A_{DC}</td><td>20 A_{DC}</td></tr>
</table>

Table 4 Unidrive-M size 4

<table>
<tr><th>Model</th><th>Drive Voltage</th><th>Maximum continuous input current</th><th>Maximum overload input current (10s)</th><th>$700V_{DC}$ supplemental fuse (minimum rating)</th><th>$700V_{DC}$ supplemental fuse (maximum rating)</th><th>Maximum fuse clearing i^2t allowed</th><th>Maximum allowable utility prospective fault current</th><th>Individual drive capacitance</th><th>Maximum frame block capacitance</th></tr>
<tr><td>Mxxx-042 00137</td><td rowspan="2">200/
240 V_{AC}</td><td>21.2 A_{DC}</td><td>32.2 A_{DC}</td><td>25 A_{DC}</td><td rowspan="4">100 A_{DC}</td><td rowspan="4">12.5 A^2s</td><td rowspan="4">100 kA</td><td rowspan="2">1760 µF</td><td rowspan="4">4140 µF</td></tr>
<tr><td>Mxxx-042 00185</td><td>29.4 A_{DC}</td><td>43.5 A_{DC}</td><td>30 A_{DC}</td></tr>
<tr><td>Mxxx-044 00150</td><td rowspan="2">380/
480 V_{AC}</td><td>21.1 A_{DC}</td><td>34.1 A_{DC}</td><td>25 A_{DC}</td><td rowspan="2">660 µF</td></tr>
<tr><td>Mxxx-044 00172</td><td>27.3 A_{DC}</td><td>39.1 A_{DC}</td><td>30 A_{DC}</td></tr>
</table>

Table 5 Unidrive-M size 5

Model	Drive Voltage	Maximum continuous input current	Maximum overload input current (10s)	$700V_{DC}$ supplemental fuse (minimum rating)	$700V_{DC}$ supplemental fuse (maximum rating)	Maximum fuse clearing i^2t allowed	Maximum allowable utility prospective fault current	Individual drive capacitance	Maximum frame block capacitance
Mxxx-052 00250	200/ 240 V_{AC}	32.6 A_{DC}	54.3 A_{DC}	40 A_{DC}	125 A_{DC}	12.5 A^2s	100 kA	1560 µF	4680 µF
Mxxx-054 00270	380/ 480 V_{AC}	32.8 A_{DC}	59.1 A_{DC}	40 A_{DC}				780 µF	
Mxxx-054 00300		33.9 A_{DC}	65.7 A_{DC}	40 A_{DC}					

Table 6 Unidrive-M size 6

Model	Drive Voltage	Maximum continuous input current	Maximum overload input current (10s)	$700V_{DC}$ supplemental fuse (minimum rating)	$700V_{DC}$ supplemental fuse (maximum rating)	Maximum fuse clearing i^2t allowed	Maximum allowable utility prospective fault current	Individual drive capacitance	Maximum frame block capacitance
Mxxx-062 00330	200/ 240 V_{AC}	53.1 A_{DC}	70.1 A_{DC}	60 A_{DC}	160 A_{DC}	25.0 A^2s	100 kA	3000 µF	7500 µF
Mxxx-062 00440		61.6 A_{DC}	93.4 A_{DC}	63 A_{DC}					
Mxxx-064 00350	380/ 480 V_{AC}	40.5 A_{DC}	74.6 A_{DC}	50 A_{DC}				1500 µF	
Mxxx-064 00420		51.2 A_{DC}	89.5 A_{DC}	60 A_{DC}					
Mxxx-064 00470		73.8 A_{DC}	120.0 A_{DC}	80 A_{DC}					

Table 7 Unidrive-M size 7

Model	Drive Voltage	Maximum continuous input current	Maximum overload input current (10s)	$700V_{DC}$ supplemental fuse (minimum rating)	$700V_{DC}$ supplemental fuse (maximum rating)	Maximum fuse clearing i^2t allowed	Maximum allowable utility prospective fault current	Individual drive capacitance
Mxxx-072 00610	200/ 240 V_{AC}	73.8 A_{DC}	120.0 A_{DC}	80 A_{DC}	125 A_{DC}	12.5 A^2s	100 kA	4680 µF
Mxxx-072 00750		92.4 A_{DC}	147.5 A_{DC}	100 A_{DC}				
Mxxx-072 00830		115.1 A_{DC}	163.3 A_{DC}	125 A_{DC}				
Mxxx-074 00660	380/ 480 V_{AC}	92.4 A_{DC}	147.5 A_{DC}	100 A_{DC}				2340 µF
Mxxx-074 00770		92.4 A_{DC}	147.5 A_{DC}	100 A_{DC}				
Mxxx-074 01000		118.4 A_{DC}	211.5 A_{DC}	125 A_{DC}				

Drive Rating Information (continued)

Table 8 Unidrive-M size 8

Model	Drive Voltage	Maximum continuous input current	Maximum overload input current (10s)	$700V_{DC}$ supplemental fuse (minimum rating)	$700V_{DC}$ supplemental fuse (maximum rating)	Maximum fuse clearing i^2t allowed	Maximum allowable utility prospective fault current	Individual drive capacitance
Mxxx-082 01160	200/ 240 V_{AC}	153.4 A_{DC}	238.9 A_{DC}	160 A_{DC}	200 A_{DC}	44.0 A^2s	100 kA	7020 µF
Mxxx-082 01320		185.3 A_{DC}	271.8 A_{DC}	200 A_{DC}				
Mxxx-084 01340	380/ 480 V_{AC}	171.6 A_{DC}	296.8 A_{DC}	175 A_{DC}				3510 µF
Mxxx-084 01570		199.2 A_{DC}	340.0 A_{DC}	200 A_{DC}				

Table 9 Unidrive-M size 9A

Model	Drive Voltage	Maximum continuous input current	Maximum overload input current (10s)	$700V_{DC}$ supplemental fuse (minimum rating)	$700V_{DC}$ supplemental fuse (maximum rating)	Maximum fuse clearing i^2t allowed	Maximum allowable utility prospective fault current	Individual drive capacitance
Mxxx-092 01760	200/ 240 V_{AC}	211.8 A_{DC}	345.2 A_{DC}	250 A_{DC}	315 A_{DC}	142 A^2s	100 kA	9360 µF
Mxxx-092 02190		280.4 A_{DC}	461.7 A_{DC}	315 A_{DC}				
Mxxx-094 02000	380/ 480 V_{AC}	249.4 A_{DC}	451.3 A_{DC}	250 A_{DC}				4680 µF
Mxxx-094 02240		291.9 A_{DC}	491.7 A_{DC}	315 A_{DC}				5460 µF

Drive Rating Information (continued)

Table 10 Unidrive-M size 9D

Model	Drive Voltage	Maximum continuous input current	Maximum overload input current (10s)	700V_{DC} supplemental fuse (minimum rating)	700V_{DC} supplemental fuse (maximum rating)	Maximum fuse clearing i^2t allowed	Maximum allowable utility prospective fault current	Individual drive capacitance
Mxxx-092 01760	200/ 240 V_{AC}	221.5 A_{DC}	360.9 A_{DC}	225 A_{DC}	500 A_{DC}	460 A^2s	100 kA	9360 µF
Mxxx-092 02190		287.7 A_{DC}	473.8 A_{DC}	300 A_{DC}				
Mxxx-094 02000	380/ 480 V_{AC}	260.6 A_{DC}	471.7 A_{DC}	300 A_{DC}				5460 µF
Mxxx-094 02240		301.6 A_{DC}	508.0 A_{DC}	315 A_{DC}				

Table 11 Unidrive-M size 10D

Model	Drive Voltage	Maximum continuous input current	Maximum overload input current (10s)	700V_{DC} supplemental fuse (minimum rating)	700V_{DC} supplemental fuse (maximum rating)	Maximum fuse clearing i^2t allowed	Maximum allowable utility prospective fault current	Individual drive capacitance
Mxxx-102 02830	200/ 240 V_{AC}	388.7 A_{DC}	677.0 A_{DC}	400 A_{DC}	500 A_{DC}	460 A^2s	100 kA	14040 µF
Mxxx-102 03000		430.6 A_{DC}	717.7 A_{DC}	450 A_{DC}				
Mxxx-104 02700	380/ 480 V_{AC}	404.4 A_{DC}	682.5 A_{DC}	450 A_{DC}				7020 µF
Mxxx-104 03200		456.2 A_{DC}	808.8 A_{DC}	500 A_{DC}				

Table 12 Unidrive-M size 11D

Model	Drive Voltage	Maximum continuous input current	Maximum overload input current (10s)	700V_{DC} supplemental fuse (minimum rating)	700V_{DC} supplemental fuse (maximum rating)	Maximum fuse clearing i^2t allowed	Maximum allowable utility prospective fault current	Individual drive capacitance
Mxxx-114 03770	380/ 480 V_{AC}	534.5 A_{DC}	922.3 A_{DC}	550 A_{DC}	800 A_{DC}	1330 A^2s	100 kA	8970 µF
Mxxx-114 04170		595.7 A_{DC}	1020.1 A_{DC}	600 A_{DC}				
Mxxx-114 04800		701.0 A_{DC}	1150.3 A_{DC}	800 A_{DC}				10920 µF

Supplemental Fuse List

Table 13 Supplemental Fuse List

Fuse rating	Max clearing i^2t allowed for Amperage	Mersen A70QS (14x52)/(22x58)	Mersen FR14/FR22 (14x52)/(22x58)	Mersen A070 URD	SIBA URDC (NH000)	SIBA URZ (14x51)	Bussmann FWP (14x51)/(22x58)	Bussmann FWP	Littlefuse LA70QSF (14x51)/(22x58)	Littlefuse LA70QSF (stud tabs)
6 A_{DC}	0.019 A^2s	A70QS6-14F	FR14GC69V6	-	-	50 118 06.6	-	-	-	-
8 A_{DC}	0.030 A^2s	A70QS8-14F	FR14GC69V8	-	-	50 118 06.8	-	-	-	-
10 A_{DC}	0.067 A^2s	-	-	-	-	-		-		
12 A_{DC}	0.120 A^2s	A70QS12-14F	FR14GC69V12	-	-	50 118 06.12, 50 201 06.12	-	-	LA70QS12-14F	-
15 A_{DC}	0.190 A^2s	A70QS15-22F	-	-	-	-	FWP-15A14F	-	-	-
16 A_{DC}	0.190 A^2s	A70QS16-14F	FR14GC69V16	-	-	50 118 06.16, 50 201 06.16	-	-	LA70QS16-14F	-
20 A_{DC}	0.360 A^2s	A70QS20-14F, A70QS20-22F	FR14GC69V20, FR22GC69V20	-	-	50 118 06.20, 50 201 06.20	FWP-20A14F, FWP-20A22F	-	LA70QS20-14F, LA70QS20-22F	LA70QS20-4
25 A_{DC}	0.480 A^2s	A70QS25-14F, A70QS25-22F	FR14GC69V25, FR22GC69V25	-	-	50 118 06.25, 50 201 06.25	FWP-25A14F, FWP-25A22F	-	LA70QS25-14F, LA70QS25-22F	LA70QS25-4
30 A_{DC}	1.50 A^2s	-	-	-	-	-	FWP-30A14F	-	-	-
32 A_{DC}	1.50 A^2s	A70QS32-14F, A70QS32-22F	FR14GC69V32, FR22GC69V32	-	-	50 201 06.32	FWP-32A14F, FWP-32A22F	-	LA70QS32-14F, LA70QS32-22F	-
35A_{DC}	1.50 A^2s	-	-	-	20 292 20.35	-	-	-	-	LA70QS35-4
40 A_{DC}	1.50 A^2s	A70QS40-14F, A70QS40-22F	FR14GC69V40, FR22GC69V40	-	-	50 201 06.40	FWP-40A14F, FWP-40A22F	-	LA70QS40-14F, LA70QS40-22F	LA70QS40-4
50 A_{DC}	3.08 A^2s	A70QS50-22F	FR14GC69V50, FR22GC69V50	-	20 292 20.50	50 201 06.50	FWP-50A14F, FWP-50A22F	-	LA70QS50-14F, LA70QS50-22F	LA70QS50-4
60 A_{DC}	3.08 A^2s	-	-	-	-	-	-	-	LA70QS60-22F	-
63 A_{DC}	3.08 A^2s	A70QS63-22F	FR22GC69V63	A070URD30**0063	20 292 20.63	-	FWP-63A22F	-	LA70QS63-22F	-
70 A_{DC}	6.60 A^2s	-	-	-	-		-	-	LA70QS70-22F	-
80 A_{DC}	6.60 A^2s	A70QS80-22F	FR22GC69V80	A070URD30**0080	20 292 20.80	-	FWP-80A22F	-	LA70QS80-22F	LA70QS80-4
90 A_{DC}	6.60 A^2s	-	-	-	-	-	-	-	-	-
100A_{DC}	12.5 A^2s	A70QS100-22F	-	A070URD30**0100	20 292 20.100	-	FWP-100A22F	FWP-100A	LA70QS100-22F	LA70QS100-4
125A_{DC}	12.5 A^2s	-	-	A070URD30**0125	20 292 20.125	-	-	FWP-125A	-	LA70QS125-4
150 A_{DC}	11.7 A^2s	-	-	-	-	-	-	-	-	-
160 A_{DC}	16.7 A^2s	-	-	A070URD30**0160	20 292 20.160	-	-	-	-	-
175 A_{DC}	16.7 A^2s	-	-	-	-	-	-	FWP-175A	-	LA70QS175-4

Note: All of the fuses listed in this section are rated at 700V_{DC}.

Supplemental Fuse List (continued)

Table 14 Supplemental Fuse List (continued)

Fuse rating	Max clearing i^2t allowed for Amperage	Mersen A70QS (14x52)/(22x58)	Mersen FR14/FR22 (14x52)/(22x58)	Mersen A070 URD (square body)	SIBA URDC (NH000)	SIBA URZ (14x51)	Bussmann FWP (14x51)/(22x58)	Bussmann FWP (stud tabs)	Littlefuse LA70QSF (14x51)/(22x58)	Littlefuse LA70QSF (stud tabs)
200A_{DC}	22.0 A^2s	-	-	A070URD30**0200, A070URD31**0200	20 292 20.200	-	-	FWP-200A	-	LA70QS200-4
225 A_{DC}	31.3 A^2s	-	-	-	-	-	-	FWP-225A	-	-
250 A_{DC}	42.5 A^2s	-	-	A070URD30**0250, A070URD31**0250	20 292 20.250	-	-	-	-	LA70QS250-4
300 A_{DC}	71.2 A^2s	-	-	-	-	-	-	FWP-300A	-	LA70QS300-4
315 A_{DC}	67.0 A^2s	-	-	A070URD30**0315, A070URD31**0315	20 292 20.315	-	-	-	-	-
350 A_{DC}	95.6 A^2s	-	-	-	-	-	-	FWP-350A	-	LA70QS350-4
400A_{DC}	130 A^2s	-	-	A070URD30**0400, A070URD31**0400, A070URD32**0400	-	-	-	FWP-400A	-	LA70QS400-4
450A_{DC}	165 A^2s	-	-	A070URD30**0450, A070URD31**0450, A070URD32**0450	-	-	-	FWP-450A	-	LA70QS450-4
500A_{DC}	264 A^2s	-	-	A070URD30**0500, A070URD31**0500, A070URD32**0500, A070URD33**0500	-	-	-	FWP-500A	-	LA70QS500-4
550 A_{DC}	332 A^2s	-	-	A070URD30**0550, A070URD31**0550, A070URD32**0550, A070URD33**0550	-		-		-	LA70QS550-4
600 A_{DC}	332 A^2s	-	-	-	-	-	-	FWP-600A	-	LA70QS600-4
630 A_{DC}	433 A^2s			A070URD31**0630, A070URD32**0630, A070URD33**0630	-	-	-	-	-	-
700 A_{DC}	530 A^2s	-	-	-	-	-	-	-	-	-
800 A_{DC}	880 A^2s	-	-	A070URD31**0800, A070URD32**0800, A070URD33**0800	-	-	-	FWP-800A	-	LA70QS800-4

Note: All of the fuses listed in this section are rated at 700V_{DC}

Parallel DC Bus Braking Resistance & Power Ratings

Notes:

1. Resistor initial tolerance ± 10%
2. Power ratings are at minimum initial tolerance

Table 15 Parallel DC Bus Braking Resistance and Power Rating - 200V

Unidrive M model	Minimum nominal resistance [1] (Ω)	Instantaneous power rating [2] (kW)	Average power for 60s [2] (kW)
03200050	22	7.7	1.7
03200066			2.2
03200080			3.1
03200106			4.2
04200137	18	9.4	5.1
04200185			7.4
05200250	19	8.9	8.9
06200330	10	16.9	13.9
06200440			16.9
07200610	4.5	37.6	24.8
07200750			30.6
07200830			36.3
08201160	2.3	73.5	49.2
08201320			60.1
09201760	1.4	120.8	75.4
09202190			90.1
10202930	1.7	99.5	99.5
10203000			99.5

Table 16 DC Bus Braking Resistance and Power Rating - 400V

Unidrive M model	Minimum nominal resistance [1] (Ω)	Instantaneous power rating [2] (kW)	Average power for 60s [2] (kW)
03400025	74	9.2	1.7
03400031			2.3
03400045			3.1
03400062			5.1
03400078	50	13.6	6.4
03400100			7.3
04400150	37	18.3	12.5
04400172			13.9
05400270	40	16.9	16.9
05400300	22	30.8	29.4
06400350	20	33.8	32.3
06400420			33.8
06400470			33.8
07400660	7.5	90.2	59.7
07400770			75.8
07401000			90.1
08401340	6.3	107.4	107.4
08401570			107.4
09402000	2.6	260	175
09402240			176.7
10402700	3.1	218.1	218.1
10403200			218.1

Drive Mounting Hole and Footprint Information

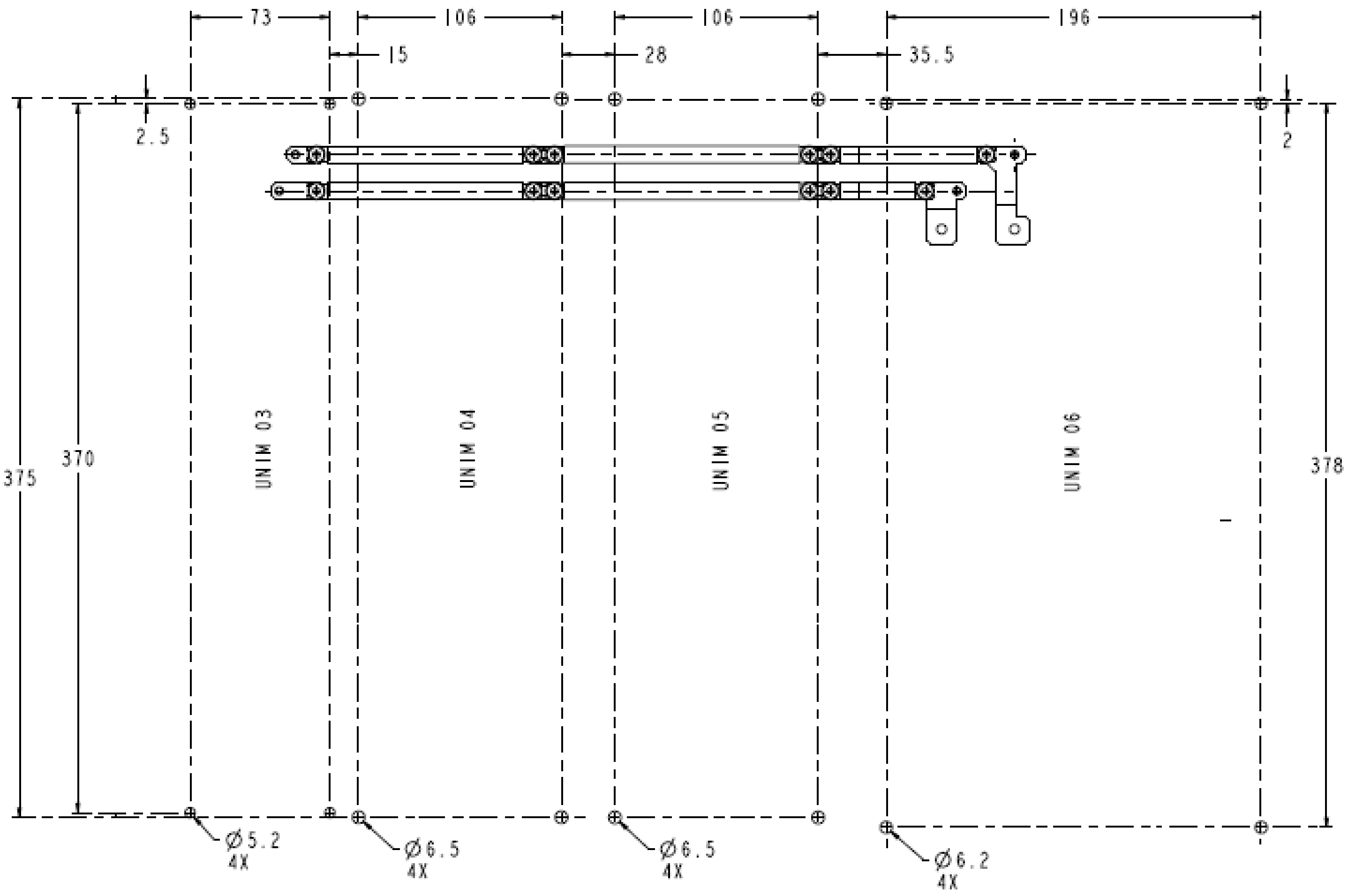

Figure 14 Drive Mounting Holes and Footprints

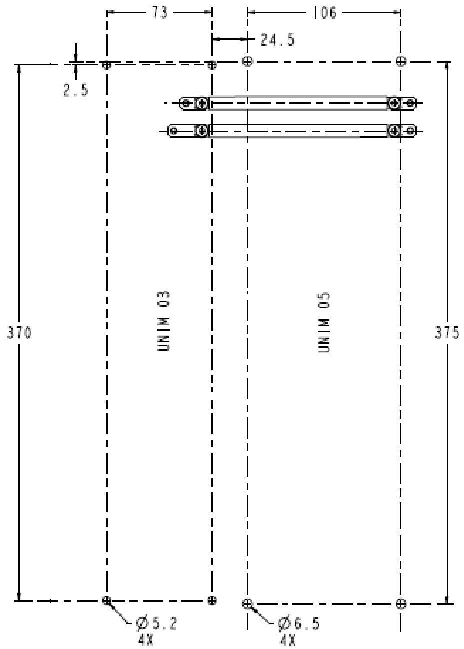

Figure 15 Footprint of Unidrive M frame size 03 and 05

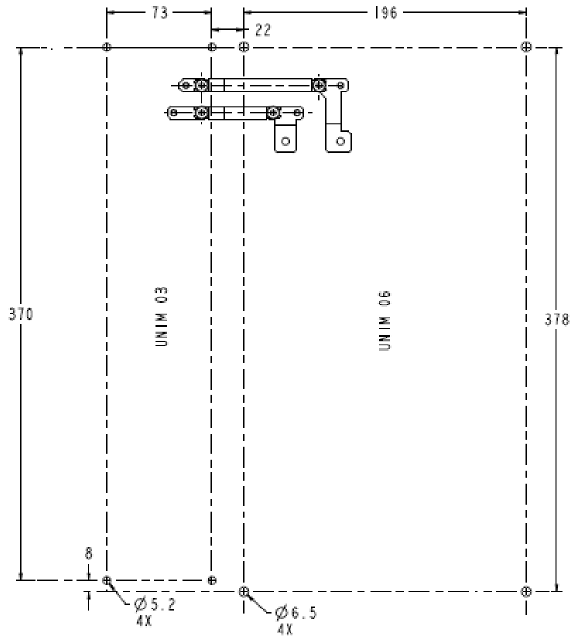

Figure 16 Footprint of Unidrive M size 03 and 06

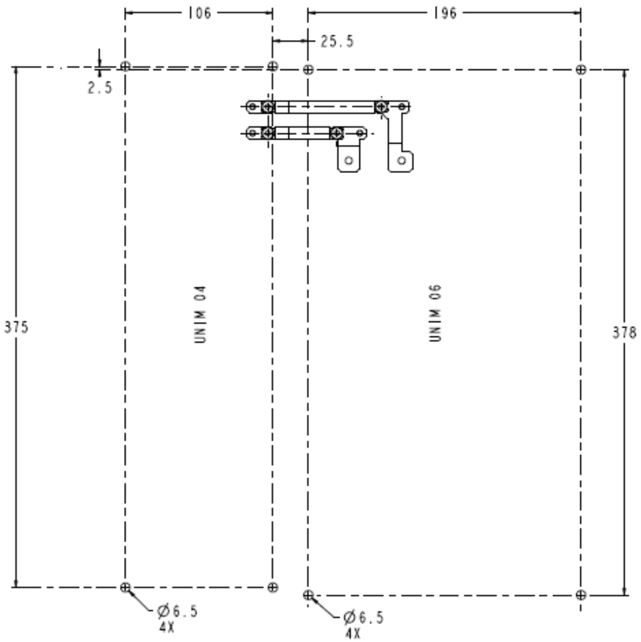

Figure 17 Footprint of Unidrive M frame size 04 and 06

Note: Bus bars shown for clarity

Glossary

AC Fuse (See *Branch Fuse*)

Block (See *Frame Block*)

Branch Fuse The set of fuses that connects each converter, and therefore the “common bus” system of drives, to the utility supply. (See *Converter*)

Converter Refers to the electronic device that is creating DC energy from an AC source. (See *Parent Bus*)

DC Fuse (See *Supplemental Fuse*)

Frame block Refers to a number of drives that share their DC energy directly without supplemental DC fuses between these drives. (See *Fused; Local Bus; Mixed; Unfused; Unmixed*)

Fuse (See Branch Fuse; Supplemental Fuse)

Fused Refers to individual drives, or even frame blocks, sharing their DC energy through supplemental DC fuses. (See *Supplemental Fuse*)

Inverter Refers to the drive that is controlling a motor.

Local Bus Refers to the bus that is created when connecting drives directly together without supplemental DC fuses between these drives. (See *Frame Block*)

Mixed Refers to drives of different frame sizes. (See *Frame Block*)

Parent Bus Refers to the bus that originates from the DC current/power source, and feeds all other drives via supplemental fuses. (See *Converter; Supplemental Fuses*)

Supplemental Fuse Pairs of DC fuses that are used to protect the “common bus” system by limiting the amount of energy that can flow between drives. (See Inverter)

Unfused Refers to drives sharing their DC energy directly, using bus bars or cables, without the use/requirement of supplemental DC fuses. (See *Frame Block*)

Unmixed Refers to drives within the same frame size that may or may not contain drives with different current/power ratings. (See *Frame Block*)