

An Interpretation of Conversion, Rounding and Smoothing Terms

Public Sector Rounding Working Group

This Interpretation of conversion, rounding and smoothing terms has been developed by the Public Sector Rounding Working Group. The explanations given are interpretations of the group, intended to facilitate discussion and understanding within the public sector. They should not be regarded as definitive or comprehensive in any way.

Adjustment

Non-technical term for smoothing.

Article 18 Amounts

Amounts which are set in euro (formerly ECUs) for which each EU member state adopts an equivalent national currency value. An example is the Travellers' Allowance (duty-free allowance).

Conversion

The arithmetic process by which amounts expressed in a National Currency Unit – for example Deutschmarks, French francs and lira – are converted into euro, and vice versa, using a fixed conversion rate.

The conversion process is governed by a set of rules laid down by the European Council of Ministers – the European Community (EC) conversion and rounding rules.

Conversion can produce amounts expressed to any number of decimal places.

European Community (EC) Conversion and Rounding Rules

The European Community (EC) regulations governing the conversion and rounding of monetary amounts, laid down by the European Council of Ministers. These are outlined in Council Regulation (EC) No. 1103/97. Converting and rounding an NCU or euro amount according to these rules delivers an amount that is legally equivalent to the original amount. This concept of 'legal equivalence' underpins the translation of monetary amounts during a changeover.

The EC conversion and rounding rules are directly applicable in all EU member states (including the UK) in relation to the currencies of countries that have joined the single currency. They do not currently apply to sterling, but the strong working assumption is that they would apply following any UK decision to join.

E-Day

The day on which euro notes and coins are first issued in a participating country.

Fixed Conversion Rate

Rate of exchange at which the euro and a National Currency Unit (NCU) are locked.

Fixed conversion rates are defined in the form $\text{€ } 1 = x.\text{xxxxx NCU}$ and are set to six significant figures. For example, the rate for the Irish punt is set at $\text{€ } 1 = 0.787564 \text{ IEP}$, while the rate for Italian lira is set at $\text{€ } 1 = 1936.27 \text{ ITL}$.

Granularity

A measure of the accuracy to which a value can be expressed in a particular currency. This is dictated by the value of the smallest unit or sub-unit of the currency in question.

A 'high' granularity currency is one in which values can be expressed to a high degree of accuracy because the value of the smallest unit or sub-unit of the currency is quite low. A 'low' granularity currency is one in which values cannot be expressed to such a degree of accuracy because the value of the smallest unit or sub-unit is higher.

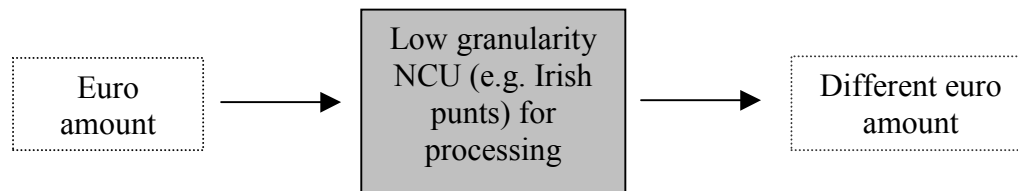
For example, the French franc has a higher granularity than the euro because values can be expressed more precisely using francs and centimes than they can using euro and cent. This is because the centime – the smallest sub-unit of the franc – has a lower value than the cent – the smallest sub-unit of the euro. The Irish punt, in contrast, has a lower granularity than the euro. At current exchange rates, sterling also has a lower granularity than the euro. It should be noted that granularity is a relative, rather than an absolute measure.

An explanation of the significance of granularity is set out under 'Horizontal Rounding Discrepancies.'

Horizontal Rounding Discrepancies

Horizontal rounding discrepancies arise from the translation of a National Currency Unit (NCU) amount into euro (or vice versa) followed by a retranslation to the original currency unit. This might take place, for example, in IT systems – with euro *inputs* being translated into an NCU for processing, before being retranslated to euro on *output*. Small differences can result from the rounding that is inevitable with each translation – meaning that the euro output might be slightly different to the euro input. This can cause presentational difficulties and problems within IT systems.

It should be noted that horizontal rounding discrepancies only arise when translating from a ‘high’ granularity currency into a lower granularity currency and retranslating back to the ‘high’ granularity currency. For example, horizontal rounding discrepancies might arise from translations from euro into Irish punts and retranslations to euro, but not the other way around.



Example: translation of a euro amount into Irish punts and retranslation into euro

$$\text{EUR } 1459.00 \times 0.787564 \Rightarrow 1149.05587... \text{ IEP} \Rightarrow 1149.06 \text{ IEP}$$

$$1149.06 \text{ IEP} \div 0.787564 \Rightarrow 1459.005236 \text{ EUR} \Rightarrow \mathbf{1459.01 \text{ EUR}}$$

Conversion rate: € 1 = 0.787564 IEP

Horizontal rounding discrepancies are sometimes referred to as ‘reconversion errors.’

Implicit Bilateral Rates

A conversion rate between two National Currency Units (NCUs) derived from the fixed euro conversion rates for those two currencies.

Example: an implicit bilateral rate between the Deutschmark and the French franc

The fixed conversion rate for the Deutschmark is € 1 = 1.95583 DEM. The fixed conversion rate for the French franc is € 1 = 6.55957 FRF. An implicit bilateral rate between the French franc and the Deutschmark, derived from the official rates is:

$$1 \text{ DEM} = \frac{6.55957 \text{ FRF}}{1.95583} = \mathbf{3.3538548 \text{ FRF}}$$

A range of implicit bilateral rates between two NCUs are possible, depending on how many significant figures the implicit bilateral rate is defined to. Because of this, the EC conversion and rounding rules state that implicit bilateral rates should not be used

for conversions between two NCUs, unless the rate in question gives one of the results possible under the official ‘triangulation’ method.

Inverse Conversion Rate

A rate derived from the fixed conversion rate, defined in the form 1 National Currency Unit (NCU) = € x.xxxxx (rather than € 1 = x.xxxxx NCU, as the official conversion rates are).

Example: an inverse conversion rate for the Deutschmark

The fixed conversion rate for the Deutschmark is € 1 = 1.95583 DEM. An inverse conversion rate for the Deutschmark is:

$$1 \text{ DEM} = \frac{1}{1.95583} \text{ EUR} = 0.5112918 \text{ EUR}$$

A range of inverse conversion rates between an NCU and the euro are possible, depending on how many significant figures the inverse conversion rate is defined to. Because of this, the EC conversion and rounding rules state that inverse conversion rates should not be used in calculations.

Lead Currency Unit

In order to avoid discrepancies due to vertical rounding, retailers and other economic agents might determine and indicate a ‘lead currency unit’ – a unit which always serves as the basis for calculating the amount a client eventually has to pay.

The definition of a ‘lead currency unit’ (probably the National Currency Unit until an E-Day and the euro afterwards) would neither prevent retailers from accepting payments in either currency nor from displaying prices in another unit for information purposes. It would simply mean that prices expressed in the other currency would not be used for calculating the amount to be paid; the calculation would have to take place on the basis of the ‘lead currency unit.’ Payment of the sum could then be accepted in either currency unit.

Legacy Currency

The former currency of a participating member state which becomes a non-decimal sub-denomination of the euro at the date of entry.

‘Monetary amounts to be paid’ and ‘Monetary amounts to be accounted for’

‘Monetary amounts to be paid’ cover all forms of monetary obligations. ‘Amounts to be accounted for’ cover all other monetary amounts (e.g. amounts in legislative provisions, sales offers, amounts at which tangible assets are valued).

Article 5 of the EC conversion and rounding rules states that all ‘monetary amounts to be paid or accounted for’ should be rounded to the nearest cent after conversion to euro, and to the nearest sub-unit after conversion to a National Currency Unit (NCU).

However, the European Commission’s guidance on interpreting the EC rules states that in the case of ‘monetary amounts to be accounted for’, the rule has to be understood as a minimum standard of accuracy – it is the highest rounding inaccuracy tolerated by the EC regulations.

In general, monetary amounts to be accounted for should be rounded after conversion to the nearest cent or legacy currency sub-unit. However, in cases where amounts are traditionally expressed with more than two decimal places (such as petrol prices per litre or gas prices per cubic metre), displaying a price expressed to a fraction of a cent would be compatible with the EC rules. Rounding to two decimal places would only have to take place at the time of payment.

This is reflected in Recital 11 of Council Regulation (EC) No. 1103/97, which states that the EC conversion and rounding rules do not affect any rounding practice, convention or national provisions providing a higher degree of accuracy for intermediate computations. Intermediate computations cover all those steps where a converted amount does not in itself constitute a monetary obligation, but is an element in a sequence of acts which may lead up to the establishment of a monetary obligation.

National Currency Unit

See legacy currency.

Price Points

Psychologically significant prices, such as DEM 9.99 or FRF 99.99. Price points are a type of signal amount.

Redenomination

The process of changing the currency in which a monetary amount (e.g. a price, a benefit payment, a tax threshold) is set.

During a changeover to the euro, all monetary amounts set in a National Currency Unit have to be redenominated in euro. For many public sector monetary amounts, this requires legislation. Redenomination is a ‘one-off event’ for each monetary amount, usually taking place towards the end of a transition period.

Revalorising

The process by which monetary amounts are reviewed and up-rated according to inflation or Government policy. For most public sector organisations, the majority of revalorising takes place with effect from the beginning of the financial year.

Revalorising is sometimes referred to as realignment or up-rating.

Rounding

The process by which converted legacy currency and euro amounts are rounded to produce more manageable amounts. The EC conversion and rounding rules dictate that converted monetary amounts should generally be rounded to the nearest cent or legacy currency sub-unit.

A converted amount rounded according to the EC rules is legally equivalent to the original legacy currency or euro amount.

Rounding Discrepancies

Any anomalies or differences that arise as a result of the conversion and rounding process. Two common types of rounding discrepancies are horizontal and vertical rounding discrepancies.

Rounding discrepancies are sometimes referred to as rounding differences.

Signal Amounts

Fixed monetary amounts which have a value chosen for their psychological significance or administrative convenience. For example, a tax threshold at IEP 10,000, or a benefit payment at DEM 500. Price points such as DEM 9.99 might also be regarded as signal amounts.

It should be noted that identifying signal amounts is somewhat subjective. However, as a general rule all 'round' numbers (e.g. DEM 5, FRF 10, FIM 100, ITL 250) and all memorable numbers (e.g. DEM 9.99, FRF 99.99) should be regarded as signal amounts.

Shape Retention

The principle that amounts should retain a similar level of accuracy when redenominated in euro. Retaining the shape of an amount previously expressed in whole thousands of NCUs, for example, would mean establishing a euro amount expressed in whole thousands of euro. Similarly, retaining the shape of an amount

previously expressed to two decimal places in an NCU would mean establishing a euro amount expressed in euro and cent.

Retaining the shape of a particular amount might be important for psychological reasons or, in the case of some amounts, to avoid the need for major changes to systems and processes.

It should be noted that retaining the shape of certain monetary amounts could involve a significant change in their value.

Smoothing

As part of a changeover to the euro, all monetary amounts denominated in a legacy currency must be redenominated in euro. This is a 'one-off event' for each amount, usually taking place towards the end of a transition period.

As with all translations of monetary amounts, redenomination must take place in accordance with the EC conversion and rounding rules. Following such conversion and rounding, however, amounts that are being redenominated might be 'smoothed' in order to give an easily memorable or convenient amount.

For example, an Irish tax threshold of £10,000 would translate, according to the EC conversion and rounding rules, to a euro threshold of € 12,697.38. As part of redenomination, this threshold might be 'smoothed' – perhaps to € 12,700.

T-Day

The day on which the euro becomes the legal currency of a participating country and the exchange rate between the National Currency Unit (NCU) and the euro is irrevocably locked. The euro replaces the NCU in question at the fixed conversion rate and the latter becomes a non-decimal sub-denomination of the former.

Transition Period

The period from the day on which the euro becomes the legal currency of a participating country (T-Day) and the day on which electronic transactions in a National Currency Unit are no longer legal.

Threshold Values

Values which are used to divide monetary amounts into different categories. The upper and lower limits of income tax bands, for example, are threshold values. Threshold values might or might not be signal amounts.

Tolerances

The level of inaccuracy that might occur within an IT system or business process before the system responds in some way (e.g. by sending a payment reminder).

Transparency Amounts

See signal amounts.

Translation

The process of converting and rounding a monetary amount according to the EC conversion and rounding rules.

A ‘translated’ amount is legally equivalent to the original amount.

Triangulation

The method laid down by the EC conversion and rounding rules for converting between two National Currency Units (e.g. French francs and Deutschmarks).

According to this method, the initial NCU amount must first be converted into euro. In a second step, the euro amount can then be converted into the desired NCU. The intermediate result in euro can be rounded, but not to less than 3 decimal places.

Other algorithms (e.g. implicit bilateral rates) may only be used if they produce one of the results possible under the triangulation method. It should be noted that it is now generally accepted that it is not possible to find a method that is guaranteed to produce the same level of accuracy as triangulation.

It should be noted that triangulation is only applicable to conversions between NCUs of countries going through a transition period *at the same time*.

Vertical Rounding Discrepancies

Vertical rounding discrepancies occur where items translated from one currency to another are used in any kind of calculation. For example, if a series of converted and rounded amounts are added together, the sum will only exceptionally match the converted and rounded total of the original amounts. Vertical rounding discrepancies can also arise from subtractions, multiplications and other forms of calculation.

Vertical rounding discrepancies can arise wherever there are calculations and occur most commonly within systems processing. Some of the rounding discrepancies cancel out, but in other cases, they systematically accumulate. This can cause presentational difficulties and problems within IT systems.

Vertical rounding discrepancies are sometimes referred to as ‘calculation errors.’

Example: sales receipt in Finnish markka and euro

	EUR	FIM
1 snow shovel	35.32	210
5 m wire	2.52	15
Paint	9.08	54
1 brush	9.42	56
1 screw-driver	31.45	187
20 kg garden peat	38.85	231
Total	126.64	753 (= EUR 126.65)

Conversion rate: € 1 = FIM 5.94573

In this example, the sum of the amounts in FIM is 753, which translates to € 126.65. However, if each individual amount is translated into euro before the addition, the final result is € 126.64 – a difference of 1 cent.