COMPOUNDED SINGAPORE OVERNIGHT RATE AVERAGE INDEX ("SORA INDEX"), COMPOUNDED SORA AND MAS FLOATING RATE NOTES ("MAS FRN"): A USER GUIDE

(Revised as of 1 September 2020)

Table of Contents

Annexes

Section A: SORA Index and Compounded SORA

1   Background

1.1   MAS is the administrator of the Singapore Overnight Rate Average ("SORA").

1.2   SORA is an overnight rate. Financial products that reference overnight rates typically reference an average of overnight rates, rather than a single day's reading of the rate. Compounding over a period is a way to compute the average, while reflecting the economic costs of borrowing overnight over the specified period. Relative to simple averaging, compounding interest rates reflects the time value of money more accurately.

1.3   SORA averages will be calculated using the compounded methodology of daily SORA rate ("Compounded SORA"). It is also aligned to the definition of the SGD-SOR-COMPOUND floating rate option in the International Swaps and Derivatives Association's ("ISDA") 2006 Definitions that is used in SORA derivatives. As such, SORA derivatives can be readily used to hedge financial products (e.g. loans, floating rate notes) that reference Compounded SORA.

1.4   In addition to SORA, MAS will publish daily:

(a)   Compounded SORA of 1-month, 3-month and 6-month tenors; and

(b)   a SORA Index.

The 1-month, 3-month and 6-month Compounded SORA provides reference rates for unsecured interbank SGD transactions in Singapore, compounded over historical 1-month, 3-month and 6-month periods.

The SORA Index is a daily data series representing the returns from earning compounded interest each day at the daily SORA rate. This is set to a value of 1.0000000000 on 3 January 2020, and computed up to 10 decimal places. The change in the SORA Index for any reference period (i.e. between any two dates) can be used to calculate the compounded SORA over that period.

The SORA Index and Compounded SORA is collectively referred to as the "SORA Averages" henceforth.

1.5   Interest would compound only on a business day in Singapore. On any other day, simple interest would apply at an interest rate equal to the SORA rate on the business day immediately preceding the non-business day in Singapore. For example, over a typical weekend, we would apply Friday's SORA rate (published on the following Monday) for three days (Friday, Saturday and Sunday). Friday's SORA rate would be multiplied by a day count of 3 and compounded once across the entire weekend[1]. Holidays will be treated like non-business days.

1.6   Interest will be calculated using the actual number of calendar days, assuming a 365-day year (fixed), aligned with the broader SGD market convention.

2   Publication

2.1   SORA for a given Singapore business day ("SORA Value Date") is published by 9am on the next Singapore business day ("SORA Publication Date"). SORA is published on the MAS website, and is also available

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[1] Refer to Annex A for an example.

on Bloomberg (Ticker: SIBCSORA Index) and Refinitiv (Screen: SORA = MAST). The corresponding SORA Index and Compounded SORA (1-month, 3-month and 6-month) will be published together with SORA on the SORA Publication Date.

2.2   SORA and the SORA Averages are provided on an "as is" basis without any warranties of any kind, and MAS shall not be liable for any damage or loss which may arise from reliance on the data obtained from the MAS website.

3   Republication

3.1   The SORA Averages will be republished in the event of a republication of SORA, or error(s) in the calculation of the SORA Averages. Any republication will be done by 12pm on the SORA Publication Date, after which no further amendments will be made.

4   Calculation Methodology for Compounded SORA

4.1   Compounded SORA for a period can be calculated from daily SORA rates using the following formula:

$$\left[\prod_{i=1}^{d_o}\left(1+\frac{SORA_i \times n_i}{365}\right)-1\right] \times \frac{365}{d}$$

where:

"d_o", for any calculation period, is the number of Singapore business days in the relevant calculation period;

"i" is a series of whole numbers from one to d_o, each representing the relevant Singapore business days in chronological order from, and including, the first Singapore business day in the calculation period;

"$SORA_i$", for any day "i" in the relevant Calculation Period, is a reference rate equal to SORA in respect of that day as published on or about 9am Singapore time, on the following Singapore business day.

"n_i" is the number of calendar days in the calculation period for which $SORA_i$ applies; and

"d" is the number of calendar days in the relevant calculation period.

The resulting percentage will be rounded to the nearest ten-thousandth of a percentage point (i.e. 0.0001%).

5   Calculation Methodology for the SORA Index

5.1   The SORA Index aims to simplify the calculation of compounded interest rates. The SORA Index will be calculated as follows:

$$\text{SORA Index}_i = \text{SORA Index}_{i\text{-}1} \text{ x } \left(1 + \frac{\text{SORA}_{i-1} \times n_{i-1}}{365} \right)$$

where:

"SORA Index$_i$" = The index for date i, calculated and published on date i, rounded to 10 decimal places (SORA Index$_1$ = 1.0000000000 published on 3 January 2020);

"SORA$_{i-1}$" = The SORA rate for Singapore business day i-1, published on Singapore business day i; and

"n_{i-1}" = The number of calendar days for which SORA$_{i-1}$ applies. This is equal to the number of calendar days between Singapore business day i-1 and Singapore business day i.

5.2   An illustrative series of the SORA Index data is appended in Annex A.

6   Calculating Compounded SORA from the SORA Index

6.1   Compounded SORA for any reference period can be computed from the SORA Index values for any pair of start and end dates using the following formula:

$$\text{Compounded SORA rate between x and y} = \left(\frac{SORA\ Index\ y}{SORA\ Index\ x} - 1 \right) \text{x} \frac{365}{d}$$

Where:

"x" = Start date of the reference period
"y" = End date of the reference period
"d" = The number of calendar days in the reference period

6.2   Annex B provides an example of calculating Compounded SORA using the SORA Index.

6.3   From 1 September 2020, MAS publishes the SORA Index on the MAS Website in 10 decimal places instead of 8 decimal places as initially published. Past SORA Index data from 1 January 2020 to 31 August 2020 was also republished on the MAS Website on 1 September 2020. There is no change to the scale of the SORA Index which has a value of 1.0000000000 on the Publication Date of 3 January 2020. On the other hand, Bloomberg scales the SORA Index by 100, rounded off to 8 decimal places, in order to maintain the same degree of precision as the SORA Index published on the MAS Website.

7   Calculation Methodology for Compounded SORA (1-month, 3-month, 6-month)

7.1   MAS will publish Compounded SORA with tenors of 1-month, 3-month and 6-month, as reference points for market participants. The use of months instead of days in the day count convention is aligned with the existing practice in the SOR market.

7.2   The start dates of the periods are determined as follows:

- Start dates are determined by referring to the corresponding numerical dates exactly 1 month, 3 months and 6 months prior to the publication date (i.e. a publication date of 15 December 2020 would have start dates of 15 November 2020, 15 September 2020, and 15 June 2020 respectively).
- If the start date falls on a date that does not exist, then the start date is moved to be the last calendar day of that month. For example, as '31 November 2020' does not exist, 30 November 2020 would be the start date for the 1-month rate to be published on 31 December 2020.
- It is possible for different end dates to share the same start date. On 29 March 2020, the 1-month rate will have a start date on 29 February 2020. On 30 March 2020 and 31 March 2020, the 1-month rate also share the same start date on 29 February, as '30 February' and '31 February' do not exist.
- If the start date falls on a non-business day in Singapore, then the SORA rate from the preceding business day in Singapore is applied and multiplied by the number of days from the start date to the next business day in Singapore. For example, as 15 November 2020 is a Sunday and a non-business day, to calculate the 1-month Compounded SORA on 15 December 2020, the SORA rate on 13 November will be applied to 15 November with a 1-day day count.
- Given the above adjustments, Compounded SORA for each tenor (e.g. the 1-month Compounded SORA) could have a different number of days, depending on the number of days in the reference period.

7.3   For ease of computation, MAS will use the formula referring to the SORA Index (in 10 decimal places) for the computation of Compounded SORA. This formula will be used for the 1-month, 3-month and 6-month Compounded SORA, as well as the Coupon Rate for the MAS SORA FRN.

$$\left(\frac{SORA\ Index\ y}{SORA\ Index\ x} - 1\right) X \frac{365}{d}$$

where:
"x" is the Start date of the relevant Observation Period
"y" is the End date of the relevant Observation Period
"d" is the number of calendar days in the relevant Observation Period.

7.3   Annex A provides an example of calculating Compounded SORA from the SORA Index.

Section B: MAS Floating Rate Notes ("MAS FRN")

8   Objective of MAS FRN

8.1   Active and vibrant derivatives and cash markets based on SORA is critical in supporting the successful adoption of SORA as a benchmark. To help kick-start the SORA-based derivatives and cash markets, MAS will broaden the suite of money market instruments used to manage banking system liquidity by issuing floating rate notes ("MAS FRN") based on SORA. The issuance of the SORA-based MAS FRN seeks to provide a reference for market participants looking to use SORA in cash products. The usage of SORA in cash markets would reinforce the take-up of SORA-based derivatives. Hedging needs will also be matched by SORA-based derivatives, reducing basis risk for cash market users. To facilitate take-up of the MAS FRN, MAS will commence the publication of the SORA Index and Compounded SORA Averages on 6 August 2020 on MAS' website.

9   Term Sheet

9.1   The term sheet of the 6-month MAS FRN is set out below.

1	Issuer	Monetary Authority of Singapore
2	Announcement Date	First Monday of every month, or the first Singapore business day thereafter
3	Auction Date	1 Singapore business day after the Announcement Date
4	Issue Date	The first Friday after the Announcement Date, or the first Singapore business day thereafter
5	Issue Price	Par
6	Maturity Date	6 months after the Issue Date, or the first Singapore business day thereafter (e.g. If the Issue Date is 3 August 2020, the Maturity Date will be on 3 February 2021)
7	Maturity Payment	Principal (at par) will be paid on the Maturity Date, or the first Singapore business day thereafter
8	Currency	Singapore dollar
9	Interest Payment Date	Payable in arrears on Maturity Date
10	Interest Type	Floating rate
11	Benchmark	Singapore Overnight Rate Average (SORA), compounded in arrears

12 Interest: A. Accrual Period	From and including, the Issue Date to, but excluding the Maturity Date, or, if MAS elects to redeem the notes, the redemption date
B. FRN Structure	2-day Backward Shifted Observation Period, i.e. the Observation Period for calculation of interest amount starts and ends two Singapore business days prior to the Accrual Period. The applicable day count for SORA will be adjusted backwards by two Singapore business days as well
C. Observation Period	The period from, and including, the date two Singapore business days preceding the Issue Date to, but excluding, the date two Singapore business days preceding the Maturity Date
D. Compounded SORA	$$\left[\prod_{i=1}^{d_o}\left(1+\frac{SORA_i \times n_i}{365}\right)-1\right]\times\frac{365}{d}$$ where: "d_o", for any Observation Period, is the number of Singapore business days in the relevant Observation Period; "i" is a series of whole numbers from one to d_o, each representing the relevant Singapore business days in chronological order from, and including, the first Singapore business day in the Observation Period; "$SORA_i$", for any day "i" in the relevant Observation Period, is a reference rate equal to SORA in respect of that day as published on or about 9:00 a.m., Singapore time, on the following Singapore business day; "n_i" is the number of calendar days in the Observation Period for which $SORA_i$ applies; and "d" is the number of calendar days in the relevant Observation Period. The resulting percentage will be rounded to the nearest ten-thousandth of a percentage point (i.e. 0.0001%). For ease of computation, MAS will use the formula referring to the SORA Index (in 10 decimal places) for the computation of Compounded SORA. $$\left(\frac{SORA\ Index\ y}{SORA\ Index\ x}-1\right)X\frac{365}{d}$$ where: "x" is the Start date of the relevant Observation Period "y" is the End date of the relevant Observation Period

	"d" is the number of calendar days in the relevant Observation Period. The resulting percentage will be rounded to the nearest ten-thousandth of a percentage point (i.e. 0.0001%).
E. Lock-out convention[2]	None[3]
F. Interest Amount	The amount of interest accrued and payable on the FRN will be equal to the (i) the outstanding principal amount of the FRN multiplied by (ii) the Compounded SORA plus the Cut-off Spread determined during the Auction and (iii) the number of calendar days in the Accrual Period divided by 365, subject to a minimum of zero
G. Cut-off Spread	As determined in the FRN's Primary Auction; expressed in the nearest hundredth of a percentage point (i.e. 0.01%)
H: Reset Frequency[4]	Daily
I. Day Count Convention	• Actual/365 (fixed); Actual is based on the number of calendar days in the Accrual Period • Following business day convention, i.e. if the Interest Payment Date or the Maturity Date falls on a non-business day in Singapore, the payment of Interest and Maturity Payment will be made on the next succeeding business day in Singapore, but the Interest Payment Date/ Maturity Date will not be postponed and no interest will accrue from the Interest Payment Date/ Maturity Date until the actual date of payment of Interest and Maturity Payment.
13 Business Day	Any day other than a Saturday, Sunday, public holiday or bank holiday in Singapore
14 Auction Technique	A uniform-price auction format in which each competitive bid specifies a spread (which can be positive, zero, or negative, expressed in the nearest hundredth of a percentage point (i.e. 0.01%). Only competitive bids are accepted. There is no allotment limit imposed. Successful competitive bids will be allotted the notes at a uniform yield, based on the highest accepted spread of successful competitive bids submitted at the auction. The issue amount will be awarded to competitive tenders from the lowest spread to the highest spread.

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[2] The last available SORA rate is used as a cut-off rate and is repeated for the number of days in the lock-out period, which is typically before the Maturity Date.

[3] There are no lock-out days, where the cut-off SORA rate is repeated for a number of days.

[4] This refers to how often the rate adjusts. A daily reset frequency means that a new SORA rate is used daily on Singapore Business Days for the computation of interest.

15	Underwriter	Each Primary Dealer is obliged to tender for a minimum share of the issue on offer
16	Bid Format	Spread above Compounded SORA, expressed in the nearest hundredth of a percentage point (i.e. 0.01%)
17	Denomination Amount	S$1,000, and in multiples of S$1,000 There is no maximum amount an institution can hold
18	Investors	Institutional investors only
19	Settlement	• T+3 for auctions; T+1 in the secondary market on a delivery-versus-payment (DVP) basis • Settled via the MAS Electronic Payment System (MEPS+)
20	Custody	By book entry in the investor's custody account. Institutions without a MEPS+ account need to open an MAS Bills account with a primary dealer.
21	Secondary Market Trading	• Primary Dealers: e-trading platform or through brokers • Institutional investors: through brokers, and through Primary Dealers' dealer-to-client platforms • Trading hours are from 9am to 11:30am and 2pm to 4:30pm
22	Trading Basis	• Prices to 2 decimal places (for both Primary Market and Secondary Market Trading) • FRN does not trade ex-coupon
23	Closing Prices for MAS Facilities	Primary Dealers are to submit closing prices for the MAS FRN, which would provide an official end-of-day price for valuation and settlement. Closing prices should be submitted in price terms, to 2 decimal places. The bid-ask spread for Closing prices submission should not be more than 4 cents.
24	Typical Transaction Size	S$5 million
25	Regulatory Treatment	MAS FRN are accepted as eligible collateral at MAS' facilities. Banks will be able to use the MAS FRN to fulfil liquidity and asset maintenance requirements (AMR). MAS Notice 761 and MAS Notice 762 also apply to the MAS FRN.

10   Treatment of Negative Coupon Rates for MAS FRN

10.1   If SORA becomes negative on any particular day, this would be reflected in the computed SORA Index and Compounded SORA (1-month, 3-month, 6-month**)**. A significantly negative SORA rate on any particular day, or persistently negative SORA rates for several days, could result in SORA Index values falling below the value of 1.0000000000, and Compounded SORA turning negative. This could in turn lead to the coupon rate

of the FRN, i.e. the sum of the Compounded SORA and Cut-off Spread determined during the Auction, to turn negative. However, to support the growth of the MAS FRN, the coupon rate of the FRN will be floored at zero for an initial period as decided by MAS.

11   Tenor and Issuance Frequency

11.1   The MAS FRN will be of 6-month tenor. As the market becomes more familiar with the MAS FRN, other tenors such as 1-year or 2-year FRN could be issued subsequently.

11.2   The MAS FRN will be issued monthly, on the first Friday of every month, or the first Singapore business day thereafter. The announcement date, auction date, issue date, issue size and tenor will be updated in the MAS FRN Issuance Calendar on the MAS Website.

Annex A – Example of SORA Index and calculating the Compounded SORA using the SORA Index

SORA Publication Date	SORA Value Date	SORA Rate (%)	Calendar day applicable	SORA Index (10dp)
Mon 6/1/2020	Fri 3/1/2020	1.2271	N/A	1.0001008575
Tue 7/1/2020	Mon 6/1/2020	0.9619	1	1.0001272136
Wed 8/1/2020	Tue 7/1/2020	1.0309	1	1.0001554610
Thu 9/1/2020	Wed 8/1/2020	1.0006	1	1.0001828790
Fri 10/1/2020	Thu 9/1/2020	1.0299	1	1.0002111006
Mon 13/1/2020	Fri 10/1/2020	1.1810	3	1.0003081896

The calculations below illustrate how the compound rate for a loan drawn on Monday 6 January 2020 and repaid on Monday 13 January 2020 could be calculated using the formula in paragraph 4.1 and paragraph 6.1.

Compounded rate $=$ $\left[\prod_{i=1}^{d_o}\left(1+\frac{SORA_i \times n_i}{365}\right)-1\right]\times\frac{365}{d}$

(using the underlying SORA) $=$ $[\{(1+\frac{0.9619\% \, x \, 1}{365}) \times (1+\frac{1.0309\% \, x \, 1}{365}) \times$

$(1+\frac{1.0006\% \, x \, 1}{365}) \times (1+\frac{1.0299\% \, x \, 1}{365}) \times$

$(1+\frac{1.1810\% \, x \, 3}{365})\} - 1] \times \frac{365}{7})$

$=$ 1.0810%

Compounded rate $=$ $(\frac{SORA\ Index_{13/1/20}}{SORA\ Index_{6/1/20}}-1) \times \frac{365}{d}$

(using the Index) $=$ $(\frac{1.0003081896}{1.0001008575}-1) \times \frac{365}{7}$

$=$ 1.0810%

Annex B – Example of FRN Interest Computation

This example illustrates the computation of accrued interest for an FRN that was issued on 9 January 2020, and matured on 29 January 2020, and issued with cut-off spread of 0.10%.

On the Interest Payment Date/ Maturity Date, the Accrued Interest will be computed using SORA Index in 10 decimal places, and Annualised Coupon Rate in 4 decimal places. The Accrued Interest (in dollars) will be rounded off to 2 decimal places.

Start Date (SORA Value Date)	End	SORA	SORA Day Count	SORA Index (10 decimal places)	No. of cumulative calendar days in Observation Period	Annualised Compounded SORA (%) *	Annualised Coupon Rate (%) **	No. of cumulative calendar days in Accrual Period	Accrued Interest (S) ***
Thu 02-Jan-20	Fri 03-Jan-20	1.6813	1	1.0000000000					
Fri 03-Jan-20	Mon 06-Jan-20	1.2271	3	1.0001008575					
Mon 06-Jan-20	Tue 07-Jan-20	0.9619	1	1.0001272136					
Tue 07-Jan-20	Wed 08-Jan-20	1.0309	1	1.0001554610	1				
Wed 08-Jan-20	Thu 09-Jan-20	1.0006	1	1.0001828790	2				
Thu 09-Jan-20	Fri 10-Jan-20	1.0299	1	1.0002111006	3	1.0309	1.1309	1	15,491.78
Fri 10-Jan-20	Mon 13-Jan-20	1.181	3	1.0003081896	6	1.0158	1.1158	4	61,139.73
Mon 13-Jan-20	Tue 14-Jan-20	1.0595	1	1.0003372259	7	1.0205	1.1205	5	76,746.58
Tue 14-Jan-20	Wed 15-Jan-20	0.8209	1	1.0003597239	8	1.1008	1.2008	6	98,695.89
Wed 15-Jan-20	Thu 16-Jan-20	0.8514	1	1.0003830583	9	1.0949	1.1949	7	114,579.45
Thu 16-Jan-20	Fri 17-Jan-20	0.9215	1	1.0004083146	10	1.0607	1.1607	8	127,200.00
Fri 17-Jan-20	Mon 20-Jan-20	1.1806	3	1.0005053898	13	1.0375	1.1375	11	171,404.11
Mon 20-Jan-20	Tue 21-Jan-20	0.7793	1	1.0005267513	14	1.0259	1.1259	12	185,079.45
Tue 21-Jan-20	Wed 22-Jan-20	1.0474	1	1.0005554623	15	1.0617	1.1617	13	206,878.08
Wed 22-Jan-20	Thu 23-Jan-20	1.0442	1	1.0005840864	16	1.0415	1.1415	14	218,917.81
Thu 23-Jan-20	Fri 24-Jan-20	1.0101	1	1.0006117766	17	1.0419	1.1419	15	234,636.99
Fri 24-Jan-20	Tue 28-Jan-20	1.2578	4	1.0007497020		1.0421	1.1421	19	297,258.90
Tue 28-Jan-20	Wed 29-Jan-20	1.1813	1	1.0007820906		1.0403	1.1403	20	312,410.96

* Uses Compounded SORA formula based on SORA Index, with SORA and Day Count from 2 Business Days prior, rounded off to 4 d.p.

** Uses Compounded SORA plus illustrative spread of 0.10%, rounded to 4 d.p.

*** Uses assumed principal of S$500m, SORA Index in 8 d.p. and Annualised Coupon Rate in 4 d.p., and subsequently rounded off to 2 d.p.

The compounded interest can also be calculated using the SORA Index on 7 January 2020 and 24 January 2020 (2 business days before the issuance date and maturity date respectively). The formula to compute the compounded SORA is:

$$\text{Compounded SORA rate between x and y} = \left(\frac{SORA\ Index\ y}{SORA\ Index\ x} - 1\right) x \frac{365}{d}$$

Where:

"x" is 7 January 2020;

"y" is 24 January 2020; and

"d" is the day count from 7 January 2020 to 24 January 2020.

Principal	$ 500,000,000.00
FRN issued on	09-01-20
FRN matures on	29-01-20
Number of days	20
Start of interest observation period	07-01-20
End of interest observation period	24-01-20
Number of days	17
Compounded SORA for FRN (using index)	1.0403%
Illustrative auction-determined spread of	0.10%
Final interest payments	$ 312,410.96