

# Auto-Hedger Algo

*For the Exegy Metro trading platform*

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## Overview

The Axonetric LLC Auto-Hedger is an automated delta hedging algo that supports both passive and aggressive execution across a wide variety of operational configurations. Both per-trade options hedging and/or portfolio delta hedging are supported. By working futures orders, the algo improves hedge execution prices and also allows the opportunity for potentially offsetting deltas to cancel out portions of pending hedges, additionally reducing hedging transaction costs. The Auto-Hedger accumulates partial fill deltas in an intelligent manner to prevent over- or under-hedging and also tracks remainder deltas resulting from delta rounding. The user can specify any manner of options expiration to futures expiration mappings for full flexibility. Specifications are conveniently organized and edited through a grid graphical control. Futures hedges can also be initiated manually, and will follow the same passive (working) logic.

## Per-Trade Delta Hedging Logic

The algo dynamically selects between passive and aggressive futures execution based on the following comprehensive logic flow (for per-trade options hedging or manually initiated hedges). To designate that any specific options or options strategy click trade in Metro should not be hedged (that would otherwise be eligible), the user can simply uncheck the "Autohedge" checkbox in the Metro order ticket. By default, any admin-entered trades (aka, "manual trades") in Metro are not hedged by default.

1. The amount of futures delta required is calculated from the delta of the options or options strategy trade. If any existing remainder delta already exists (from prior recent algo hedges), it will be used to either partially or completely offset the incoming options delta.
2. Assuming the options trade delta was not completely offset at step (1), it will be compared to the "*Delta Trigger*" value for the corresponding hedge future. This value represents the threshold at which the user considers the outstanding delta to be significant enough to initiate futures hedging.
3. Assuming the options trade delta  $\geq$  the "*Delta Trigger*" value from step (2), the algo will now compare the # of currently working futures hedges to the # of newly needed futures hedges. If an existing working futures hedge order can be either partially or completely offset, that will happen automatically. Assuming some # of futures needed remains, the algo will then compare the new working futures order's size to the "*Max Working Qty*" value.
  - a. Any futures hedging size  $>$  "*Max Working Qty*" will be processed immediately for aggressive hedging. Any remaining futures hedging size  $\leq$  "*Max Working Qty*" will proceed with passive execution at step (4).
4. The passive execution loop runs indefinitely until either the futures order is fully filled, completely offset by new incoming options deltas, or reaches a terminal order state according to the logic below.
  - a. The top-of-book futures spread is tracked and the top-of-book size ratio is computed as (size on the side needed / sum of size on both sides). If this computed ratio is less than the defined "*Min Qty Ratio*" value, then the algo will attempt to aggressively execute at step (5).
  - b. If the size on the side of the spread needed becomes  $<$  "*Min Qty Value*", then the algo will attempt to aggressively execute at step (5).
  - c. If the "*Req. Whole Working Qty*" checkbox is checked, and the size on the side of the spread needed becomes  $<$  the current working futures order size, then the algo will attempt to aggressively execute at step (5).
5. An internal counter tracks the number of times this step (5) has been reached. If this internal counter value is  $>$  "*Working Slippage (ticks)*" value (which is a 0+ value), then the hedge order will be processed for a final action (terminal state) by step (6). If the internal counter value is  $\leq$  "*Working Slippage (ticks)*" value, then the algo will make a non-terminal attempt at aggressive execution, due to a

- violation of (4.a), (4.b), or (4.c), by modifying the current working futures order to the current top-of-book price which is expected to result in a fill.
- a. If the futures order fills successfully, this logic is complete (exited). Any excess delta from the futures hedge order is remembered as a "remainder delta".
  - b. If the futures order fails to be filled (for example, because the spread up-ticks or down-ticks while the order price modify is being processed, or while the message is being sent to the exchange, then it is considered a "working slippage" event and passive execution logic continues at the new price spread at step (4).
6. At this stage, passive execution is no longer allowed, and final (terminal) processing of the order will proceed as follows:
- a. If the Configure screen setting "*afterExceedingWorkingSlippage*" value is "Let order sit", then the order will remain open at its last price assigned in step (5) and the algo will no longer manage it. Either the market will move back into this order for a fill, or the user will have to manually handle the execution of this order that will be viewable sitting in the futures ladder. This possibility will require the user's attention from time to time.
  - b. If the Configure screen setting "*afterExceedingWorkingSlippage*" value is "Execute aggressively", then the order will be automatically processed for final aggressive execution.
    - i. If the "*Exec. Order Type*" value is "Market", the existing futures limit order will be canceled and a market order will be sent to the exchange instead, guaranteeing a fill. This logic is then complete (exited). Any excess delta from the futures hedge order is remembered as a "remainder delta".
    - ii. If the "*Exec. Order Type*" value is "Limit", then the user has additional control over the possible fill price of this final aggressive execution order. The existing futures limit order will have its price modified to be FINAL\_LIMIT\_PRICE. If the order is to buy futures, then the FINAL\_LIMIT\_PRICE = top-of-book ask + "*Exec. Padding (ticks)*" increments (a 0+ value). If the order is to sell futures, then the FINAL\_LIMIT\_PRICE = top-of-book bid - "*Exec. Padding (ticks)*" increments (a 0+ value). The exchange will match the order at the best price based on the current spread at the time the exchange's matching engine processes the order.
      1. If the order is filled, then this logic is complete (exited). Any excess delta from the futures hedge order is remembered as a "remainder delta".
      2. If the order is not filled, it will no longer be managed by the algo. Either the market will move back into this order for a fill, or the user will have to manually handle the execution of this order that will be viewable sitting in the

futures ladder. This is a rare possibility may require the user's attention.

The user, at his or her discretion, may chose to cancel a working order from within the Metro futures ladder at any time. If this occurs, the algo will relinquish control of the current hedging in that future and the user will be responsible for hedging those deltas (and any that may be remaining behind it, if `"Max Show Qty"` is being used for hedge iceberging purposes).

Option deltas for a given hedging future are accumulated in a delta accumulation queue. Partial fills of an options order are also accumulated in the delta accumulation queue. Any remainder delta, as referenced in step (1) above, is also stored in the queue. The moving time length of the delta accumulation queue can be controlled by the Configure screen setting `"deltaQueueMemory"`, which accepts a 120-3600 number of seconds. This setting is not allowed to be less than 120 (2 minutes), because that could excessively interfere with the accumulation of deltas from partial fills. Any individual partial fill may have a small delta amount, but added together, the total delta from all the partial fills could become significant enough to hedge. This is why deltas are accumulated in a queue implemented as a moving time window. After the `"deltaQueueMemory"` time length has elapsed, any remaining un-hedged delta components less than the `"Delta Trigger"` value (in total) will be permanently forgotten.

### Portfolio Delta Hedging Logic

The Portfolio delta hedging logic works in a different way, as described here. Note that portfolio hedging can be run simultaneously with "per-trade" hedging, or as a standalone process.

A portfolio hedging mission is added to the "Portfolio Hedging" grid. The user specifies the `"Symbols"` and trade `"Accounts"` which are relevant to the hedging mission. For example, the symbols "LO, LO1, LO2, LO3, LO4, LO5" are valid because they all map to the same underlying symbol (CL). The `"H Into Front"` checkbox specifies whether or not to hedge the portfolio delta into the front futures expiration, or instead into each individual futures expiration corresponding to the expirations where the options deltas exist. Portfolio deltas are scanned every 10 seconds. Three different optional triggers can be enabled to trigger a portfolio delta hedging event. Each optional trigger also accepts a different delta hedging % (which defaults to 100%). Note that, unlike the per-trade hedging logic previously described, portfolio hedging logic always uses market orders (and no working of the futures hedging orders occurs).

If the (optional) `"Delta Trigger"` checkbox is checked, and the  $|\text{portfolio delta}| > \text{"Delta Trigger Val"}$  for the mission, then a portfolio hedging event may occur as long as the

Configure screen setting `"minSecsBetweenPortfolioHedges"` is not in violation (which allows the user to specify a minimum elapsed time period between consecutive `"Delta Trigger"`-initiated hedges, to prevent possible over-hedging). The number of hedging futures bought or sold may depend on the Configure screen setting `"deltaTriggerHedgeBehavior"`, which indicates whether the algo should attempt to fully zero the portfolio delta, or just get back within the `|"Delta Trigger Val"|` range. The optional `"Delta SP"` checkbox allows the user to activate "spread protection" logic before initiating delta-triggered hedges. The spread protection logic guards against certain scenarios that might cause undesirable fill prices, such as an abnormally wide spread, or a spread that has moved too far away from the last traded price.

If the (optional) `"Time Trigger"` checkbox is checked, then the mission will perform hedging of any portfolio deltas at the time specified by the `"Time Trigger Val"` value (e.g. "2:30 PM"). The time-triggered portfolio hedging can also be executed as a time-weighted average price (TWAP) over multiple hedging orders performed on a uniform time interval. For example, if the `"Time Trigger Val"` value was specified as "2:28 PM / 3 / 60", this format would instruct the algo to hedge  $\frac{1}{3}$  of the portfolio delta every 60 seconds, starting at 2:28 PM (over 3 orders total).

Lastly, if the (optional) `"Manual Trigger"` checkbox is checked, then the mission will perform portfolio hedging on demand, at the user's request. As with the other triggers, the hedging % can be specified with the `"Manual Trigger H%"` value.

### **"Auto-Hedger Mappings" Grid**

The "Mappings" grid allows the user to specify the mapping (or "funnel") of various options and/or options expirations to the specific futures contract (expirations) they should be hedged in. Multiple "Mappings" grid rows may point to the same hedging future. Each row in the "Mappings" grid can have the following columns defined:

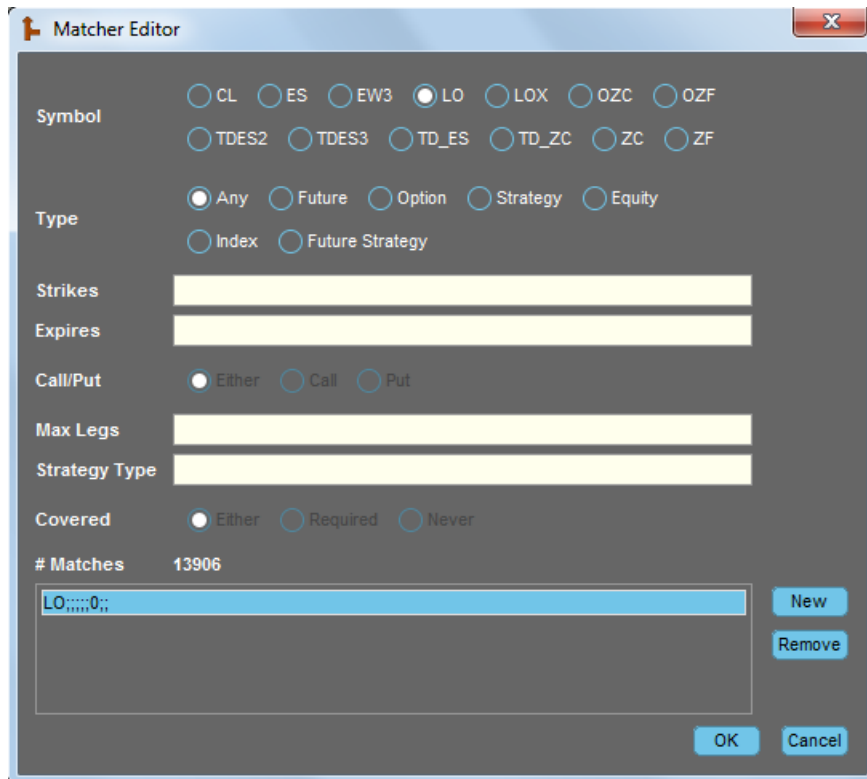
- `"Active"` - this checkbox indicates whether the row's mapping is currently enabled or not.
- `"Label"` - this optional text value allows the user to enter any descriptive text to label or identify the row.
- `"Priority"` - this optional integer value allows the user to specify a 1+ priority for the row. If a traded option or options strategy matches two or more rows, then the row with the lower value will be used (i.e. a Priority 1 value supersedes a Priority 2 value). This allows for "catch-all" type rows and/or more complex configurations.
- `"Instrument"` - when this cell is double-clicked, it opens the Matcher Editor dialog, where the user can specify which options and options strategies the row should match. Typically the "Expires" criterion field is used. Multiple expirations

can be specified with commas, such as "DEC23, JAN24, FEB24". Alternatively, the exact 8-digit YYYYMMDD date of expiration can be specified for any non-monthly options expiration dates (e.g. "20231221"). The "Type" criterion field is usually set to "Any" to allow both outright and options strategies to match.

- **"Symbol"** - this read-only column is not set by the user, but will be populated with the appropriate symbol from the **"Instrument"** field, once the "Apply Changes" button is next clicked.
- **"Expires"** - this read-only column is not set by the user, but will be populated with the appropriate expirations (if any were specified) from the **"Instrument"** field, once the "Apply Changes" button is next clicked.
- **"Strikes"** - this read-only column is not set by the user, but will be populated with the appropriate strikes (if any were specified) from the **"Instrument"** field, once the "Apply Changes" button is next clicked.
- **"Types"** - this read-only column is not set by the user, but will be populated with the appropriate types (if any specific types were specified) from the **"Instrument"** field, once the "Apply Changes" button is next clicked.
- **"Hedge Quotes"** - this checkbox column indicates whether or not this row should auto-hedge for filled quotes.
- **"Hedge Orders"** - this checkbox column indicates whether or not this row should auto-hedge for filled orders.
- **"Hedge Qty %"** - this field accepts an integer 1-100, which represents the percentage of delta to hedge for trades matching this row. The default is 100%.
- **"Hedging Future"** - when this cell is double-clicked, it opens the Matcher Editor dialog, where the user can specify which futures contract the row should hedge into. Typically the "Expires" criterion field is used. The Matcher Editor should display "Number of matches: 1" after the criteria are populated, indicating the user has specified a single, explicit futures contract match. The futures contract specified in this field will link to the associated row in the "Parameter" grid with the same futures contract.
- **"Delete"** - if this checkbox is checked, it will instruct the algo to delete this row from the grid the next time the "Apply Changes" button is clicked. The algo will ensure there is always at least one new empty row available in the grid to add a new row's data into.

The screenshot shows the 'Auto-Hedger Dashboard' window. At the top, there's a title bar with standard window controls and a gear icon. Below that is a tabbed interface with 'Auto-Hedger Mappings' selected. The main area contains a table with the following columns: Active, Label, Priority, Instrument, Symbol, Expires, Strikes, Types, Hedge Quotes, Hedge Orders, Hedge Qty %, Hedging Future, and Delete. The table has four rows of data. At the bottom, there are buttons for 'Discard Changes' and 'Apply Changes', and a navigation bar with tabs for 'Auto-Hedger Mappings', 'Auto-Hedger Parameters', 'Auto-Hedger Manual Order', and 'Portfolio Hedging'.

▲	Active	Label	Priority	Instrument	Symbol	Expires	Strikes	Types	Hedge Quotes	Hedge Orders	Hedge Qty %	Hedging Future	Delete
1	<input type="checkbox"/>	corn dec 2021		OZC;;;DEC21;0;;	OZC	DEC21			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	100		<input type="checkbox"/>
2	<input type="checkbox"/>	EW3		EW3;;;0;;	EW3				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	100	ES,F;;;DEC22;0;;	<input type="checkbox"/>
3	<input type="checkbox"/>	LO		LO;;;0;;	LO				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	100		<input type="checkbox"/>
4	<input type="checkbox"/>								<input type="checkbox"/>	<input type="checkbox"/>	100		<input type="checkbox"/>



### “Auto-Hedger Parameters” Grid

The “Parameters” grid allows the user to specify the specific parameters related to passive and aggressive execution for hedge orders involving the futures contract associated with the row. Note that multiple “Mappings” grid rows may funnel options deltas into a single futures contract and these deltas will all be pooled together in aggregate for hedging purposes and will be worked or hedged (in aggregate) according to the parameters of the row associated with that futures contract. Unlike per-trade hedging, the portfolio hedging does not use this grid (as no hedges are worked when portfolio hedging events are triggered).

Note that editing a “Parameters” grid row is not possible if any “Mappings” grid row is currently “Active” that points to the future associated with that “Parameters” grid row. To edit a “Parameters” grid row, first uncheck the “Active” column checkbox for any “Mappings” grid rows that point to it, then click the “Apply Changes” button. Then the “Parameters” grid row may be edited.

Each row in the “Parameters” grid can have the following columns defined:

- “Hedging Future” - this column (the key column for the row) behaves identically to the “Hedging Future” column from the “Mappings” grid. A single futures

contract must be explicitly matched in the Matcher Editor. All the parameters specified in the remaining columns of this row will be specific to the single futures contract specified here.

- **"Max Working Qty"** - this (optional) integer value allows the user to specify a 1+ maximum number of lots that can be worked in this future at any one time. If not specified, this limit defaults to 1000 internally. Any required hedging lots in excess of this value will be aggressively executed, while the rest may continue to be worked passively. This field allows the user to control the maximum risk associated with an open (working) futures order.
- **"Max Show Qty"** - this optional integer value allows the user to specify a 1+ maximum hedge order size, in order to feed the required total hedging size into the market in a slower, piecemeal fashion over multiple smaller orders (aka, "iceberging"). In some products, this behavior is desirable to prevent the market from knowing the true hedging size needed at any one time and therefore gaming the trader. If this value is left blank (or "0" is entered), then no iceberging will occur and the full hedge size needed will be worked right from the start.
- **"Delta Trigger"** - this integer value allows the user to specify how much accumulated delta (in the delta accumulation queue) is required to initiate the first futures hedge. A value of "50" would indicate that, if one ATM call or put traded, the algo would then round up to the first futures lot (100 delta) and start working the hedge. A value of "200" would indicate that the algo should not begin hedging until at least 2 futures worth of delta had accumulated. Common values here are "50" or "75".
- **"Min Qty Ratio"** - this decimal value specifies the minimum top-of-book size ratio the user is willing to tolerate and still remain in passive (working) mode. The ratio is calculated as (size on the side needed / sum of size on both sides). Values commonly fall between 0.5 (quite conservative) to 0.25 (fairly normal). Values as low as 0.05 (very aggressive / optimistic) could be appropriate in certain markets where spreads don't move very much and new size often arrives to replenish a fading size on either side of the spread. See the "Per-Trade Delta Hedging Logic" section for more details.
- **"Min Qty Value"** - this integer values specifies the minimum top-of-book size (on the side of the spread needed) that the user is willing to tolerate and still remain in passive (working) mode. The appropriate value here depends on the specifics of the futures' market liquidity. See the "Per-Trade Delta Hedging Logic" section for more details.
- **"Req. Whole Working Qty"** - this checkbox, if checked, indicates that the algo will require at least the current working quantity for the top-of-book size (on the side of the spread needed) for the algo to remain in passive (working) mode. This value is usually false (unchecked) for most products, as it can be overly restrictive. See the "Per-Trade Delta Hedging Logic" section for more details.
- **"Working Slippage (ticks)"** - this 0+ integer value defines the maximum number of slippage events allowed while the algo remains in passive (working) mode.



Once this count is exceeded, any unfilled futures hedge order will be processed for a final action (passive mode is no longer allowed). See the "Per-Trade Delta Hedging Logic" section, step (5), for more details.

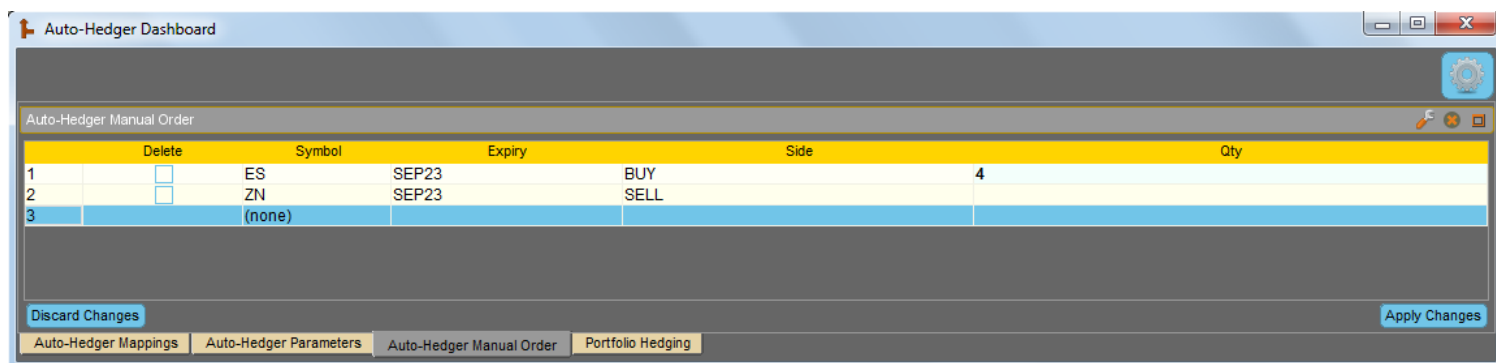
- **"Exec. Order Type"** - this is the order type used for the final aggressive execution stage. Either "Market" or "Limit" may be specified. A "Market" order guarantees a fill, but the worst-case fill price is uncontrollable. A "Limit" order allows control over the worst-case fill price, but cannot guarantee that a fill will take place. See the "Per-Trade Delta Hedging Logic" section, step (6.b), for more details.
- **"Exec. Padding (ticks)"** - this 0+ integer value is only relevant if **"Exec. Order Type"** = "Limit". In this case, the limit price used for the aggressive execution attempt is padded by this number of price increments. If the order is to buy futures, then the final limit price = top-of-book ask + **"Exec. Padding (ticks)"** price increments. If the order is to sell futures, then the final limit price = top-of-book bid - **"Exec. Padding (ticks)"** price increments.
- **"Account Override"** - this optional text field allows the user to override the trade account assigned to the hedging orders for this futures contract. If left blank, the algo will use the default trade account assigned to the overall algo.
- **"Delete"** - if this checkbox is checked, it will instruct the algo to delete this row from the grid the next time the "Apply Changes" button is clicked. The algo will ensure there is always at least one new empty row available in the grid to add a new row's data into.

	Hedging Future	Max Working Qty	Max Show Qty	Delta Trigger	Min Qty Ratio	Min Qty Value Req	Whole Working Qty	Working Slippage (ticks)	Exec. Order Type	Exec. Padding (ticks)	Account Override	Delete
1	ZC:F;;DEC21;0;;	50	5	50	0.3	1	<input type="checkbox"/>	1	LIMIT	5		<input type="checkbox"/>
2	ES:F;;SEP22;0;;	100	6	50	0.25	15	<input type="checkbox"/>	3	LIMIT	4		<input type="checkbox"/>
3	ES:F;;MAR24;0;;	100	1	50	0.3	50	<input type="checkbox"/>	2	MARKET	0		<input type="checkbox"/>
4				50	0.3	0	<input type="checkbox"/>		MARKET	0		<input type="checkbox"/>

### "Manual Order" Grid

The "Manual Order" grid allows the user to arbitrarily initiate a futures hedge, using the same execution logic that the per-trade hedging follows. This grid functions as a simple order ticket. As long as all four Qty required columns are populated for any row(s), then the corresponding futures order(s) will be entered as soon as the "Apply Changes" button is clicked. The **"Qty"** column value will be cleared after this takes place, in order to prevent an accidental double entry, in case the button was unintentionally re-clicked.

- **"Delete"** - if this checkbox is checked, it will instruct the algo to delete this row from the grid the next time the "Apply Changes" button is clicked. The algo will ensure there is always at least one new empty row available in the grid to add a new row's data into.
- **"Symbol"** - select the desired futures symbol using the cell's dropdown. The options displayed in the dropdown are not controlled by the algo, but rather are embedded in the dashboard configuration on the Metro client. See the paragraph below on how to edit these values.
- **"Expiry"** - select the desired futures contract expiration using the cell's dropdown. The options displayed in the dropdown are not controlled by the algo, but rather are embedded in the dashboard configuration on the Metro client. See the paragraph below on how to edit these values.
- **"Side"** - this dropdown value allows the user to select either BUY or SELL.
- **"Qty"** - this 1+ integer value indicates the number of futures lots to be bought or sold.



To edit the available dropdown values for either the **"Symbol"** or **"Expiry"** columns, the user can click the small wrench icon in the upper-right of the dashboard. A dialog will appear that displays the specifications for each grid column. A certain text format starting with "choice:" encodes the dropdown options for a given column. Each option is encoded as Value=Value, separated by semicolons. The default "(none)" option should generally come first, followed by any options relevant to the user. For example, some dropdown options for the **"Expiry"** column might look like:  
 "choice:(none)=NONE;MAR23=MAR23;JUN23=JUN23;SEP23=SEP23;DEC23=DEC23".

It is important that the user save the Metro layout after performing any changes to the dashboard configuration, so that these changes persist the next time the Metro client is restarted. Column spacings, column orderings, dropdown choices, and any other dashboard configuration changes will be lost after the next Metro client restart, unless they are first saved to the user's Metro layout.

## "Portfolio Hedging" Grid

This grid allows the specification of portfolio delta hedging missions, which follow the logic outlined in the previous section "Portfolio Delta Hedging Logic". Each row in this grid can have the following columns defined:

- **"Scan"** - this checkbox column allows the user to enable the "scanning" stage of the mission. In the scanning stage, portfolio deltas matching the mission will be reported in the **"Options Delta"**, **"U Delta"**, and **"Total Delta"** columns, but no hedging actions will be allowed to trigger.
- **"Hedge"** - this checkbox column allows the mission to go live, enabling the possible triggering of the various hedging triggers. This checkbox can only be checked if the **"Scan"** checkbox is also checked.
- **"Symbols"** - this required text column allows the user to specify the symbol or symbols applicable to the mission. If multiple symbols are specified (in a comma-separated list), then they must share the same underlying futures symbol. For example, weekly options symbols can be lumped in with the monthly expirations (e.g. "LO, LO1, LO2, LO3, LO4, LO5" is valid because all have the CL future as the underlying).
- **"Accounts"** - this optional text column allows the user to additionally filter the eligible portfolio delta by the associated trade account(s). Multiple accounts can be specified in a comma-separated list. Leaving this column blank will include all accounts.
- **"H Into Front"** - this checkbox specifies whether or not the mission should hedge all matching portfolio deltas into the "front month" futures contract (only). If unchecked, the deltas will instead be hedged into multiple different futures expirations matching the various mapped underlyings for any existing options positions. If this checkbox is checked, the "front month" futures contract is defined as the earliest (nearest) futures expiration for which an options position still exists that has that futures contract mapped as underlying instrument in Metro. This logic serves to prevent an undesirable situation where the mission could hedge portfolio deltas into a futures contract only a few days away from expiration.
- **"Delta Trigger"** - this column allows the user to enable the optional delta trigger logic.
  - **Off** - this setting means the trigger is disabled.
  - **On (AND)** - this setting means the trigger is enabled, but can only trigger a portfolio hedging event if this trigger is true and any other trigger set to "On (AND)" is also true.
  - **On (OR)** - this setting means the trigger is enabled, and can trigger a portfolio hedging event if this trigger is true (independent of any other possibly enabled triggers).

- **"Delta Trigger Val"** - this numeric field is required if **"Delta Trigger"** is checked. It represents the  $|\text{portfolio } \Delta|$  threshold (in units of futures lots), above which will trigger a portfolio hedging event. This value must be between 0.75 and 100.0.
- **"Delta Trigger H%"** - this optional numeric field allows the user to specify the % of portfolio delta to be hedged if/when the "Delta trigger" is triggered. If specified, the value must be greater than 0.0 and  $\leq 100.0$ . If blank, this field defaults to 100.0 (100% hedging).
- **"Delta SP"** - this optional checkbox column enables a special feature called "spread protection" if/when the "Delta trigger" is triggered (it does not apply to the other possible triggers). This feature monitors the top-of-book spread in the hedging future and can skip the portfolio hedging event if certain undesirable characteristics are present. Undesirable cases include an abnormally wide top-of-book spread (relative to a moving average through time), abnormal lack of trading activity (which could indicate the market is closed or halted), or a top-of-book spread that has deviated too far from the last traded price. While this feature cannot guarantee to filter out every adverse scenario, it can help avoid a hedge into an undesirable futures spread in some of the more common cases.
- **"Time Trigger"** - this column allows the user to enable the optional time-based trigger logic.
  - Off - this setting means the trigger is disabled.
  - On (AND) - this setting means the trigger is enabled, but can only trigger a portfolio hedging event if this trigger is true and any other trigger set to "On (AND)" is also true.
  - On (OR) - this setting means the trigger is enabled, and can trigger a portfolio hedging event if this trigger is true (independent of any other possibly enabled triggers).
- **"Time Trigger Val"** - this optional text field is required if **"Time Trigger"** is checked. Two different formats are allowed. The simple time format (e.g. "2:30 PM") instructs the mission to hedge any portfolio delta remaining at the specified time. A more advanced time-weighted average price (TWAP) format can be specified using the following format: "start time / number of orders / interval between orders in seconds". For example, "2:28 PM / 3 / 60", instructs the mission to hedge  $\frac{1}{3}$  of the portfolio delta every 60 seconds, starting at 2:28 PM (over 3 orders total). All specified times are with respect to the server's time zone.
- **"Time Trigger H%"** - this optional numeric field allows the user to specify the % of portfolio delta to be hedged if/when the "Time trigger" is triggered. If specified, the value must be greater than 0.0 and  $\leq 100.0$ . If blank, this field defaults to 100.0 (100% hedging).
- **"Manual Trigger"** - this optional checkbox column allows the user to manually initiate a portfolio hedging event for the mission. The user checks the column and then clicks the "Apply Changes" button in the dashboard, and the mission will then initiate hedge processing of the current matching portfolio delta (if

any). This checkbox will automatically be unchecked after the processing is complete.

- **"Manual Trigger H%"** - this optional numeric field allows the user to specify the % of portfolio delta to be hedged if/when the "Manual trigger" is triggered. If specified, the value must be greater than 0.0 and  $\leq 100.0$ . If blank, this field defaults to 100.0 (100% hedging).
- **"Options Delta"** - this read-only reporting column will display the current matching portfolio delta for the mission (in units of futures lots), as long as the **"Scan"** checkbox has been enabled.
- **"U Delta"** - this read-only reporting column will display the current underlying futures delta for the underlying symbol associated with the mission (in units of futures lots), as long as the **"Scan"** checkbox has been enabled. Note that this futures delta consists of both preexisting futures positions (if any) and any futures that may have been bought or sold since the mission began.
- **"Total Delta"** - this read-only reporting column will display the current net portfolio delta ("**Options Delta**" + "**U Delta**"), as long as the **"Scan"** checkbox has been enabled. This is the value that is compared against **"Delta Trigger Val"** to see if the "Delta trigger" is triggered (assuming **"Delta Trigger"** is checked).
- **"Delete"** - if this checkbox is checked, it will instruct the algo to delete this row from the grid the next time the "Apply Changes" button is clicked. The algo will ensure there is always at least one new empty row available in the grid to add a new row's data into.

▲	Scan	Hedge	Symbols	Ac... H Into F...	Delta Trigg...	Delta ...	Delta Tri...	Delta SP	Time Trigger	Time Trigg...	Time Trigger...	Manual Tri...	Manual T...	Options Delta	U Delta	Total Delta	Delete
1	<input type="checkbox"/>	<input type="checkbox"/>	ES, EW1, EW2, EW3	<input checked="" type="checkbox"/>	On (OR)	3.5	100	<input checked="" type="checkbox"/>	Off			<input type="checkbox"/>	100				<input type="checkbox"/>
2	<input checked="" type="checkbox"/>	<input type="checkbox"/>	LO	<input type="checkbox"/>	On (AND)	4.0	100	<input checked="" type="checkbox"/>	On (AND)	3:45 PM		<input type="checkbox"/>	100	0.0	0.0	0.0	<input type="checkbox"/>
3	<input type="checkbox"/>	<input type="checkbox"/>	BTC	<input checked="" type="checkbox"/>	Off		100	<input type="checkbox"/>	Off			<input type="checkbox"/>	100				<input type="checkbox"/>
4	<input type="checkbox"/>	<input type="checkbox"/>		<input checked="" type="checkbox"/>	Off		100	<input type="checkbox"/>	Off			<input type="checkbox"/>	100				<input type="checkbox"/>

## Configuration Settings

The settings in the job Configuration screen are global settings that will apply to all of the algo's missions. Changes made to these settings will not take effect until after the job is restarted. Note that some of these settings (those considered "advanced settings") may be hidden from view if the "Simple Mode" checkbox is checked in the bottom of the Configuration screen.

### "*verbosity*"

This value controls the level of detail reported in the log.

- Minimal
- Basic
- Full
- Debug (only useful for debugging)

Recommended initial value is 1 (Basic). For troubleshooting issues, it may be helpful to temporarily increase the verbosity.

### "*deltaQueueMemory*"

The integer number of seconds to remember/accumulate fractional deltas (120-3600). The default is 600 (10 minutes). This setting is explained in more detail in the "Per-Trade Delta Hedging Logic" section.

### "*afterExceedingWorkingSlippage*"

The terminal hedging behavior will occur after a passively working order has exceeded this value of 'slippage'. This setting is explained in more detail in the "Per-Trade Delta Hedging Logic" section.

- Let order sit
- Execute aggressively
- Let sit for Metro order hedges only - this uncommonly used setting causes "Let order sit" behavior for the hedging of filled Metro orders, but causes "Execute aggressively" behavior for the hedging of filled Metro quotes.

### "*testCode*"

This setting is rarely used and controls certain special behavior regarding the grids at startup. Unless otherwise instructed, users should leave this setting at the default value (Update grids for new column).

### "*sideQtyBookDepth*"

This 1+ integer value specifies the number of top-of-book price levels to include (on each side of the spread) in the "*Min Qty Ratio*" calculation. The default value (1) is recommended for most markets. Setting this to a value higher than 1 may produce counterintuitive behavior if the user is not fully aware of how this calculation will work with their typical futures book depth.

### "*sideQtyBookDepthWeighting*"

This setting controls the book depth weighting used if "*sideQtyBookDepth*" > 1. Otherwise, it is irrelevant.

- Simple sum - this setting adds the size on the included top-of-book price levels using a simple sum.

- **Linear** - this setting adds the size on the included top-of-book price levels with a linear weighting, such that price levels further away from the top-of-book have their size moderately discounted in a linear fashion.
- **Exponential** - this setting adds the size on the included top-of-book price levels with an exponential weighting, such that price levels further away from the top-of-book have their size heavily discounted.

#### ***"insertAllMetroOrderHedgesStatically"***

This uncommonly used setting allows the user to toggle a special behavior where the algo will place all futures hedge orders for filled Metro options orders (but not for filled quotes) in a static fashion. This means that the initial working price set at step (4) in the "Per-Trade Delta Hedging Logic" section will be the final price of the hedge order. The algo will no longer manage the hedge order after initially booking it. Most users will want to keep the default value (No).

#### ***"onlyHedgeForTradersList"***

This optional text setting allows the user to specify one or more traders that the algo will hedge for. Options trades placed under other traders will always be ignored. Multiple traders may be specified with a comma-separated list. The default value (blank field) is very common and allows the algo to hedge for all traders on the server.

#### ***"onlyHedgeForAccountsList"***

This optional text setting allows the user to specify one or more trade accounts that the algo will hedge for. Options trades placed under other trade accounts will always be ignored. Multiple trade accounts may be specified with a comma-separated list. The default value (blank field) is very common and allows the algo to hedge for all trade accounts on the server.

#### ***"optionalFlags"***

This uncommonly used text field allows the user to set certain text codes to trigger special behavior. The default is a blank field.

- **RESTORE** - this text code instructs the algo to list the available historical grid data backups in log, before immediately exiting. The algo saves a new grid backup daily with a numerical format. In the event of a grid data loss, this functionality may be helpful in restoring the lost grid data.
- **RESTORE\_N** - this text code instructs the algo to load the historical backup with the numerical code N. For example, "RESTORE\_1449" would load the grid data from the historical backup taken on the day labeled 1449. The available numerical codes available for restoration can be listed using the "RESTORE" code first.

#### ***"fillPriceStickinessInMs"***

This integer setting accepts a value 0-30000 and controls the number of milliseconds that must elapse between consecutive aggressive execution attempts. A value greater

than 0 is recommended, because most markets display a "liquidity replenishment" dynamic that allows for price levels with decreasing size to be replenished with more liquidity if the algo only waits a brief amount of time (for example, when iceberging). The default value (500) seems to work well in most markets and leads to better hedge fill prices in some common scenarios. It is not recommended to set this value too high.

#### *"splitStratHedgingPerLegExpiry"*

This setting allows the user to toggle the hedging behavior taken for options spreads with multiple expirations in their legs (e.g. calendar spreads). The default value (No) is very common and instructs the algo to hedge the spread's total delta into just one future (determined by the Mappings row that matches the first leg). The alternative value (Yes) instructs the algo to instead hedge the individual delta of each individual options leg into the individual underlying futures contract for that leg. This leads to more hedges in total. The (Yes) setting is uncommon and may only be appropriate in certain markets with a very deep term structure (for example, strip spreads in the Eurodollar).

#### *"minSecsBetweenPortfolioHedges"*

This 10+ integer setting specifies the minimum number of seconds required between possible consecutive portfolio hedging actions. In many use cases, it is detrimental to perform portfolio hedging too frequently (over-hedging). Therefore, this important setting allows the user to specify the minimum period required between any two portfolio hedging events (however the *"Manual Trigger"* is exempt from this constraint). The default value is 60 (1 minute) and many users may wish to further increase this value.

#### *"deltaTriggerHedgeBehavior"*

This setting specifies the specific mode of delta hedging taken for the *"Delta Trigger"* (only).

- *Attempt to zero delta* - this setting indicates that, when a "Delta trigger" event is triggered, the algo will attempt to hedge the current portfolio delta to zero (or as close as possible).
- *Just get within delta range* - this setting indicates that, when a "Delta trigger" event is triggered, the algo will only buy or sell sufficient futures to get the portfolio delta back within the allowed range, which is represented by -(*"Delta Trigger Val"*) to +(*"Delta Trigger Val"*). In most cases, this setting will require less overall futures lots to be bought or sold for hedging over the course of a given time period.

#### *"noPortfolioHedgingUntilMktTrade"*

This setting allows the user to toggle an optional safety feature wherein no portfolio hedging action may be taken until at least one market trade has been seen in any one of the symbols specified in the mission's *"Symbols"* column. This constraint avoids certain



situations where the algo could possibly attempt to perform a portfolio hedging action while the market is closed, which would lead to an order rejection at the exchange.

**Configure - AxonetricLlcAutoHedgerJob.1**

**System Defined**

Name	Description	Value
dynamic	job supports dynamic configuration ...	<input type="checkbox"/>
owner	job owner	
ownergroup	job group owner	
autostart	auto-start job when server starts	<input type="checkbox"/>
autostop	auto-stop job if no active users	<input type="checkbox"/>
group	job group identifier	
description	description of this job	Axonetric LLC: Auto-Hedger Job
priority	job priority	normal
orderoptions	configure default order options	trader=kevin;account=DEFAULT;exchange=NONE;routeTo=NONE;a...
limits	configure job limits	ordersPerSec=500;modifiesPerSec=500;openOrders=500;tradesPe...

**Job Defined**

Name	Description	Value
verbosity	log detail level	Debug
deltaQueueMemory	number of seconds to remember/accumul...	600
afterExceedingWorkingSlippage	terminal hedging behavior after exceeding...	Execute aggressively
testCode	special startup grid behavior	Update grids for new column
sideQtyBookDepth	number of price levels to include in the sid...	1
sideQtyBookDepthWeighting	booked qty weighting if book depth > 1	Simple sum
insertAllMetroOrderHedgesStatically	insert all Metro order hedges statically?	No
onlyHedgeForTradersList	optional comma-separated list of traders t...	
onlyHedgeForAccountsList	optional comma-separated list of account...	
optionalFlags	RESTORE=list available db backups, REST...	

Job status is STARTED

Simple Mode