**Dutchtronix Oscilloscope Clock 3.1**

| Item | PCB Designator | Description | Digi-Key Part Number | e-Bay | Advanced Circuits | Mouser Part Number |
|---|---|---|---|---|---|---|
| | | Bare 3" x 3" PCB (provide Gerber files and order bare PCB) | | | | |
| 1 | PCB | Minimum Order quantities may apply. | | | www.4PCB.com | |
| 2 | IC1 | 20MHz ATMEGA328P-PU 8BIT 32KB FLASH 28DIP | ATMEGA328P-PU-ND | | | 556-ATMEGA328P-PU |
| 3 | IC2 | AD7302BNZ DAC 8BIT V-OUT 20DIP | AD7302BNZ-ND | | | 584-AD7302BNZ |
| 4 | IC3 | 8563 RTC CLK/CALENDAR I2C 8-PIN DIP | | PCF8563P | | |
| 5 | IC5 | HIN232ACPZ TTL to RS232C Level Converter/Driver | HIN232ACPZ-ND | | | 968-HIN232ACPZ |
| 6 | Battery | Renata CR1225FV 48mAH Coin Cell 3V Lithium | | | | 614-CR1225FV-LF |
| 7 | Q1 | CRYSTAL 20.0000MHz +/-10ppm 18pF | 887-1248-ND | | | 520-ECS200-18-4X-CKM |
| 8 | Q4 | Citizen CFS-20632768HZFB CRYSTAL 32.7680kHz +/- 5ppm 12.5pF | 300-8763-ND | | | 695-CFS-20632768HZFB |
| 9 | D3, D4 | BAT42 Schottky diode | 497-2495-1-ND | | | 511-BAT42 |
| 10 | D5 | 1N4001 diode 50V 1A | 1N4001GDICT-ND | | | 621-1N4001G-T |
| 11 | R8 | Amphenol PT10LV10-102A2020-S POT 1K OHM LINEAR | 1993-1115-ND | | | 531-PT10V-1K-S |
| 12 | S1, S2 | TE Connectivity 1825910-6 SWITCH TACTILE SPST-NO 0.05A 24V | 450-1650-ND | | | |
| 13 | S3 | SWITCH SLIDE SPDT 200MA 30V | EG1903-ND | | | 612-EG1218 |
| 14 | D2 | Green LED 10mcd at 7mA diffused 3mm round | 732-5008-ND | | | 710-151031VS06000 |
| 15 | D1 | Red LED 10mcd at 7mA diffused 3mm round | 732-5006-ND | | | 710-151031SS06000 |
| 16 | IC4 | 5V 1A Regulator LM7805CT | 296-47192-ND | | | 926-LM7805CT/NOPB |
| 17 | Q3 | 2N3904 TRANS NPN 40V 0.2A TO-92 | 2N3904FS-ND | | | 512-2N3904BU |
| 18 | C7, C8 | Panasonic CAP ALUM 10uF 20% 16V RADIAL | P19513CT-ND | | | 667-ECA-1CM100I |
| 19 | C6, C17 | Rubycon CAP ALUM 100uF 20% 35V RADIAL | 1189-1300-ND | | | 232-35ZLH100MEFC63X1 |
| 20 | C3, C4 | AVX CAP CER 22pF 100V NP0 RADIAL | 478-SR151A220GAA-ND | | | 581-SR151A220GAA |
| 21 | C1, C2, C5, C12, C13, C14, C15, C16, C18 | Kemet CAP CER 0.1uF 50V X7R RADIAL | 399-9867-1-ND | | | 80-C320C104J5R7301 |
| 22 | R1, R2, R3, R4, R5 | RES 10K ohm 1/4W 5% AXIAL | CF14JT10K0CT-ND | | | 660-CF1/4CT26A103J |
| 23 | R6, R9 | RES 390 ohm 1/4W 5% AXIAL (value is for LEDs specified) | CF14JT390RCT-ND | | | 660-MF1/4LCT52R391J |
| 24 | R7, R14 | RES 1K ohm 1/4W 5% AXIAL | CF14JT1K00CT-ND | | | 660-MFS1/4LCT52R102J |
| 25 | R13 | RES 4.7K ohm 1/4W 5% AXIAL | CF14JT4K70CT-ND | | | 660-CFS1/4C472J |
| 26 | IC1 Socket | CONN IC DIP SOCKET 28POS TIN | ED90054-ND | | | 575-11044328 |
| 27 | IC2 Socket | CONN IC DIP SOCKET 20POS GOLD | ED90036-ND | | | 575-11043320 |
| 28 | IC3 Socket | CONN IC DIP SOCKET 8POS GOLD | ED90032-ND | | | 575-11043308 |
| 29 | IC4 Socket | CONN IC DIP SOCKET 16POS GOLD | ED3016-ND | | | 575-110433161 |
| 30 | X1 | CONN D-SUB RCPT 9POS R/A SOLDER DB9 Connector | 609-5188-ND | | | 649-LD09S13A4GV00LF |
| 31 | J2, J3 | Molex CONN BNC RCPT R/A 50 ohm PCB | WM5507-ND | | | 538-73100-0223 |
| 32 | J1 | Kycon KLDX-0202-A CONN PWR JACK 2X5.5MM SOLDER | 2092-KLDX-0202-A-ND | | | 806-KLDX-0202-A |
| 33 | CH1, CH2 | TERM TURRET SINGLE L=3.96MM | ED1069-ND | | | 575-2506200440000 |
| 34 | VCCSELECT, RXROUTE, TXROUTE, GND | CONN HEADER VERT 3POS 2.54mm | 732-5316-ND | | | 710-61300311121 |
| 35 | RS232 | CONN HEADER VERT 3POS 2.54mm WITH LOCKING TAB | A19470-ND | | | 571-6404563 |
| 36 | Power | CONN HEADER VERT 2POS 2.54mm WITH LOCKING TAB | A1921-ND | | | 571-6404562 |
| 37 | 1PPS | CONN HEADER VERT 2POS 2.54mm | | | | |
| 38 | ISP | CONN HEADER VERT 10POS 2.54mm | 2057-PH2-10-UA-ND | | | 200-TSW10507GD |
| 39 | Header Shunt 1, 2, 3, 4 | 2-pin header shunt 0.1 inch center-to-center | | | | 855-M7582-05 |

**Optional USB Connection** Components (Note: If used, install these first. Do not attempt installation, unless you have experience installing SMT components.)

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|---|---|---|---|---|---|---|
| 40 | IC6 | IC USB FS SERIAL UART 28-SSOP | 768-1306-ND | | | 895-FT232RL-TUBE |
| 41 | X2 | USB CONN RCPT TYPEB 4POS R/A | ED2983-ND | | | 649-61729-1011BLF |
| 42 | L1 | FERRITE BEAD 0805 | 240-2395-1-ND | | | 875-HI0805R800R-10 |
| 43 | C11 | CAP TANT 10uF 10% 16V 1206 | 478-8235-1-ND | | | 647-F931C106KAA |
| 44 | C10 | CAP CER SMD 0805 .01uF 100V X7R | 399-17617-1-ND | | | 80-C0805C103K1R7210 |
| 45 | C9 | CAP CER 0.1uF 50V Y5V 0805 | 399-1177-1-ND | | | 80-C0805C104Z5V |

**Optional GPS** (Note: Requires programming through its TTL-level serial port to set up for the Dutchtronix Oscilloscope Clock. Backup battery + tab can be connected to the backup battery connection on the Ducthtronix Oscilloscope Clock PCBA to save programı

| Item | PCB Designator | Description | Digi-Key Part Number | e-Bay | Advanced Circuits | Mouser Part Number |
|---|---|---|---|---|---|---|
| 46 | N/A | Adafruit 66 CH Ultimate GPS Module | 1528-1153-ND | | | 485-746 |

Remove the 1PPS connector header on the Dutchtronix oscilloscope clock PCBA and connect the Ultimate GPS 1PPS output to the 1PPS input on the 1PPS connector pad. Commands must be entered into the Ultimate GPS, before connection of RX input and TX output, respectively, to the Dutchtronix TXROUTE and RXROUTE serial interface connections and the Dutchtronix oscilloscope clock must be set up to communitate with the GPS and the "M" command needs to be sent to the Dutchtronix Oscilloscope Clock, before the physical connection is made. To preserve the settings for the Ultimate GPS, connect the backup battery connection (connect directly to the battery + pad on the PCB and GND pin) to the backup battery pads on the Ducthtronix clock PCBA. Connect the Ultimate GPS Vin pin to the +5V supply on the Dutchtronix clock PCBA. Set the Ultimate GPS to communicate at 4800 baud and to ouput $GPRMC data only, once every 5 seconds. Set the Dutchtronix oscillioscope clock GPS setting and the baud to 4800 (should change to 4800 baud when the GPS setting is completed). Then connect the serial port of the ultimate GPS to the TXROUTE and RXROUTE pins on the Dutchtronix oscilloscope clock PCBA.
Ultimate GPS Command for 4800 baud:
$PMTK251,4800*14<CR><LF>
Ultimate GPS Command for 9600 baud (default):
$PMTK251,9600*17<CR><LF>
Ultimte GPS Command for 19200 baud:
$PMTK251,19200*22<CR><LF>
Ultimate GPS Command to set the Ultimate GPS to output $GPRMC data only, once every 5 seconds:


Note: In the image to the left, traces to the RS232 3-pin header have been modified to accommodate the Adafruit Ultimate GPS connection to TXROUTE and RXROUTE on the Dutchtronix oscilloscope clock PCBA for TTL level serial port operation. The Adafruit Ultimate GPS board was mounted using 1/16 inch thick 3M 110 double sided foam tape stuck to the top of the PCF8563P RTC clock chip and top edge of the ATMEGA328P. To program the Ultimate GPS, an adapter was made to connect the USB 5V TTL level serial port to the 3-pin connector attached to the Ultimate GPS. The Realterm serial port software was used for communication to program the Ultimate GPS.

## ATMega328P Programmer

| Item | PCB Designator | Description | Digi-Key Part Number | e-Bay | Advanced Circuits | Mouser Part Number |
|---|---|---|---|---|---|---|
| 47 | N/A | Olimex AVR-ISP-MK2; ATAVRISP2 COMPATIBLE PROGRAMMER | 1188-1008-ND | | | 909-AVR-ISP-MK2 |

Notes for the Olimex AVR-ISP-MK2: Use with the Atmel Studio development software available at:
https://www.microchip.com/mplab/avr-support/atmel-studio-7
Set the programming tool type as AVRISP mkII and Device Type as ATmega328P. With the AVR-ISP-MK2 connected to the 10 pin header on the Dutchtronix Oscilloscope Clock PCBA, make sure the 5V supply is connected and on, before starting programming. When connecting to the 10 pin header, make sure Pin 1 is lined up properly. In Atmel Studio, right click on AVRISP mkII under Available Tools and select Device Programming. Set the Device Type to ATmega328P. Be aware that the AVR-ISP-MK2 will indicate a 3.3V connection to Atmel Studio regardless of the actual voltage level. Ignore this indication. Verify that the AVR-ISP-MK2 is communicating with the Atmega328P. When programming using the Dutchtronix Oscilloscope firmware with boot loader+clock software, set only the following fuses:
1. Ext Crystal Osc. Frequency 8.0- MHz, Start-up time PWRDWN/RESET: 16k CK/14 CK + 65mS
2. Boot reset vector Enabled (Boot Flash section size=512 words Boot start address=$3E00; [BOOTSZ=10])
3. Preserve EEPROM memory through the Chip Erase cycle.
4. Serial program downloading (SPI) enabled.
5. Brown-out detection level at VCC=2.7V.
6. You should now have the following fuses settings check marked: SPIEN, EESAVE, BOOTZ0, BOOTRST, BODLEVEL1.

7. Make sure that the CKDIV8 fuse setting is unchecked and will not be set. You should have: Low 0xFF, High 0xD4, and Extended 0xFD. Apply the settings to program the fuses.
8. Next, specifically initialize (clear) all memory (EEPROM and FLASH). Then use only the Flash programming feature to load and program the boot loader+clock software. The FLASH and the EEPROM boot loader will both be programmed.
9. When programming has properly completed, the green LED on the Dutchtronix oscilloscope clock PCB should be blinking. Be sure that the 1PPS jumper was installed (or there is a 1PPS pulse coming from the GPS, if it was installed instead).

**Display Case**

| Item | Designator | Description | | |
|---|---|---|---|---|
| 48 | N/A | Acrylic Housing for Clock | shopPOPdisplays | Custom Size Acrylic Display Box with Black Base - Plexiglass - shopPOPdisplays |

ming.