



## **GC1000-NTP Interface with Optional Weather Display Operating Instructions and Installation**

The GC1000-NTP interface emulates IRIG formatted time code data broadcasts by WWV stations. It is designed to connect directly to the Heath GC-1000 Most Accurate Clock. The RF board is no longer needed. GPS data (GPS not included) is received and interpreted, or Network Time Protocol (NTP) data is received using a WiFi connection, interpreted, and delivered to the tone decoder board of the GC-1000. The interface is powered directly from the clock, at +5v. Installation is simple and fully reversible, using only four wires, six if display control is used.

A weather display upgrade is available with the interface, or later as an upgrade. A small OLED display is mounted inside the clock, just above the seconds LEDs. A sensor displays inside temperature and humidity. Outside temperature, humidity, pressure, wind direction and speed, and current weather conditions, are downloaded from Weather Underground and displayed on the OLED screen.

Features of the interface include:

- Initial setup and configuration are accomplished using a web browser on a pc or mobile device.
- UTC offsets with 30 and 45 minute time differences are supported, so the GC-1000 can be used anywhere in the world.
- Daylight Saving Time (DST) start and end times are automatically handled by the GC1000-NTP.
- Connects to a GPS satellite receiver (not included), or open or password protected WiFi networks.
- Display on/off control by weekday or weekend.
- Accuracy is approximately one second for NTP, better for GPS.
- Optional weather reporting includes inside temperature and humidity. Outside temperature, humidity, pressure, wind direction and speed, and current weather conditions, are downloaded from Weather Underground.

### **Button functions:**

Short press and release – restart interface

GC1000-NTP Revision 3.4

Long, ten second hold and release – restart interface in access point mode to set or reset configuration

Long, twenty second hold and release – same as above, and reset all settings to defaults

### Configuration settings:

Defaults are for USA, Eastern Time –

DST = March, Week 2, Sunday, 2:00AM

STD = November, Week 1, Sunday, 2:00AM

Option	Description	Setting
1	Access Point Name	Defaults to GC1000-NTP
2	NTP or GPS	Source for time info
3	SSID	WiFi network name (Networks will be displayed in a dropdown)
4	Password	WiFi password
5	NTP server	Server that provides time information (default is us.pool.ntp.org)
6	GPS Baud Rate	Match setting of GPS receiver
7	LED data indicator	Off, On with Display, Always On (On with display turns off indicator when display is off. See #21-29. Blinks as packet data is generated, red=0, green=1, blue=mark)
8	UTC offset hours	0 – 13 hours (0 = no offset from UTC)
9	UTC offset minutes	0, 30, 45
10	UTC offset direction	+/-
11	DST offset hours	0 – 13 hours (0 = no DST)
12	DST offset direction	+/-
13	DST start month	1 – 12 month
14	DST start week of month	1 - 5
15	DST start day of week	1 – 7 (Sunday = 1)
16	DST start time change	0 – 23 hours
17	DST end month	1 – 12 month
18	DST end week of month	1 - 5
19	DST end day of week	1 – 7 (Sunday = 1)

Option	Description	Setting
20	DST end time change	0 – 23 hours
21, 24, 27	Display Off Time	0-23 Turns off display at this time
22,25, 28	Display On Time	0-23 Turns on display at this time
23, 26, 29	Display Days	All, Weekdays, Weekends
		<b>Following are available with the Weather option only:</b>
30	Weather Underground Key	Sign up here to get a free developer key: <a href="https://www.wunderground.com/signup?mode=api_signup">https://www.wunderground.com/signup?mode=api_signup</a>
31	Postal Code or Station ID	Connects IDInterface to Weather Underground weather station. Less than 7 characters is recognized as a postal code. Seven characters or more is recognized as a station id.
32	WU Poll Interval	1-60 minutes Free Weather Underground Stratus plan allows 500 calls per day so this should not be set to less than 3.
32	Inside Sensor Display	Off, Temperature, add Humidity
33	Outside Data Display	Off, Temperature, add Humidity, add Humidity & Pressure, add Humidity, Pressure, & Wind
34	Current Weather Display	Current weather
35	Scale	Fahrenheit-inHg-mph, Celsius-hPa-kph
36	Offset	Inside temperature offset. Scale is -.5 degree per increment.
37	Labels	Use labels for each parameter displayed. This substantially lengthens the string of characters.
38	Weather Display	Off with Time Display, Always On

## Setup

If the interface has not been previously configured, it will start in access point mode, with SSID = GC1000-NTP.

Connect using WiFi from a pc or mobile device. After the connection is made, use a browser to connect to IP address 192.168.13.1.

Set the time source to NTP or GPS.

Set remaining options as required and press the save button at the bottom of the form. The NTP password must be blank for an open connection, or eight or more characters long for a password protected connection. Anything less than eight characters will be ignored and the interface will assume that the connection is to an open, unsecured access point.

**DO NOT USE PUNCTUATION OR CONTROL CHARACTERS IN THE PASSWORD FIELD. SOME CHARACTERS (DEFINITELY '?') WILL CORRUPT THE SETUP DATA. IF THAT HAPPENS, PRESS THE BUTTON FOR TWENTY SECONDS TO RESET SETTINGS TO DEFAULTS.**

For GPS, make sure the baud rates match. Most modern GPS modules default to 9600 baud. A good, inexpensive choice is the Ublox Neo-6M, commonly available on eBay. Use a TTL level GPS module that works at 3.3v, not RS-232.

A short press and release of the button will restart the interface. A long press greater than ten seconds will restore access point mode to reconfigure settings. A long press greater than twenty seconds will restore access point mode and will reset all settings to defaults.

At startup, the blue RGB LED will blink the software version number.

If display on/off times overlap, the lowest numbered times have the highest priority.

## Weather Display (optional upgrade)

Original, Version 3 interface boards can be updated by flashing the latest software. Later boards purchased without the weather option can be upgraded at extra cost. Those boards must have the microcontroller returned for reprogramming.

Weather display is an option that includes additional software, an OLED display, and a sensor.

Install the hardware following the instructions below, and enter setup parameters as desired.

If GPS is used as the time source, WiFi must be available to download data from Weather Underground. Be sure to select a WiFi SSID and enter the password.

If weather data is not displayed, carefully verify that the following information is entered correctly: Weather Underground key, Postal Code, WiFi SSID, WiFi password.

Weather Underground Terms of Service must be accepted before accessing API Data.  
[Weather Underground Terms of Service](#)

[Sign up for a free developer key here.](#)



## Messages

Message codes are indicated by the data light on the GC-1000, and red on the RGB LED. They are displayed approximately every five seconds. The interface will continue to attempt connection while message codes are displayed.

- 1 blink – Waiting in access point mode for configuration data to be entered.
- 2 blinks – No WiFi connection (NTP setting only).
- 3 blinks – No NTP server connection (NTP setting only).
- 4 blinks – No GPS connection (GPS only).
- 5 blinks – No time source selected – GPS not available or WiFi info not available or not entered correctly.
- 6 blinks – Software has been illegally copied and will not run on currently installed hardware.

DST time changes occur three or four minutes after the set time, due to the way the clock processes data frames.

For GPS connection, verify that the receiver is working, and that baud rates match.

GPS connection and messages take much longer to respond than NTP connection and messages.

With the weather option, the following connection messages are displayed on the screen:

Access Point XXX

Connecting to XXX

NTP Sync with us.pool.ntp.org (this message may display quickly or not at all)

Connecting to GPS

Waiting for Time Source

## Software Updates

Occasional software updates may be provided to improve performance and/or add new features. Carefully follow these instructions to update the software.

Connect the board to a PC using a USB cable. In Device Manager, note the COM port. It is not necessary to remove power from the clock, or to remove the processor board from the interface.

Click [ESP32 Flash Download Tool](#) to download the programming software, and click on the

file to install and run. It is stored on the site as a .RAR file so a compatible utility must be used to unpack the file. . It is also stored at [angryelectrons.co](http://angryelectrons.co) on the product page, as a zip file. Extract it and run the .exe file.

Select *ESP32 Download Tool* from the menu.

Select *SPI Download* tab and enter the following settings:

*Download Path Config:* Select the file provided by email or the web site by clicking on the box with three dots, on the first line. After “@”, enter address 0x00010000. Check the box to the left of the file name.

**DO NOT CHECK ANY OTHER BOX IN THE LEFT COLUMN. IF THEY ARE CHECKED BY DEFAULT, UNCHECK THEM.**

Additional Settings

*Crystal Freq:*40M

*SPI SPEED:* 40MHz

*SPI MODE:* QIO

*FLASH SIZE:* 32Mbit

*COM:* Port: Enter the port noted in the Device Manager.

*BAUD:* Select 921600. If the update fails, try a slower baud rate.

**DO NOT SET OR CHANGE ANY OTHER SETTINGS. REVIEW TO MAKE SURE ALL SETTINGS ARE CORRECT, ESPECIALLY THE ADDRESS AFTER “@.” IF INCORRECT SETTINGS ARE FLASHED, THE PROCESSOR MAY HAVE TO BE RETURNED FOR REPROGRAMMING.**

Click *START*. When finished, disconnect the USB cable and disconnect power from the clock for a few seconds.

## **Notice**

This software and hardware product is Copyright (C) 2017 OCEAN7 Watch Company d/b/a Angry Electronics. All Rights Reserved.

## Installation

The following are not step by step installation instructions. It is presumed that the user has some basic knowledge of electronics including soldering techniques, and understands normal precautions regarding line voltages present in the GC-1000 power supply.

Regardless of whether the GC1000-NTP is installed, a switching power supply upgrade and electrolytic capacitor replacement is recommended, to reduce heat and prolog the life of the clock. Information and instructions are available on the Internet. The procedure is beyond the scope of this document. The aforementioned upgrades are not required for the GC1000-NTP interface installation to function correctly.

The GC1000-NTP uses four or six connections to the clock, two for data, ground, and +5v. An additional two connections are required for display on/off control.

1. Remove and store the R.F. Board. It is not used and will needlessly draw power and create heat.
2. Remove the tone decoder and display boards.
3. Remove IC U402, and IC U403 from the tone decoder. Bend out pin 8 on each IC, and replace in their sockets.
4. Connect two wires from the marked locations on the GC1000-NTP, to the back of the tone decoder board, pin 8 on the IC socket of each of the previously removed ICs.
5. To use the display on/off control, connect point F on the interface to the front of the display board, where the switch contact is soldered. Point R similarly goes to the back of the display board switch contact. The switch must be in the off position (toward the rear) for the interface to control the display, otherwise it will always be on. Version 3 board connects are reversed – F to back, R to front.
6. Connect ground and +5v to convenient locations on the clock, preferably close to the power supply.
7. Reinstall tone decoder and display boards.
8. The GC1000-NTP board can be mounted inside or outside of the case. Installation details are left to the user. See the photo below.
9. GPS miniature phone jack connection - Ring: data, Tip: +3.3v, Sleeve: ground. Tx on the GPS goes to Ring. Rx on the GPS is not used.

GC-1000 switch settings:

GC1000-NTP Revision 3.4



1. Time zone 1,2,4,8,8 – all off, or UTC (GMT) on
2. Daylight S.T. – off, controlled by GC1000-NTP
3. Propagation delay – untested - adjust as desired

## Assembly

**DO NOT PRESS THE BUTTON LABELED BOOT OR FLASH ON THE ESP32 MICROCONTROLLER, OR IT MAY BE PERMANENTLY DISABLED.** If that happens, the board may have to be returned for reprogramming. It is OK to press the EN button to reboot the ESP32, but that should never be necessary. Use the button on the interface board to reboot, or remove power.

Install components marked on the board, using the schematic and the parts list.

The ESP32 microprocessor board is installed with the micro USB connector facing the side of the interface board with the pushbutton. The antenna goes on the side marked, 'U1' or 'Antenna.'

Headers are strongly recommended for U1, the ESP32 microcontroller, so that it can be removed if necessary for replacement or reprogramming. A 40 pin header is included. It must be cut into two, 19 pin parts. Note that some interface pc boards have three rows of holes for the headers, to accommodate different types of microcontrollers. Be sure to compare the microcontroller to the interface board, to select the correct sets of holes.

The RGB LED may be installed on the board, or wired remotely so that it can be positioned in place of the Data LED. This is a nice, fully reversible modification because it will blink red for '0', green for '1', and blue for 'mark,' and it is controlled by the display on/off logic based on setting #7. Decide before soldering the LED directly to the board.

One pin of the LED is longer than the other three. That pin goes to the hole on the board that is marked with dots on either side. That is the anode. Order is red, anode, green, blue.

If installing in place of the Data LED, remove one lead of R145 to disable the existing Data LED, and bend the Data LED so that it faces down toward the board. Wire the RGB LED to the interface, and tie it to the existing LED with a piece of wire or small tie wrap. This way no permanent modification is made to the GC-1000.

Consider adding an additional pushbutton on the back of the case in parallel to SW1 replacing one of the unused BNC connectors, so the case will not have to be opened to change or reset parameters.

Reference	Part	Description
U1	ESP32	Espressif ESP32 WROOM DevKitC or compatible
R1, R2, R7	220 ohm ¼ watt	Resistor
R8	1k ohm ¼ watt	Resistor

Reference	Part	Description
R4,R5, R6	1.2k ohm ¼ watt	Resistor
R3	10k ohm ¼ watt	Resistor
Q1,Q2,Q3	2N3904	Transistor
D1	1N5819	Shottky diode
Q4	NDP6020P	MOSFET
C1,C3	100nf	Capacitor
C2	100uf 16v	Electrolytic capacitor
	Header - Female	For the ESP32 microcontroller, 19 pins x 2
J3	Stereo Phone Jack	3.5mm SMD header jack, SJ-3523-SMT-TR, Digikey CP-3523SJCT-ND, for GPS (GPS not included)
SW1	Pushbutton	
LED1	RGB LED	Common Anode
Circuit Board		GC1000-NTP circuit board
<b>Weather Only</b>		
	OLED Display	128 x 32 bit, I2C Interface
	Sensor	BME280, I2C Interface
R100, R101	2.7k ohm ¼ watt	Resistor
	Header-Female	For the OLED display, 4 pins

## Weather Option

### Wiring

The BME280 sensor and the OLED display are wired in parallel. Version 3 boards do not have a separate connector available, so the sensor and display are wired to the microcontroller pins, on the bottom of the interface board.

**CHECK THE PIN LABELS CAREFULLY, ON THE DISPLAY AND SENSOR. DIFFERENT PRODUCTION RUNS HAVE SWITCHED PIN LOCATIONS!**

For version 5 boards, the display and BME280 sensor are wired in parallel, to the marked locations on connector J5.

To find the pin numbers, hold the microcontroller with the black antenna at the top, and the USB connector at the bottom. The top-left pin is 1, bottom-left is 19, bottom-right is 20, and top-right is 38. Labels on the top of the microcontroller board are in parenthesis. DO NOT get the wiring wrong. The sensor will go up in smoke if the power leads are reversed.

BME280 Sensor	OLED Display	Revision 3 Board	Revision 5 Board
VCC	VCC	Pin 1 (3V3)	J5 3.3V
GND	GND	Pin 38 (GND)	J5 GND
SCL or SCK or CLK	SCL or SCK or CLK	Pin 36 (IO22)	J5 SCL
SDA	SDA	Pin 33 (IO21)	J5 SDA
		2.7K resistors between 3V3 and Pin 36, and 3V3 and Pin 33.	2.7k resistors at R100 and R101

If the sensor or display are marked PU, usually on the back, either cut the trace between the larger pads, or don't install the 2.7k resistors. These are pullup resistors, and only one set is needed. If both the sensor and display include pullup resistors, cut the foil between the larger pads on one, and don't install the 2.7k resistors, or cut both, and install the resistors.

### Installation

The temperature and humidity sensor should not be installed inside the cabinet. Leave enough wire length so that it can be a few inches away from the case. Run the wire through the RS-232 or other opening in the back of the case.

The display should be mounted with the four pin connector, to the left side. After trying several different locations around the front of the display, we prefer to center it above or below the three, seconds LEDs. It should not be mounted on top because it may not be completely visible beneath the shaded area of the front panel, and it will also interfere with the case top. Mount it in front of the LEDs so that the bottom of the OLED panel is 1-2mm below the top of the LEDs, or mount it below the display. Secure with epoxy or silicone.

## **Optional Modifications (parts not included)**

### **Amber or green seconds and tenth-seconds 7 segment LED displays**

Quantity 3 -

Luminex LDS-C303RI - Amber

Luminex LDS-C302RI - Green

### **Blue HI SPEC LED**

Quantity 1 -

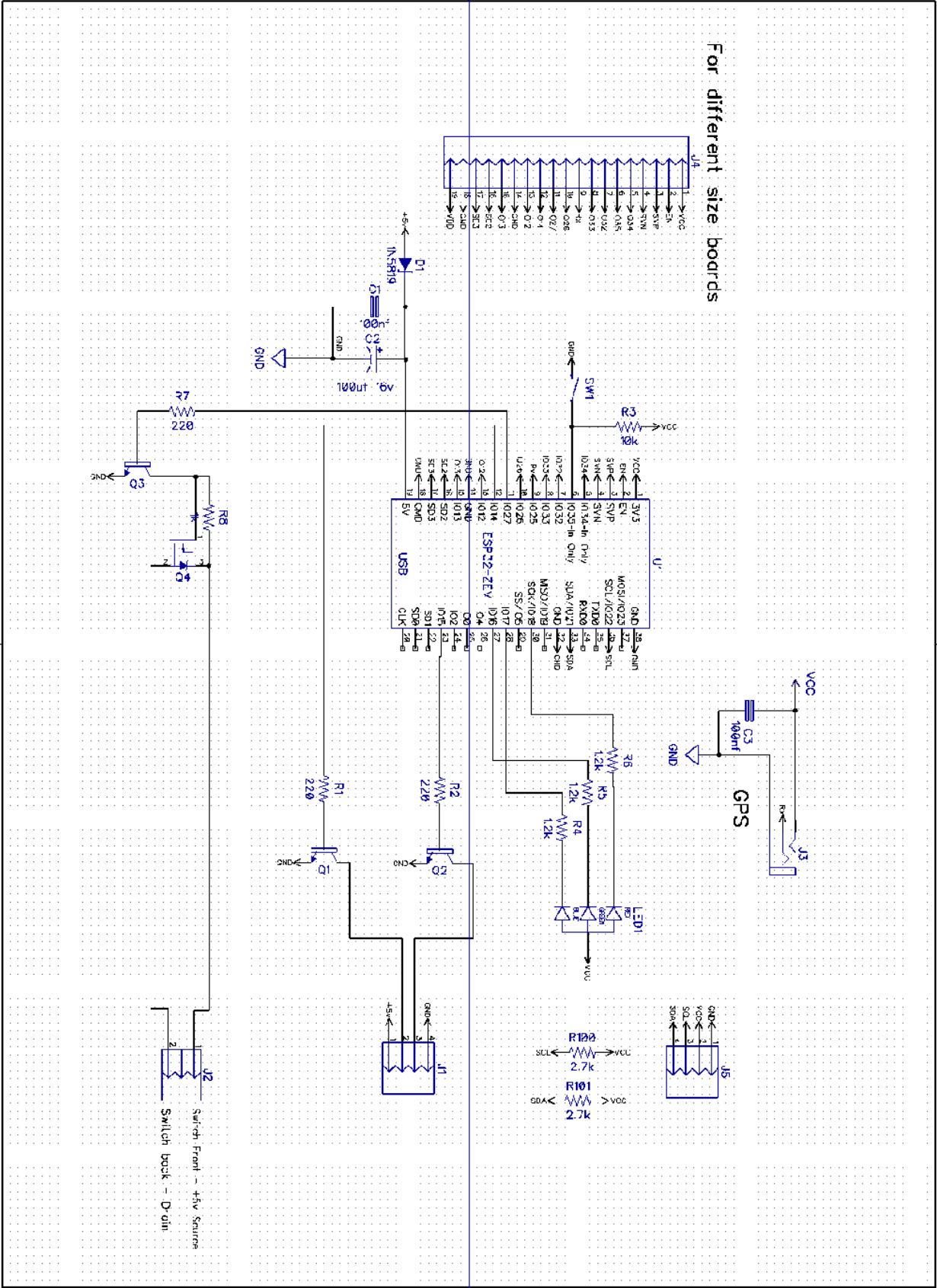
Generic 3mm blue diffused LED

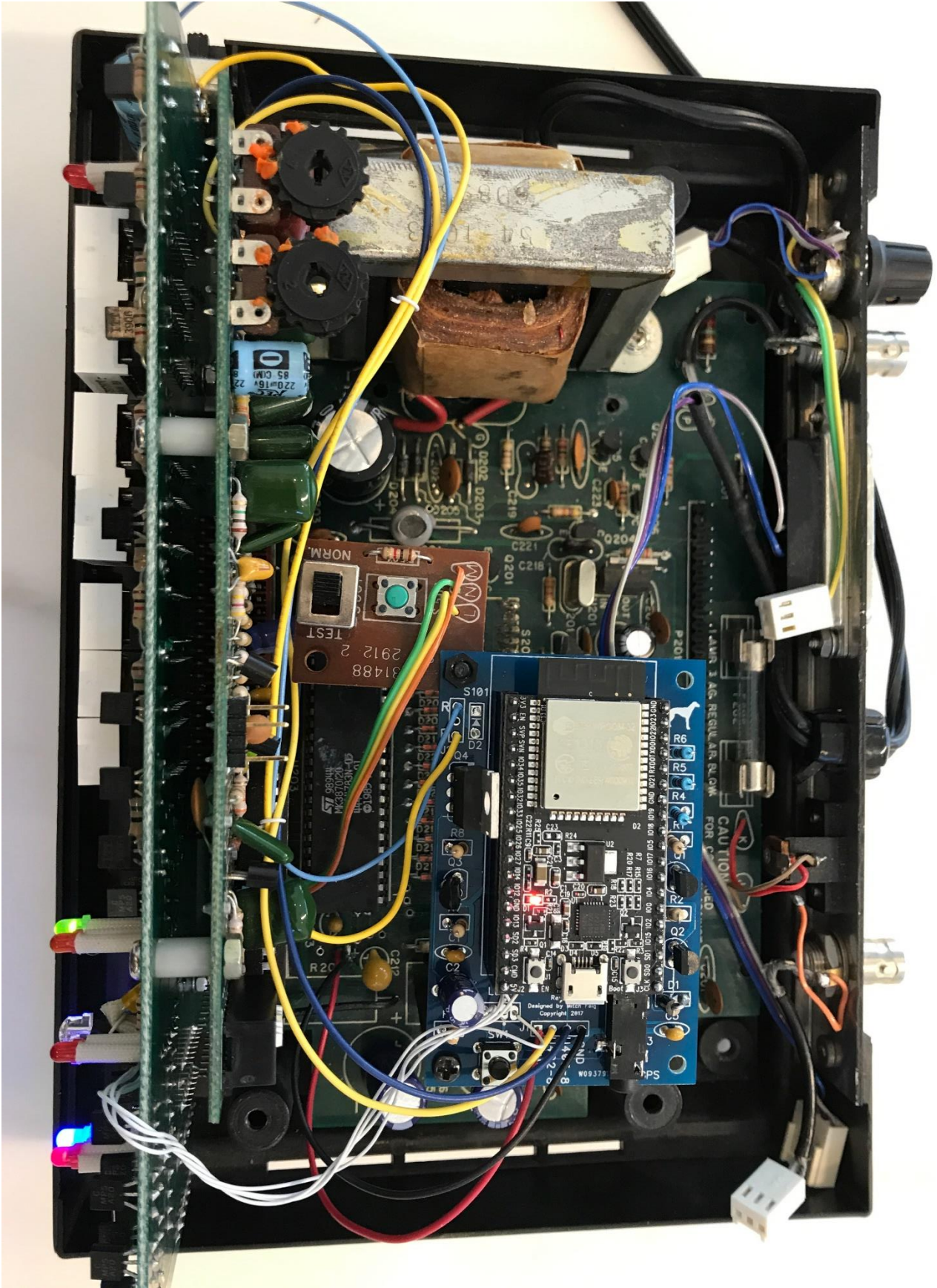
R143 – change to approximately 3.9K ohms

## **Warranty Terms and Conditions**

OCEAN7 Watch Company dba Angry Electronics ("AE") warrants that for a period of 90 days following delivery, AE products you have purchased will (a) perform in accordance with published specifications, and (b) will be free from defects in materials and workmanship. In the event an AE product does not meet this warranty, subject to the conditions set forth in these terms and conditions, AEs sole obligation will be, at its election, to repair or replace the AE product in question or to refund the purchase price. Warranty repairs will be completed at the sole discretion of AE, after examining the returned product.

**AE MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, AND ALL IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. IN NO EVENT WILL AE BE LIABLE FOR PUNITIVE, SPECIAL OR CONSEQUENTIAL DAMAGES, OR FOR AN AMOUNT IN EXCESS OF THE PURCHASE PRICE OF THE DEFECTIVE AE PRODUCT OR PRODUCTS.**





GC1000-NTP Revision 3.4