

Description of ctrlr14 operation

The ARDF transmitter (fox) controller ctrlr14 using the ATtiny84 is derived from the 8-pin ctrlr8, and the new requirement of pin-selectable startup delay times requires the additional pins.

A variant of ctrlr14 is ctrlr914 which can have a PWM audio tone output. The ctrlr914 includes all of the features to be described for ctrlr14.

The startup delay time is selected by placing a (negative true) binary number on up to three of the input pins, which is conveniently done with an 8-position rotary switch with SPST binary contacts out, with a 3-position SPST DIP switch, or with a 2X3 pin header jumper array. The inputs used are configured with internal pull up resistors, so no components other than the switch are needed for selection.

Since there are enough pins (assuming only the LED and Tx drive need pins) it simplifies mode selection to use a similar 3-pin binary input on 3 other pins. However, should another use for these mode-select pins be discovered, the analog input on a single pin could alternately be implemented.

The pins to use for these select inputs can be chosen arbitrarily as they are read one bit at a time, using the digital pin numbers taken from a 3-byte array of pin numbers in msb-to-lsb order. Choosing other pins needs only to re-specify the array values. (Note that the digital pin numbers in the arrays are those assigned by the arduino IDE, not the physical IC pin numbers). Additionally, the number of bits to be used for these selections can be 3 (8 possible selections), 2 (4 possible selections), or 1 (2 selections).

One analog input pin is used for a low battery voltage detection input.

Three pins are used for outputs, an LED, Morse keying of the transmitter, and a control line that straddles the time of a Morse transmission (push-to-talk, or oscillator control).

Pin assignments, number of select inputs, output logic polarity, and several operating features are decided at compile-time for building the firmware. The building procedure, description of features, EEPROM layout, etc. for the firmware is described more fully in the separate document `ARDFTxcontroller_ctrlr8_ctrlr14`. Once these decisions are made, the ctrlr14 controller will have three distinct operating states—fox control, delayed start, and low-battery.

Fox control state

In this operating state the controller is primarily generating the on/off Morse code keying signal for a CW transmitter, with timing determined by the operating mode chosen with the mode-select switches.

There are up to 8 modes. These modes are defined by the IARU contest rules and are summarized as follows:

- Classic (or normal) – Tx sends fox ID as slow Morse MOx, repeatedly for 1 minute, is silent for 4 minutes, then repeats.

- Sprint fast and slow – Tx sends fox ID as fast or slow Morse MOx, repeatedly for 12 seconds, is silent for 48 seconds then repeats.
- FoxOr fast and slow – Tx sends fox ID as fast or slow Morse MOx, continuously.
- Finish beacon – Tx sends Morse MO continuously.
- Spectator beacon – Tx sends Morse S continuously.
- There is one mode of the 8 presently unused.

The fox ID (MOx) is one of MOE, MOI, MOS, MOH, MO5. The controller firmware finds the ID to use in EEPROM. The Morse slow speed is approximately 10 wpm, the Morse fast speed is approximately 14 wpm.

For the timed modes (normal, sprints), the timing begins on release of the controller reset. For the sprint modes, release at the start of a one minute interval will begin the timing sequence indexed according to the fox ID—fox 1 (MOE) starts immediately, fox 2 (MOI) starts at 12 seconds after the minute, ..., fox 5 (MO5) starts 48 seconds after the minute. For the normal mode, the starting may be indexed on a 5 minute cycle. In the indexed case, fox 1 starts at the reset release, fox 2 starts one minute later, etc. The normal mode may also be non-indexed, in which case the transmission starts at release of reset regardless of which fox ID is sent.

For the timed modes, the LED will be driven with the Morse keying signal during the first transmission after reset, and then remain OFF thereafter.

For the continuous modes (beacons, FoxOr), the LED indicates the Morse keying for about 30 seconds after reset and then remains OFF.

The optional PTT or oscillator control output goes true just before the first Morse element, remains true as long as Morse sending is underway, and then goes false when the sending ends. It remains true for continuous modes. The duration of the PTT advance is either a compile-time parameter (ctrlr14) or stored in EEPROM (ctrlr914).

In each mode, the controller will insert a call sign identification at a high speed after the first sending of a MOx, and this call sign identification will repeat at a compile-time selected interval—say every 30 minutes.

Delayed start state

The purpose of the delayed start is to permit all of the transmitter controllers for a particular contest to be released from reset together, to remain (nearly) silent for the delay interval selected with the delay-select inputs, and then to all begin their operation after they have been moved into position on the contest course.

The delay-select inputs give a binary number in the range 0..8. This number is used as an index into a table of two byte integers stored in EEPROM. Delay-select 0 is reserved for no delay, and the controller would then start up in fox control state. The integer values are the number of minutes of delay.

The eighth integer in the delays table in EEPROM is used to specify a duration at the end of the delay interval during which the transmitter will send a short burst consisting of the fox ID sent at high speed, at the indexed time for the fox, once every 5 minutes during this end interval.

During the entire delayed start interval, the LED will flash once per second to indicate a delay timing is in progress.

At the end of the delayed start interval, the controller returns to the fox control state.

Low-battery state

The purpose of the low-battery state is to reduce the ON time of the transmitter to preserve the remaining battery capacity, yet continue to send ID so that the transmitter could still be located with direction finding techniques.

At the end of each timed transmission, or after about each minute of the continuous modes, the analog input pin assigned is sampled. The A/D count is compared with an integer value stored in EEPROM, and if it is below the stored count, then the controller enters the low-battery state.

In the low-battery state, the controller sends two or three MOx once every 5 minutes. In the timed modes, the low-battery transmissions occur at the time appropriate to the fox ID and mode. For example, fox 2 in the sprint modes would transmit at 12 seconds after the even minute. The first transmission after detecting the low-battery condition occurs one minute plus the index time after the previous beginning of the timed cycle. This way, the low-battery fox will still be operating in its proper time slot, but with reduced ON time. With continuous modes, there is no proper time slot so the low-battery mode just starts a minute after detecting the low voltage and then every 5 minutes thereafter.

Once in the low-battery state, the controller remains in it.