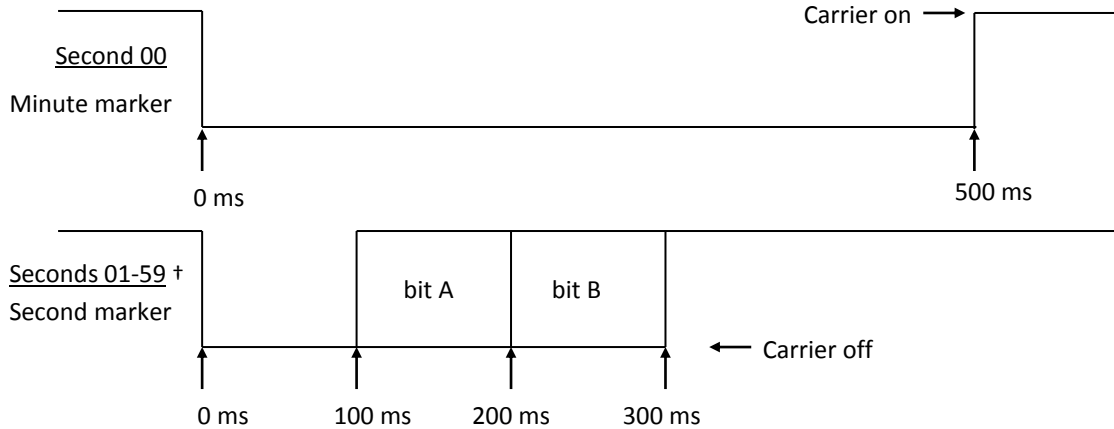# MSF 60 kHz Time and Date Code

The two bits, numbered xxA and xxB for second xx
bit polarity: 0=on, 1=off

† Most minutes have 60 seconds numbered 00-59; exceptionally a UTC minute can have 61 seconds with the extra second being numbered 60 (a positive leap second), or 59 seconds (a negative leap second).

The MSF transmission from Anthorn (latitude 54° 55' N, longitude 3° 15' W) is the principal means of disseminating the UK national standards of time and frequency which are maintained by the National Physical Laboratory. The effective monopole radiated power is 15 kW and the antenna is substantially omnidirectional. The signal strength is greater than 10 mV/m at 100 km and greater than 100 μV/m at 1000 km from the transmitter. The signal is widely used in northern and western Europe. The carrier frequency is maintained at 60 kHz to within 2 parts in 10^{12}.

The MSF time and date code format is summarised in the diagrams above. Simple on-off carrier modulation is used, the rise and fall times of the carrier are determined by the combination of antenna and transmitter. The timing of these edges is governed by the seconds and minutes of Coordinated Universal Time (UTC), which is always within 0.9 seconds of Universal Time (UT1), an astronomical time scale based on the Earth's rotation descended from Greenwich Mean Time (GMT). Every UTC second is marked by an 'off' preceded by at least 500 ms of carrier, and this second marker is transmitted with an accuracy better than ±1 ms.

The first second of the minute begins with a period of 500 ms with the carrier off, to serve as a minute marker. The other 59 (or, exceptionally, 60 or 58) seconds of the minute always begin with at least 100 ms 'off' and end with at least 700 ms of carrier. Seconds 01-16 carry information for the current minute about the difference (DUT1) between astronomical time and atomic time, and the remaining seconds convey the time and date code. The time and date code information is always given in terms of UK clock time and date, which is UTC in winter and UTC+1h when Summer Time is in effect, and it relates to the minute following that in which it is transmitted.

The allocation of the signalling bits is detailed below and on the continuation sheet. Bits 17B-*51B inclusive, and bits 01A-*16A inclusive, are currently set to '0', but may be used in the future. Bits *52B and *59B are currently set at '0' but they may be used in the future.

Minute Identifier

Bits *53A, *54A, *55A, *56A, *57A and *58A are all set permanently at '1', and are always preceded by bit *52A at '0', and followed by bit *59A at '0'. This sequence 01111110 never appears elsewhere in bit A, so it uniquely identifies the following second 00 minute marker.

*In minutes lengthened or shortened by a positive or negative leap second all these numbers are correspondingly increased or decreased by one (i.e. during these 61- or 59- second minutes the position of the time and date code is shifted by one second relative to the start of that minute).

DUT Code

The difference UT1 - UTC is known as DUT1 and is signalled to the nearest 100 ms in the range ±800 ms. A positive value means that UT1 is ahead of UTC. Bits 01B-16B are used to represent the DUT1 code in the following way, with bits not specified set to '0'.

DUT1	positive
0 ms	no bits set to '1'
+100 ms	bit 01B '1'
+200 ms	bits 01B and 02B '1'
+300 ms	bits 01B-03B inclusive '1'
+400 ms	bits 01B-04B inclusive '1'
+500 ms	bits 01B-05B inclusive '1'
+600 ms	bits 01B-06B inclusive '1'
+700 ms	bits 01B-07B inclusive '1'
+800 ms	bits 01B-08B inclusive '1'

DUT1	negative
- 0 ms	no bits set to '1'
-100 ms	bit 09B '1'
-200 ms	bits 09B and 10B '1'
-300 ms	bits 09B-11B inclusive '1'
-400 ms	bits 09B-12B inclusive '1'
-500 ms	bits 09B-13B inclusive '1'
-600 ms	bits 09B-14B inclusive '1'
-700 ms	bits 09B-15B inclusive '1'
-800 ms	bits 09B-16B inclusive '1'

Time and Date Code

Binary-Coded-Decimal Year (00-99)							
80	40	20	10	8	4	2	1
*17A	*18A	*19A	*20A	*21A	*22A	*23A	*24A

BCD Month (01-12)					BCD Day-of-Month (01-31)						Day-of-Week †		
10	8	4	2	1	20	10	8	4	2	1	4	2	1
*25A	*26A	*27A	*28A	*29A	*30A	*31A	*32A	*33A	*34A	*35A	*36A	*37A	*38A

† 0=Sunday to 6=Saturday

BCD Hour (00-23)						BCD Minute (00-59)						
20	10	8	4	2	1	40	20	10	8	4	2	1
*39A	*40A	*41A	*42A	*43A	*44A	*45A	*46A	*47A	*48A	*49A	*50A	*51A

Parity Bits

Bit *54B, taken with bits *17A-*24A inclusive, provides an odd number of bits set to '1'.
Bit *55B,   "   *25A-*35A inclusive,   "   "   "
Bit *56B,   "   *36A-*38A inclusive,   "   "   "
Bit *57B,   "   *39A-*51A inclusive,   "   "   "

Summer Time

When UK civil time is subject to a one-hour positive offset during part of the year, this period is indicated by setting bit *58B to '1'. Bit *53B is set to '1' during the 61 consecutive minutes immediately before a change, the last being minute 59, when bit *58B changes.

In the event of UK civil time undergoing an additional permanent offset, bit *58B will need to be changed once without any corresponding change in UK clock time.

Further Information

For further information please visit our website:
https://www.npl.co.uk/msf-signal