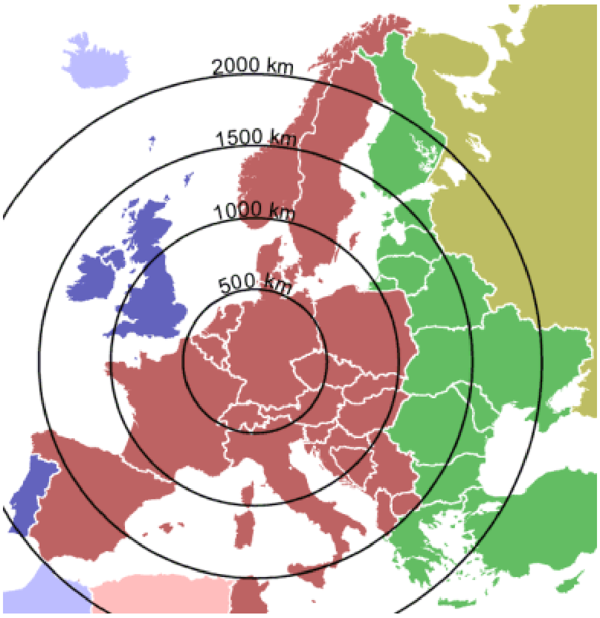
DCF77 Clock Module

The DCF 77 transmitter is located at Mainflingen near Frankfurt and radiates UTC time information on 77.5 kHz. It is receivable within approximately 2000 km of Frankfurt. Coverage depends on the receive location, interference from local electrical equipment, or any electrical storms between the receive location and Frankfurt.

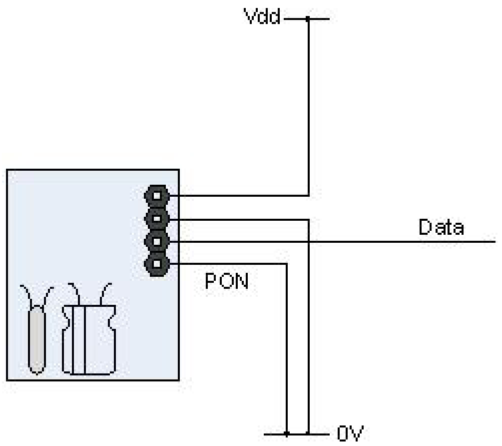
The module described in this document is designed to receive the transmissions on 77.5 kHz, and output any data-stream containing the demodulated timing information. Typical synchronization time (time to first presentation of output on the data pin) is 90 seconds.

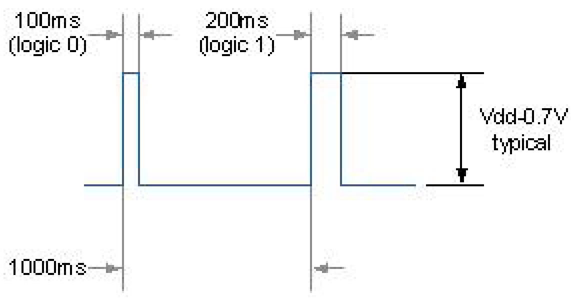


The module.

The clock module consists of a ferrite rod antenna and a small PCB with the following connections

- **Vdd** D. C. Supply voltage (range 1.2V to 4.5Vdc)
- **GND** 0V ground connection
- **Data** DCF data signal (sink/source 5uA max), see below. Typically Vdd when the DCF77 carrier is modulated, otherwise 0V. Also 0V whilst receiver is synchronising.
- **PON** Power On - connected to 0V to enable the receiver section, when open-circuit (or pulled to Vdd) the receiver section is disabled





Module Specification

Time to receive signal: maximum 20 minutes in favourable signal conditions (90 sec typical)

Operating voltage: 1.2 – 4.5V (3V typ)

Current consumption: 100uA

Reception frequency: 40 – 100kHz (77.5KHz typ)

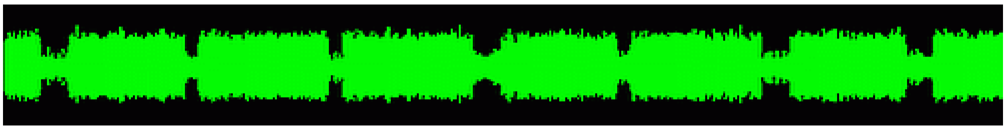
Frequency tolerance: +/-300Hz

Sensitivity: 80uV

Data output capability: 5uA max (source/sink). Only connect to a buffered input. Do not connect pull-up or pull-down resistors which would cause in excess of **5uA** to flow.

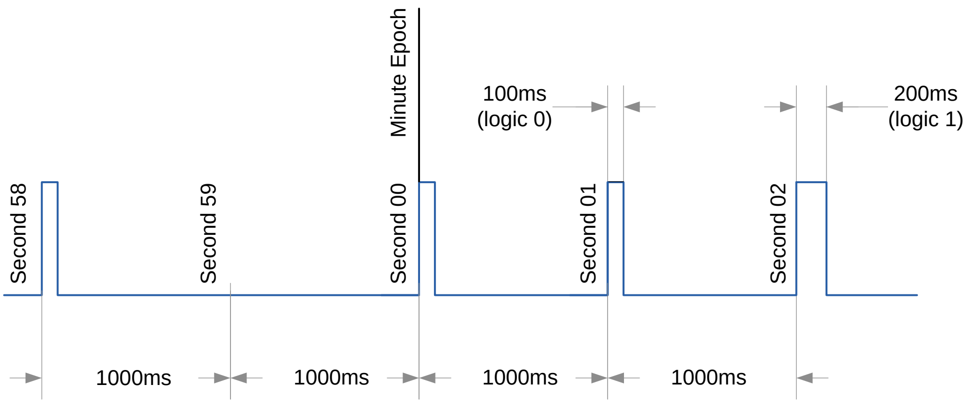
The radiated signal.

Transmitter signal is radiated at approximately 30 kW Effective Radiated Power (ERP). The timing information is conveyed by reducing the carrier amplitude by approximately 6dB (to 7.5kW ERP) for either to 200 milliseconds to represent logic 1, or 100 ms to represent logic 0.

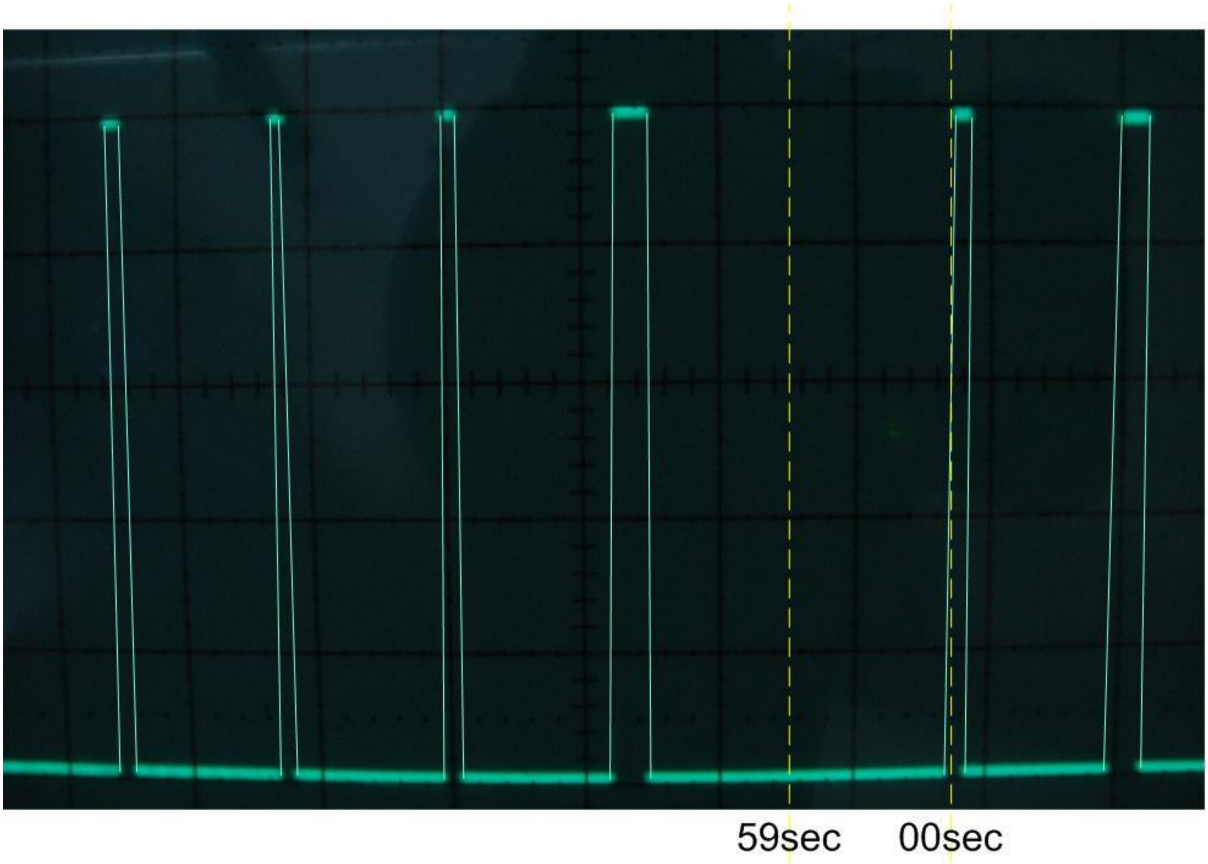


Decoding the timing information.

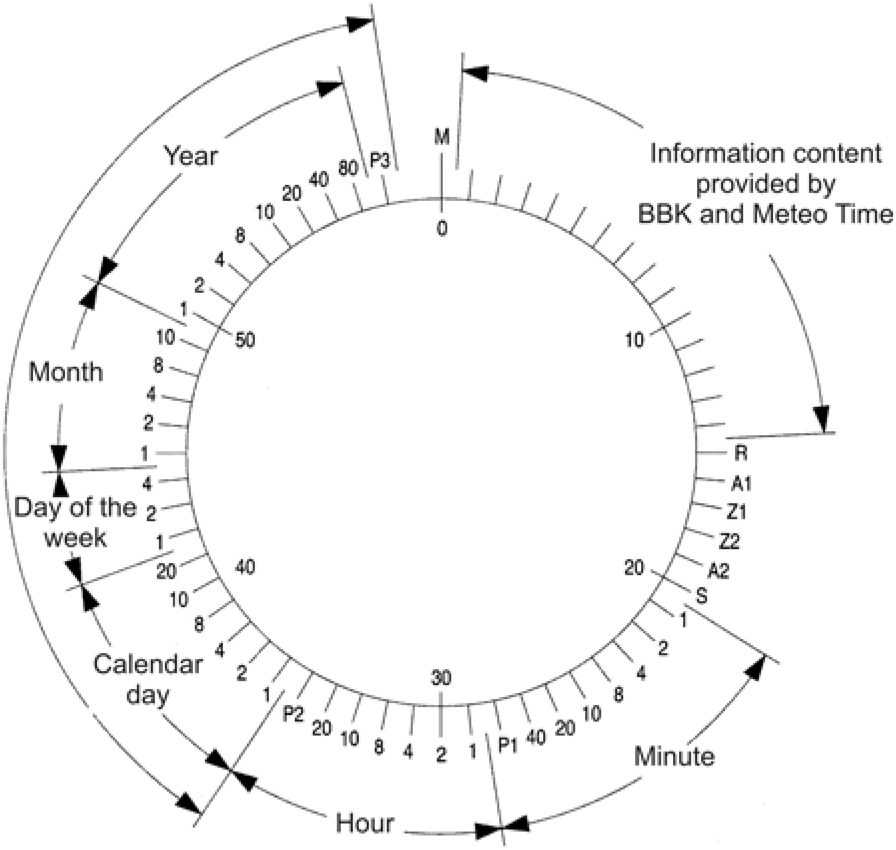
The time and date information, and so on, is encoded as binary coded decimal (BCD) and transmitted every second (excluding the 59th second). The image below is representation of where the time and date information is radiated in each minute.



The following is an 8 second exposure to capture the oscilloscope trace of the data pin around the turn of the minute.



1.



Once a minute, the numbers of minute, hour, day, day of the week, month and year are transmitted on the basis of a BCD code (BCD: Binary Coded Decimal, every digit of a number is encoded separately). From the calendar year, only the *units* place and the *tens* place are transmitted, i.e. the year 2005 only as 05.

Each code emitted contains the information for the following minute.

Details of the information transmitted

Bits 1-14 – Special Information

For many years, information about the operation of the broadcast plant was transmitted from the DCF77 control facility using second marks Nos. 1 to 14. Although prolonged second marks in this range generally indicated an irregularity in the control or transmitting facilities, this did not mean that the time information emitted in the remainder of the minute was erroneous. Such an indication of a malfunction was transmitted only very rarely, so that some developers of DCF77 decoding software carelessly assumed that these bits would never carry information.

Since the middle of 2003 only the second mark #15 (“call bit“) is used to signalize irregularities in the control facilities.

Data input to bits 1 to 14 which are broadcast via amplitude modulation are now provided by a third party. These bits are used for the purpose of public warning and transmission of weather data supplied by the Swiss firm Meteo Time GmbH.

Time Information – bit 15 onwards

Zone time bits Z1 and Z2 (second marks Nos. 17 and 18) show to which time system the time information transmitted after second mark 20 refers. For the emission of CET, Z1 has the state zero and Z2 the state one. When CEST is being emitted, this is reversed.

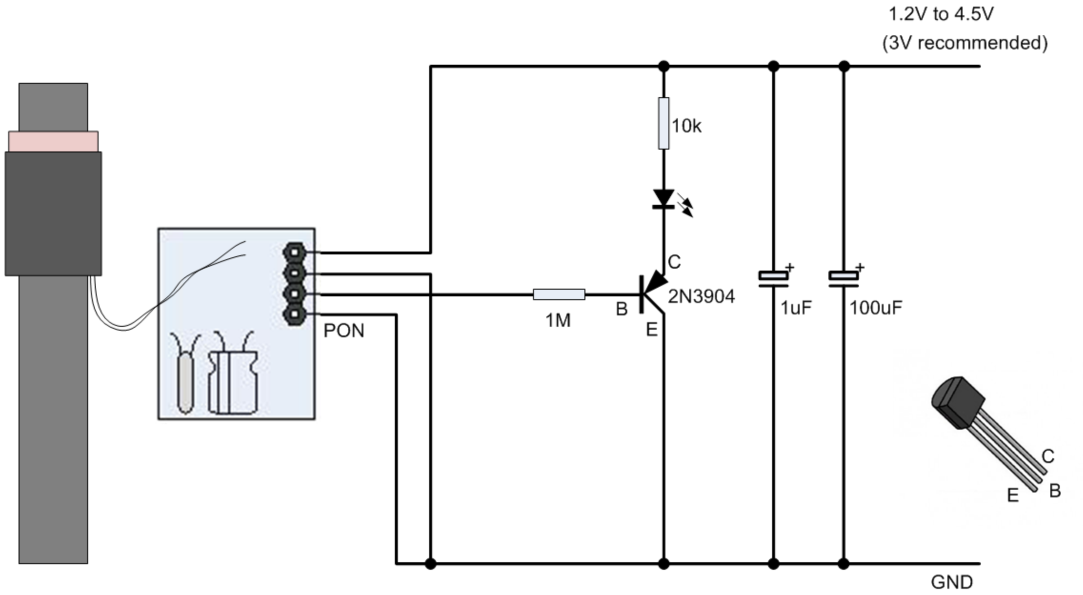
The announcement bit A1 (No. 16) indicates an imminent change-over of the time system. Before the transition from CET to CEST or back takes place, A1 is emitted for one hour in state one: before change-over from CET to CEST (CEST to CET) from 01:00:16 h CET (02:00:16 h CEST) until 01:59:16 h CET (02:59:16 h CEST).

Announcement bit A2 (No. 19) adverts the imminent introduction of a leap second. A2 is also emitted for one hour in state one before a leap second is inserted. Before a leap second is inserted on the 1st of January (1st of July), A2 is therefore emitted sixty times from 00:00:19 h CET (01:00:19 h CEST) until 00:59:19 h CET (01:59:19 h CEST) in state one.

The day of the week is encoded in accordance with standard ISO 8601 or DIN EN 28601, Monday being day one of the week. The three parity test bits P1, P2 and P3 complement the preceding information words (7 bits for the minute, 6 bits for the hour and 22 bits for the date including the number of the weekday) to an even number of ones.

In the case of the AM second marks, a leap second is inserted as follows: The 59th second mark preceding mark 01:00:00 h CET or 02:00:00 h CEST is emitted – different than before – with a duration of 0.1 s. After that, the inserted 60th second mark is emitted without carrier reduction. The probability that leap seconds must be omitted is negligible. However, the technical facilities on the transmitter allow it.

Test Circuit



It is important not to draw more than 5uA from the output pin, so a 1M resistor is used to limit the current and the transistor acts as a buffer for the led.

The two capacitors across the power supply help to provide a low impedance source of current to the module and are beneficial when using a bench power supply to overcome the inductive impedance of the leads.

Generally the led will start flasing after the module has been powered for 10 seconds of so.

Troubleshooting

Please check the following if you are having problems receiving the signal:

1. Place the antenna broadside to Frankfurt.
2. Ensure the PON pin is grounded to enable the data output.
3. Locate away from metalwork and sources of interference such as PCs , microwaves, LCD Tvs, etc. Try outside to ensure the unit is working, as certain building constructions can severely attenuate the signal.
4. Allow enough time for signal lock (generally 90 seconds, but can be up to 20 minutes). Coverage of the Frankfurt transmitter is better at night, so in poor signal areas, it may be better to synchronise your clock at 3am.
5. The data output pin can only source/sink 5uA, so you will need to feed a high impedance input such as an oscilloscope, comparator, or transistor buffer.