UNIVERSAL CLOCKS

created by Paul Rapoport with Sanketh Kolhar
http://dozenal.ae-web.ca/clock/universal

The clocks in this project operate on UTC (Co-ordinated Universal Time), to demonstrate how time may be kept in a time-zoneless world. The main result of clocks running on UTC is that the time is the same everywhere. The advantages and disadvantages of such timekeeping are discussed elsewhere; these clocks enable thorough use of UTC in practice. They are the only ones this writer knows of that allow choice of location, time band, and many other parameters. They also display both traditional and dozenal clock faces, eight each in many varieties, using analog hands and a digital readout.

Using UTC

The concept of UTC is independent of clock faces. A digital readout is sufficient, as always. The clock faces deal with the separate issue of cyclic divisions of time and their representation dynamically within one day. (Those interested in UTC but not the various clock faces should use Clock 1a.)

To know which part of the day a given UTC indicates, we must know the local offset according to longitude, at least to recognize when the day begins. Locations a predetermined distance apart will have the same offset, that distance being specified by the choice of time band, a concept analogous to that of the current time zone but more flexible.

Two offsets are indicated on these clocks: the beginning of the overnight phase (abbreviated *O,* local midnight) and of the afternoon phase (abbreviated *A,* local noon). On a 24-hour clock, midnight may be UTC 00:00 in London, but in New York (longitude -74°) it is later: about UTC 05:00. In Satara, Maharashtra, India, equidistant on the other side of 0° (longitude +74°), it is correspondingly earlier: about -05:00, i.e. 19:00.

In UTC, theoretically the day starts everywhere when it is midnight at Greenwich (0° longitude), also when it is noon 180° away. (A variation on that involving Munich and 180° from it will be mentioned below.) Alternatively, it may start at local midnight, at different times UTC according to longitude.

For phase O, the negative longitudes (with offsets less than 12:00) have a later midnight than at 0°, and the positive longitudes (with offsets more than 12:00) an earlier midnight. For phase A, the negative longitudes (with offsets more than 12:00) have an earlier noon than at +/-180°, and the positive longitudes (with offsets less than 12:00) a later noon.

The clocks

The clocks assume only continuous equidistant numbering on a round face from 1 to 12 or the equivalent. Those interested only in traditional clocks may skip the discussion of the dozenal clocks and go to the first set of three asterisks below.

It is much easier to understand UTC clocks if we use a 24-hour method of timekeeping, including on a clock face. The dozenal clocks in this project do that, in the dozenal number base. Dozenal counting and arithmetic are explained in several places on the Internet. They are better than using tens (the decimal system) and not hard to learn. The only initial oddities are the single digits for ten and eleven, because in dozenal 10 means twelve plus zero, not ten plus zero. Consequently, ↊ is ten and ↋ is eleven. Those digits have been used that way for more than a century and a half.

The dozenal clocks will be discussed first, followed by the traditional clocks. More about dozenal time reckoning is available here in either of the files titled *About dozenal clock.* From here on, a subscript *z* indicates a dozenal number.

The dozenal clocks

The chart below indicates the essence of the eight dozenal clocks. Explanations follow.

Some clocks work better in certain orientations; some clocks seem better than others. Users should investigate to determine their preferences.

Clock	coloured arcs	shortest hand	numerals	foll UTC sun	foll local sun	phases from
1a (hnh)	stationary	rotates	stationary	s **h**and	**n**one	s **h**and
2a (znz)	stationary	stationary	rotate	**z**ero	**n**one	**z**ero
3a (nhh)	stationary	rotates	stationary	**n**one	s **h**and	s **h**and
4a (nzz)	stationary	stationary	rotate	**n**one	**z**ero	**z**ero
1b (haz)	rotate	rotates	stationary	s **h**and	1 pt on **a**rcs	**z**ero
2b (zah)	rotate	stationary	rotate	**z**ero	1 pt on **a**rcs	s **h**and
3b (nhz)	rotate	rotates	stationary	**n**one	s **h**and	**z**ero
4b (nzh)	rotate	stationary	rotate	**n**one	**z**ero	s **h**and

The coloured arcs represent the phases of the local day: overnight (grey), morning (blue), afternoon (yellow), evening (red). On the A clocks they are stationary; on the B clocks they rotate.

foll: follows

s: shortest

phases from: what indicates the phases of the local day

pt: point

The letters in parentheses in the first column are an abbreviation for the information in the last three.

Clock 1. The basic UTC clock. The shortest hand follows the UTC sun if the left is considered east or the hands move counterclockwise with east to the right.
1a. The shortest hand indicates the phases of the local day.
1b. The 0 indicates the phases of the local day. One point on the arcs follows the local sun.

Clock 2. The shortest hand is stationary (pointing straight down or up) and the numerals rotate. The 0 follows the UTC sun if the right is considered east and the other hands move clockwise.
2a. The 0 indicates the phases of the local day.
2b. The shortest hand indicates the phases of the local day. One point on the arcs follows the local sun.

Clock 3. The numerals are offset counterclockwise according to longitude. The shortest hand follows the local sun if the left is considered east or the hands move counterclockwise with east to the right and the numerals offset clockwise.
3a. The shortest hand indicates the phases of the local day.
3b. The 0 indicates the phases of the local day.

Clock 4. The numerals are offset clockwise according to longitude. The shortest hand is stationary and the numerals rotate. The 0 follows the local sun if the right is considered east and the other hands move clockwise.
4a. The 0 indicates the phases of the local day.
4b. The shortest hand indicates the phases of the local day.

The following is a guide to the user choices for each dozenal clock.

Override. Co-ordinates may be entered, in decimal only: latitude between -90° and +90°, longitude between -180° and +180°. Clicking on *Go to override* activates them.

Phases o/a. The overnight phase, abbreviated *O,* indicated by the grey arc, begins at local midnight. The afternoon phase, abbreviated *A,* indicated by the yellow arc, begins at local noon. The morning phase is indicated by the blue arc, and the evening phase by the red arc.

If *Origin bottom* is chosen (see below), the phases are listed below the clock face as o/a. If *Origin top,* the order is a/o.

Band width. The measure is dromal lengths, or pentqua lengthels, from the Primel metrology. Those and **Pos'n (Position)** depend on the band chosen (see **Time band** below). The calculations acknowledge the Earth's oblate spheroid shape.

Because of that shape, other irregularities of the Earth, and the nature of measurement, the values computed on these clocks, including the time, are precise approximations with as high accuracy as certain physical and computational characteristics allow.

Under the hamburger icon are found the following.

Type. Clock 1, 2, 3, or 4, with a or b. See above for the descriptions of A and B and each clock.

Mode. Dozenal or Traditional. If Dozenal, the clock is diurnal (24-hour); if Traditional, semidiurnal (2 x 12 hours), with the usual sexagesimal division of the hours and minutes.

Direction. Clockwise or Counterclockwise. The hands may move in either direction.

Origin. Bottom or Top. The first of those represents midnight at 0° longitude, the second one noon at +/-180°. For Origin Bottom, longitude 0° (for Greenwich), and time 000_z (00:00 on a 24-hour clock), the 0 will be at the bottom of each clock. For Origin Top, longitude +/-180°, and time 000_z, the 0 will be at the top of each clock. Corresponding values for Munich are longitude 11.56470° and -168.43530° (see the next item).

Prime meridian. Greenwich or Munich. Longitude 0° may be at Greenwich, England or repositioned at 11.56470° to the east, in Munich, Germany. If the latter, longitude +/-180° passes through the least amount of land in the Pacific Ocean between the North Pole and Antarctica. If Munich is chosen, it generates the UTC value in place of Greenwich.

Time band. The time bands range from 100_z trices wide (1 dwell in Primel metrology, 10_z of them around the Earth) to 0.001_z trice (1 vibe, $1{,}000{,}000_z$ of them around the Earth) to continuous. The default value, 10_z trices (1 breather), is 2.5° in circumference.

Low inputs are of uncertain accuracy or use. They are available for experimental purposes. The designation *Continuous* is theoretical: a band width of 0, infinitely many of them around the Earth. Here it gives the same result for phase (see above) as 0.001_z trice (1 vibe), because the phase values go only to three dozenal places.

The time band together with the latitude determines the **Band width** and the **Position.** In an amount out of 100_z (perbiqua or pergross), the latter indicates how far the location chosen is from the band's border. If Origin Bottom is chosen, the border involved is the one closer to Greenwich (or Munich). If Origin Top, the border involved is the one closer to +/-180° from Greenwich (or Munich).

Display. The digital time format has 1, 2, or 3 digits after the point.

Rollover. 000+ or 1000+. Operates only in Dozenal. With the second option, ƐƐƐ.Ɛ(ƐƐ)$_z$ will advance to 1000.0(00)$_z$ instead of 000.0(00)$_z$. Throughout the local day the time will always increase, until local midnight (if Origin Bottom is chosen) or local noon (if Origin Top is chosen).

Fastest hand. Either shown or hidden.

Stop time. Any time of day may be chosen or inserted. The format is 00:00(:00), and the reference is UTC Greenwich (or Munich).

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The traditional clocks

The traditional clocks are analogs to the dozenal. Their principles are the same. Some things continue to work but others do not. For example, no hand or numeral may follow the sun, because it moves too quickly, covering an entire rotation in only half a day. Mapping one day onto one circumference or rotation of the Earth requires a hand or numeral to move around the clock once a day.

That is possible on a set of hybrid clocks. Rotation once per day of the hour hand and/or of the numerals in the opposite direction combines with the current rotation of the faster hands to produce a 24-hour clock. Then the hour hand, the 0, or both would follow the sun, in opposite directions. Those clocks, however, are not part of this project.

The following is what happens on the traditional clocks with respect to each of the user choices above. The coloured arcs represent the phases of the local day: overnight (grey), morning (blue), afternoon (yellow), evening (red). On the A clocks they are stationary. On the B clocks they rotate. (The abbreviation in the drop-down menu for each clock type is of limited use for the traditional clocks. See the dozenal clocks' descriptions above for their meaning.)

Clock 1. The basic UTC clock.
1a. The shortest hand indicates the phases of the local day.
1b. The 12 indicates the phases of the local day.

Clock 2. The shortest hand is stationary and the numerals rotate.
2a. The 12 indicates the phases of the local day.
2b. The shortest hand indicates the phases of the local day.

Clock 3. The numerals are offset counterclockwise according to longitude.
3a. The shortest hand indicates the phases of the local day.
3b. The 12 indicates the phases of the local day.

Clock 4. The numerals are offset clockwise according to longitude. The shortest hand is stationary and the numerals rotate.
4a. The 12 indicates the phases of the local day.
4b. The shortest hand indicates the phases of the local day.

Override. Same as for Dozenal. Co-ordinates may be entered, in decimal only: latitude between -90° and +90°, longitude between -180° and +180°. Clicking on *Go to override* activates them.

Phases o/a. Same principle as for Dozenal. The overnight phase, abbreviated *O,* indicated by the grey arc, begins at local midnight. The afternoon phase, abbreviated *A,* indicated by the yellow arc, begins at local noon. The morning phase is indicated by the blue arc, and the evening phase by the red arc.

Only two phases appear at a time, because the clock displays only half a day at a time. At local noon, the colour pair switches from grey-blue to yellow-red; at local midnight, the colour pair switches the other way.

Unlike for Dozenal, regardless of whether Origin Bottom or Origin Top is chosen (see below), the phases are listed below the clock face as o/a.

Band width. The measures are kilometers and miles. Those and **Pos'n (Position)** depend on the band chosen (see **Time band** below). The calculations acknowledge the Earth's oblate spheroid shape.

Because of that shape, other irregularities of the Earth, and the nature of measurement, the values computed on these clocks, including the time, are precise approximations with as high accuracy as certain physical and computational characteristics allow.

Under the hamburger icon are found the following.

Type. Clock 1, 2, 3, or 4, with a or b. See above for the descriptions of A and B and each clock.

Mode. Dozenal or Traditional. As noted above. If Dozenal, the clock is diurnal (24-hour); if Traditional, semidiurnal (2 x 12 hours), with the usual sexagesimal division of the hours and minutes.

Direction. Clockwise or Counterclockwise. Same as for Dozenal. The hands may move in either direction.

Origin. Bottom or Top. The default value for Traditional is Origin Top, although Origin Bottom may be chosen.

For Origin Bottom, at longitude 0° or +/-180° and time 00:00 or 12:00, the 12 will be at the bottom of each clock. For Origin Top and the same conditions, the 12 will be at the top of each clock. Corresponding values for Munich are longitude 11.56470° or -168.43530° (see the next item).

Prime meridian. Greenwich or Munich. Same as for Dozenal. Longitude 0° may be at Greenwich, England or repositioned at 11.56470° to the east, in Munich, Germany. If the latter, longitude +/-180° passes through the least amount of land in the Pacific Ocean between the North Pole and Antarctica. If Munich is chosen, it generates the UTC value in place of Greenwich.

Time band. The time bands range from 2 hours wide (12 of them around the Earth) to 0.1 second (864,000 of them around the Earth) to continuous. The default value, 1 hour, is 15° in circumference.

Low inputs are of uncertain accuracy or use. They are available for experimental purposes. The designation *Continuous* is theoretical: a band width of 0, infinitely many of them around the Earth. Here it gives the same result for phase (see above) as 0.1 second, because the phase values go only to one decimal place.

The band together with the latitude determines the **Band width** and the **Position.** In a percentage, the latter indicates how far the location chosen is from the band's border. Unlike for Dozenal, regardless of whether Origin Bottom or Origin Top is chosen, the border involved is the one closer to Greenwich (or Munich).

Display. The digital time format is in seconds or tenths of a second.

Rollover. Does not operate in Traditional.

Fastest hand. Either shown or hidden.

Stop time. Same as for Dozenal. Any time of day may be chosen or inserted. The format is 00:00(:00), and the reference is UTC Greenwich (or Munich).

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A further note

With UTC there is no local time. It is antithetical to think of time reckoning itself as local, because UTC negates time zones. For some locations, however, a simulation of local time in its current sense may be determined by subtracting the overnight offset from the UTC. Because daylight saving time is not part of UTC, it may be simulated by using a location 15° to the east of whatever is chosen originally, or by adding 1 hour to the result of the subtraction.

None of those Ersatz procedures works if the original location is in a time zone not in accord with where the strict 24-part longitudinal division of the Earth puts it. For example, Huntington Woods, Michigan, USA, longitude -83.1669°, has an O offset from Greenwich of 300z (6:00), placing it in the North American Central time zone. But it is near the western end of the Eastern zone. There are many such divergences on all six heavily populated continents and on islands near them or far away in the oceans.

It is also a problem to think in terms of time zones when any band is chosen other than 1 hour (60 trices). Some smaller bands seem advantageous, because they allow neighbouring areas to differ in offset by less time.

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