

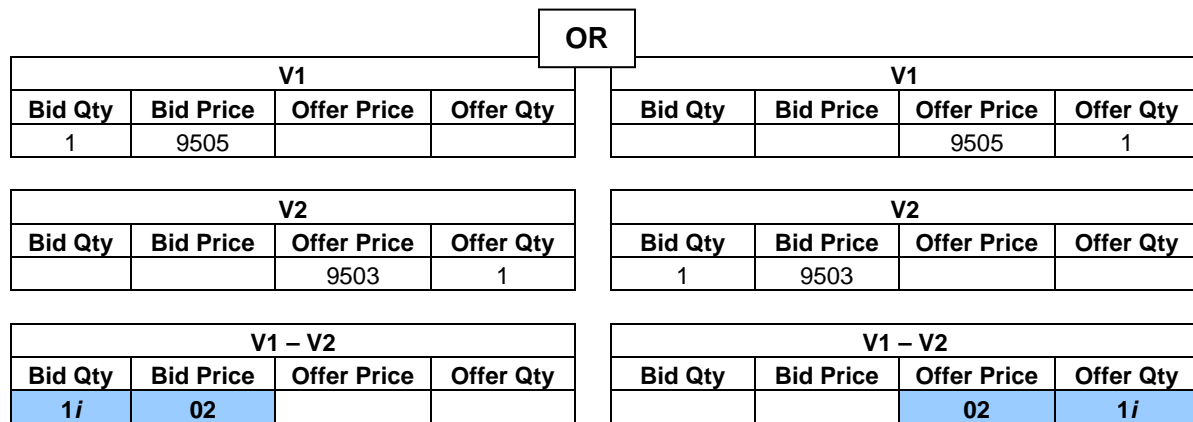
Implied Price Functionality Overview

Implied Orders – First Generation

An implied order is an order created from individual outright orders available in the market place. Implied IN/OUT spreading occurs when the trading engine simultaneously works synthetic spread orders in spread markets and synthetic orders in the individual leg markets without the risk to the trader/broker of being double filled or filled on one leg and not on the other leg. By linking the spread and outright markets, implied spread trading substantially increases market liquidity. For example, a buy in one contract month and an offer in another contract month in the same futures contract can create an implied market in the corresponding calendar spread.

There are two different ways of processing implied spread orders:

- Implied **IN** orders are derived from existing outright orders in individual contracts (legs)
- An outright order in a spread can be matched with other outright orders in the spread OR with a combination of orders in the legs of the spread based on price and the rules corresponding to the method of allocation being used
- Two possible structures of implied **IN** orders are shown below:



- Implied OUT orders are derived from the combination of an existing outright order in a spread and an existing outright order in one of the individual underlying leg
- These orders are utilized to create a contingent outright order on the other underlying leg of the spread
- An outright order in a leg can be matched with other outright orders for this specific leg OR with a combination of orders from any spread composed of this leg and orders of the other corresponding leg of the spread

- This process is executed based on price and the rules corresponding to the method of allocation being used
- Four possible structures of implied **OUT** orders are shown below:

				OR				
V1				V1				
Bid Qty	Bid Price	Offer Price	Offer Qty	Bid Qty	Bid Price	Offer Price	Offer Qty	
1	9505					9505	1	
V2				V2				
Bid Qty	Bid Price	Offer Price	Offer Qty	Bid Qty	Bid Price	Offer Price	Offer Qty	
1i	9503					9503	1i	
V1 – V2				V1 – V2				
Bid Qty	Bid Price	Offer Price	Offer Qty	Bid Qty	Bid Price	Offer Price	Offer Qty	
		02	1	1	02			

				OR				
V1				V1				
Bid Qty	Bid Price	Offer Price	Offer Qty	Bid Qty	Bid Price	Offer Price	Offer Qty	
1i	9505					9505	1i	
V2				V2				
Bid Qty	Bid Price	Offer Price	Offer Qty	Bid Qty	Bid Price	Offer Price	Offer Qty	
1	9503					9503	1	
V1 – V2				V1 – V2				
Bid Qty	Bid Price	Offer Price	Offer Qty	Bid Qty	Bid Price	Offer Price	Offer Qty	
1	02					02	1	

Implied Orders - Second Generation

Possible matches for implied orders are checked only on the instrument of the arriving order. This process improves system performance, since the system is not required to check for matches in all contracts. To avoid market anomalies, the CME Globex match engine is designed to trade one generation beyond what is disseminated. To clarify, first-generation orders are created at prices sufficient to trade. If these implied orders are not at a large enough quantity to fill the arriving order, then CME Globex builds second-generation synthetic orders until the quantity of the arriving order is completely satisfied.

Second-generation orders are built according to the following rules:

1. CME Globex will find all spreads in maturity date order that can be used to build implied orders in an instrument to trade with the arriving order.
2. Beginning with the first spread in maturity date order, CME Globex will synthesize the other legs of that spread.
3. The first-generation implied order that is used to build the second-generation implied order is **always** an implied OUT.

2nd Generation Implied IN

Second-generation implied IN orders can be made up from the combination of an outright order and an implied order on two separate underlying instruments.

2nd Generation – Implied OUT

Second generation implied OUT orders are made up from an outright spread and another implied order.

Example: Matching with 2nd Generation

Note that for the purpose of explanation, this next example has been broken down into multiple steps to fully illustrate the process. In the real market, this process will happen instantaneously, with the end users only seeing immediate executions taking place. Also, keep in mind that the second-generation orders are not be disseminated.

Market Before Matching:

CONTRACT A					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
1 st Gen Imp 2-4	2i	9600	9500	5	INCOMING
Outright 1	1	9550			

CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
1 st Gen Imp 3-5	2i	9550			
Outright 2	2	9500			

CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 3	2	9400			

CONTRACT A-CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 4	4	100			

CONTRACT B-CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 5	2	150			

Matching Notes:

- The incoming order will trade the 2-lot with the first-generation implied order that is derived from the outright orders 2 and 4 at a price of 9600.
- The incoming order will then trade the 1-lot with the outright order 1 at a price of 9550.
- This will leave a remaining 2-lot offer at a price of 9500, as well as remaining orders in CONTRACT B, CONTRACT C and the CONTRACT B-CONTRACT C

CONTRACT A					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
1 st Gen Imp 2-4	2i	9600	9500	5	INCOMING
Outright 1	1	9550	9500	2	Incoming Rem.

CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.

1 st Gen Imp 3-5	2i	9550			
Outright 2	2	9500			

CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 3	2	9400			

CONTRACT A-CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 4	4	100			
Outright 4	2	100			

CONTRACT B-CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 5	2	150			

Books After Match:

CONTRACT A					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
			9500	2	Incoming Rem.

CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
1 st Gen Imp 3-5	2i	9550			

CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 3	2	9400			

CONTRACT A-CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 4	2	100			

CONTRACT B-CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 5	2	150			

As stated in the definition of second-generation implied orders, if the first-generation implied quantities are not large enough to fill the arriving order (which, in this case, it was not), then CME Globex will build the next generation (second-generation) of synthetic orders until that arriving order quantity is completely filled.

2nd Generation Notes:

- Since Outright 4 still has a remainder of 2 after the first round of matching, it can be used along with the first-generation implied order from Outrights 3 and 5 to create a second-generation OUT order in the V1 at a price of 9650.

CONTRACT A					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
2 nd Gen (3-5) -4	2i	9650	9500	2	Incoming Rem.

CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
1 st Gen Imp 3-5	2i	9550			

CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 3	2	9400			

CONTRACT A-CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 4	2	100			

CONTRACT B-CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 5	2	150			

Matching Notes:

- The remaining 2-lot from the Incoming order can then match against this new implied order at a price of 9650.
- This match effectively trades against all of the underlying contract thereby completely satisfying the incoming quantity.

Book During 2nd Generation Matching:

CONTRACT A					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
2nd Gen (3-5) -4	2i	9650	9500	2	Incoming Rem.

CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
1st Gen Imp 3-5	2i	9550			

CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 3	2	9400			

CONTRACT A-CONTRACT B					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 4	2	100			

CONTRACT B-CONTRACT C					
Order No.	Bid Qty	Bid Price	Ask Price	Ask Quantity	Order No.
Outright 5	2	150			

In this example, everything matches completely, leaving these order books empty. Note that more thorough examples containing the creation and matching of second-generation are contained in the *Examples* section of this document.

Priority Rule

Implied orders and outright orders are matched according to the rules of the allocation method being used. This includes the following matching algorithms:

- First In First Out (FIFO)
- Pro Rata Allocation Matching
- Lead Market Maker (LMM)

First In, First Out (FIFO)

FIFO uses price and time as the only criteria for filling an order. In this algorithm, all orders at the same price level are filled according to time priority. It is important to note that a user loses order priority when the order is changed in any of the following ways:

- An increase in quantity
- A change in price and,
- A change in account number

When trades are matched using the FIFO method, outright orders at the same price level are filled according to time priority. After all possible matches have been made for the outright orders, the implied orders will trade using the rules based system mentioned under the Priority Rules section:

- All implied IN orders are aggregated together at their respective prices.
- When aggregating implied OUT orders, there can be several aggregates for each price. This is due to the fact that only one aggregate per spread is used to generate implied orders.
- Within each price aggregate, the earlier maturity will trade first (i.e., for Calendars, CONTRACT A-CONTRACT B will trade before CONTRACT A-CONTRACT C).

Example: FIFO Matching

1. Orders at the same price are prioritized by their entry times, with the oldest order having the highest priority.
2. The aggregated implied order has the lowest priority within its price level.

This means that for the example below, if any orders on the offer side were to come in at the corresponding price of 9330, then the 3-lot and 5-lot would match first (in that order), with the 2-lot implied order filled last because it has the lowest priority:

V1					
Order Time	Bid Qty	Bid Price	Offer Price	Offer Qty	Order Time
14:47	3	9330			
15:05	5	9330			
N/A	2i	9330			

Note that if the implied spreading was turned off, and the 2-lot in the example above was a real outright order, then it would have an actual timestamp and would be prioritized accordingly.

Pro Rata Allocation Matching

The matching algorithm known as “Pro Rata” or “Allocation Algorithm” is currently applied only to Eurodollar futures (Eurodollar Packs and Bundles match via FIFO). Pro Rata Allocation matches orders based on price, TOP orders (the **first order only** that “betters” a market), and size.

The Allocation Algorithm operates according to the following rules:

1. Orders placed during the “pre-opening” or at the indicative opening price (IOP) will be matched on a price and time priority basis. **Note that implied orders are not taken into consideration, as they are only active during the continuous trading session.**
2. Priority is assigned to an order that betters the market, i.e. a new buy order at 36 betters a 35 bid. Only one order per side of the market (buy side and sell side) can have this TOP order priority. There will be situations where a TOP order doesn’t exist for one or both sides of the market (for example, an order betters the market, but is then canceled). There will never be a situation that results in two orders on the same side of the market having TOP order status.
3. Only outright orders can be TOP orders, however the TOP orders of underlying orders that are creating implied orders will be taken into consideration during the matching process so as not to violate the TOP order rule in any market.
4. TOP orders are matched first, regardless of size.
5. After a TOP order is filled, Pro Rata Allocation is applied to the remainder of the resting orders at the applicable price levels until the incoming order is filled.
6. The Pro Rata algorithm allocates fills based upon each resting order’s percentage representation of total volume at a given price level. For example, an order that makes up 30% of the total volume resting at a price will receive approximately 30% of all executions that occur at that price. Approximate fill percentages may occur because allocated decimal quantities are always rounded down (i.e. a 10-lot order that receives an allocation of 7.89- lots will be rounded down to 7-lots).
7. The Pro Rata algorithm will only allocate to resting orders that will receive 2 or more contracts.
8. After percentage allocation, all remaining contracts not previously allocated due to rounding considerations are allocated to the remaining orders on a FIFO basis.
 - Outright orders will have priority over implied orders and will be allocated the remaining quantity according to their timestamps.
 - Implied orders will be then allocated by maturity, with the earliest expiration receiving the allocation before the later expiring contracts. If spread contracts have the same expiration (i.e., CONTRACT A-CONTRACT B and CONTRACT A-CONTRACT C), then the quantity will be allocated to the earliest maturing contracts making up that spread (i.e., the CONTRACT A-CONTRACT B will get the allocation before the CONTRACT A-CONTRACT C because the CONTRACT B expires before the CONTRACT C).

Example: Pro Rata Allocation Matching

Note: For this example, any of the orders involved could be either outright or implied. As timestamp is not taken into account, the outcome is the same.

Orders in the market:

Order No.	Bid Qty	Bid Price	Offer Price	Offer Qty	Order No.
INCOMING	250	9711	9711	200	1 (Top Order)
			9711	25	2
			9711	50	3
			9711	10	4

Allocation Matching calculation:

Order No.	Bid Qty	Bid Price	Offer Price	Offer Qty	Order No.	Allocation	2 nd Pass
INCOMING	250	9711	9711	200	1 (Top)	200	
			9711	25	2	14	2
			9711	50	3	29	
			9711	10	4	5	

Note that Order 1, the Top order, is filled entirely. Matching allocation is then performed for the remaining orders with the following formula:

1ST Allocation:

- $50/85 \times 50 = 29$ – Matched 2nd, after TOP order is entirely filled
- $25/85 \times 50 = 14$ – Matched 3rd
- $10/85 \times 50 = 5$ – Matched 4th

2nd Allocation:

- FIFO – the 2 lot is assigned to the order with the highest priority, which is Order 2.

The following table shows the order in which the matching takes place.

Order No.	Bid Qty	Bid Price	Offer Price	Offer Qty	Order No.	Match Qty	Match Order
INCOMING	250	9711	9711	200	1 (Top Order)	200	#1
			9711	25	2	14/2	#3/#5
			9711	50/2	3	29	#2
			9711	10	4	5	#4

Example: Pro Rata Allocation Matching with Displayed Quantity

Note: For this example, any of the orders involved could be either outright or implied. As timestamp is not taken into account, the outcome is the same.

Orders in the market:

Order No.	Bid Qty	Bid Price	Offer Price	Offer Qty	Order No.
1 (Top Order)	10 (100)*	9500	9500	30	INCOMING
2	5	9500			
3	20	9500			
4	8	9500			
5	2	9500			

* Note that Order 1 has a total quantity of 100 but is only displaying 10.

Allocation Matching calculation:

2 nd Pass	Allocation	Order No.	Bid Qty	Bid Price	Offer Price	Offer Qty	Order No.
	10	1 (Top Order)	10 (100)	9500	9500	30	INCOMING
3	2	2	5	9500			
	11	3	20	9500			
	4	4	8	9500			
	0*	5	2	9500			

* Rounded down to 0 due to quantity calculated = 1

The Display Quantity for Order 1, the Top order, is initially filled. Matching allocation is performed for remainder of orders at the price level. The Display Qty refreshes after the allocation of the remaining orders.

1ST Allocation

- $5/35 \times 20 = 2$
- $20/35 \times 20 = 11$
- $8/35 \times 20 = 4$
- $2/35 \times 20 = 1^* + 0$
- (3 remaining)

2nd Allocation

- For the 2nd Allocation, we allocate on a FIFO basis and order 2 is completed.

The table below shows the order in which the matching takes place:

Match Order	Match Qty	Order No.	Bid Qty	Bid Price	Offer Price	Offer Qty	Order No.
#1	10	1 (Top Order)	10 (100)	9500	9500	30	INCOMING
#2	2/3	2	5	9500			
#3/6	11	3	20	9500			
#4	4	4	8	9500			
#5	0	5	2	9500			

Lead Market Maker (LMM)

The LMM is a firm or trader designated by CME to make a two-sided market in an assigned product. This LMM will have the benefit of certain matching privileges and associated pricing concessions in return for meeting CME determined market obligations. Note that the LMM allocation will not begin until after the market opening sequence is complete, therefore the current opening will remain the same.

The LMM algorithm has two variations: One that allows TOP order functionality and one that does not. Note that the following LMM assumptions are associated with both algorithms:

- There can be multiple LMM's assigned per contract.
- Different LMM's may have different allocation percentages assigned per contract.
- A LMM may have multiple orders on the same side of the market for their assigned contract.
- Total LMM matching privileges per contract can never add up in excess of 100%.

LMM Algorithm Definition with TOP Order Functionality

The Lead Market Maker operates as follows when using TOP order functionality:

1. If a TOP order belongs to a LMM, then that order will be matched first and will not be included in the following calculations:
 - If the LMM has a single order at an elected price level, then it will match N% of the remaining incoming order quantity. However, the LMM's allocated match quantity cannot exceed their order size quantity.
 - If the LMM has multiple orders at an elected price level, then the LMM quantity is aggregated and will match N% of the remaining incoming order quantity. Multiple LMM orders are matched according to Pro Rata Allocation until N% quantity portion is fulfilled. However, the LMM's allocated match quantity cannot exceed their aggregated order size quantity.
2. All remaining resting orders at an elected price level (LMM as well) are matched according to time priority.
3. Note that it is possible for the TOP order to be from a LMM.

Example: LMM with 40% Predefined Percentage with a TOP Order

Order No.	Bid Quantity	Bid Price	Ask Price	Ask Quantity	Order No.
1 (TOP)	10	9100	9100	110	Incoming
2	30	9100			
3 (LMM)	20	9100			
4 (LMM)	10	9100			
5 (LMM)	30	9100			
6	100	9100			
7 (LMM)	10	9100			

Matching Notes:

- The incoming order trades with the TOP Order first.
- The remainder of the incoming order is allocated to the LMM orders' according to their predetermined percentage (40%).
- Any incoming order quantity remainder is then processed according to time priority.

Order of Execution			
Order No.	Quantity	Remainder	Incoming Available
			110
1	10	0	100
3*	20	0	80
4*	10	0	70
5*	30	20	60
Remaining Incoming allocated by FIFO			
2	30	0	30
5	20	0	10
6	100	90	0
7	10	10	0

After the TOP Order is filled, the remaining amount of the incoming order is 100-lots. The LMM's 40% of this order equals 40, which is filled by orders 3, 4, and 5 (*). The remaining amount of the incoming order is now down to 60, which is then filled according to time priority.

Order Book After Matching:

Order No.	Bid Quantity	Bid Price	Ask Price	Ask Quantity	Order No.
6	90	9100			
7 (LMM)	10	9100			

LMM Algorithm Definition without TOP Order Functionality

1. If the LMM has a single order at an elected price level, then it will match N% of the incoming order quantity. However, the LMM's allocated match quantity cannot exceed their order size quantity.
2. If the LMM has multiple orders at an elected price level, then the LMM quantity is aggregated and will match N% of the remaining incoming order quantity. Multiple LMM orders are matched on time priority basis until N% quantity allocation is fulfilled. Note that the LMM's allocated match quantity cannot exceed their aggregated order size quantity.
3. All remaining resting orders at an elected price level (LMM as well) are matched according to time priority.

Example: LMM with 35% Predefined Percentage without a TOP Order

Order No.	Bid Quantity	Bid Price	Ask Price	Ask Quantity	Order No.
Incoming	75	9500	9500	5	1
			9500	15	2 (LMM)
			9500	5	3 (LMM)
			9500	10	4
			9500	25	5 (LMM)
			9500	15	6
			9500	5	7 (LMM)
			9500	20	8
			9500	10	9

Matching Notes:

- Since there is no TOP Order in this case, the incoming order is immediately allocated to the LMM orders' according to their predetermined percentage (35%).
- Any incoming order quantity remainder continues processing according to time priority.

Order of Execution			
Order No.	Quantity	Remainder	Incoming Available
			75
2*	15	0	60
3*	5	0	55
5*	25	19	49
Remaining Incoming allocated by FIFO			
1	5	0	44
4	10	0	34
5	19	0	15
6	15	0	0
7	5	5	0
8	20	20	0
9	10	10	0

The LMM's 35% of this order equals 26.25, which is rounded down for an even 26-lot. This is filled by orders 2, 3, and 5 (*). The remaining amount of the incoming order is now down to 49, which is continues to match according to time priority (FIFO).

Order Book After Matching:

Order No.	<i>Bid Quantity</i>	Bid Price	Ask Price	Ask Quantity	Order No.
			9500	5	7 (LMM)
			9500	20	8
			9500	10	9

Futures trading is not suitable for all investors, and involves the risk of loss. Futures are a leveraged investment, and because only a percentage of a contract's value is required to trade, it is possible to lose more than the amount of money deposited for a futures position. Therefore, traders should only use funds that they can afford to lose without affecting their lifestyles. And only a portion of those funds should be devoted to any one trade because they cannot expect to profit on every trade. All references to options refer to options on futures.

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