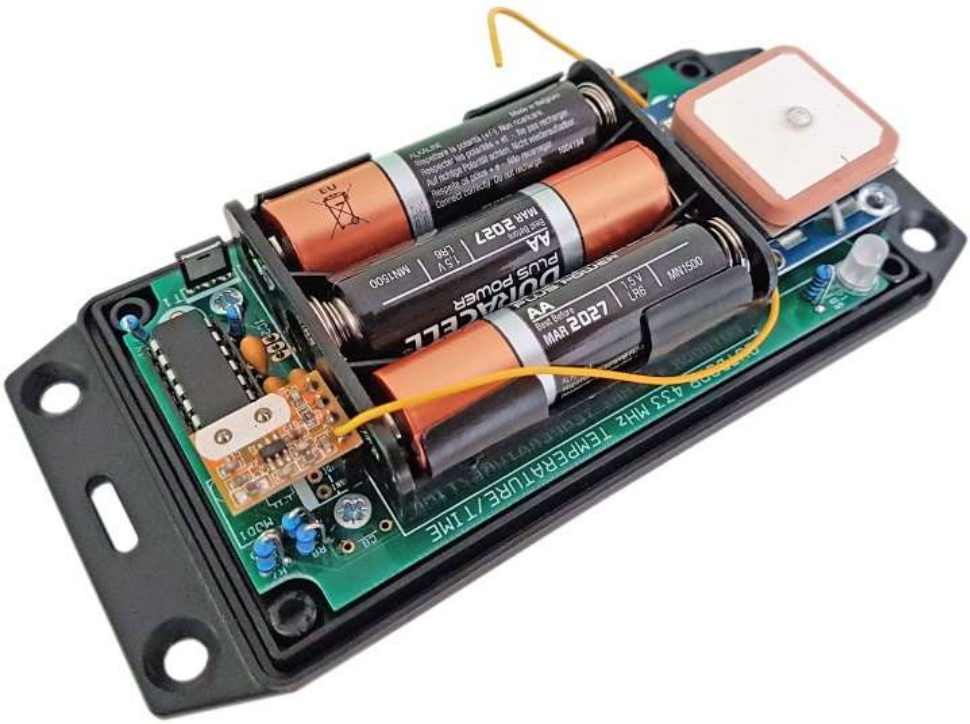
Assembly Instructions
And
User Guide

XTERNA
Module



REVISION HISTORY

Issue Number	Date	Reason for Issue
3	11 August 2022	New PCB based on DS3231
2	01 October 2018	New position for D1
1	20 April 2018	New document

1. INTRODUCTION

1.1 About the XTERNA Module

XTERNA is our new concept for synchronising time and capturing outdoor temperature for display on our clock and thermometer kits. Driven by a PIC microcontroller with advanced low power modes, the XTERNA captures time from GPS satellites every 6 to 48 hours, and stores in an on-board Temperature Controlled Crystal Oscillator (TCXO). Further, the device captures outdoor temperature every 10 minutes from an on-board DS18B20 digital temperature sensor. Every 10 minutes XTERNA transmits the time and temperature data, which can be received by our XTERNA compatible clocks.

Additional data is transmitted such as battery voltage and GPS fix time.

Supplied as a complete hobby kit of parts (For shipping reasons, batteries are not included), the kit takes approx 30-40 minutes to comfortably assemble. The TCXO IC is pre-soldered, so there is no fiddly SMD soldering to worry about.

Naturally, XTERNA is sealed against rain ingress. Battery life is estimated between 6 to 12 months. We recommend high quality branded batteries for the longest operation between battery changes.

The module should be placed outdoors, but as close as possible to the indoor clock or thermometer. Avoid direct sunlight and shelter from rain as far as possible.

1.2 Specification

Working Temperature Range: -40 °C to +60 °C. (-40 °F to +140 °F)
Typical Reception Range: 10 to 30 Metres (30 to 100 ft).

2. TOOLS AND EQUIPMENT REQUIRED

2.1 Tools required to assemble the PCB.

The following tools will be required to assemble the PCB:

- Soldering iron with a small tip (1-2 mm).
- Wire cutters to trim the excess component leads after soldering. (Tip: A small pair of nail clippers works very well for this function).
- Wire strippers (Tip: A small pair of scissors is quite suitable).
- Multimeter for identifying the resistors.
- Screwdrivers.

2.2 Materials you will need.

Solder – lead / tin solder is highly recommended. **USE LEAD/ TIN SOLDER!**.

Lead free solder, as now required to be used in commercial products in Europe, has a much higher melting point and can be very hard to work with.

Desoldering wick (braid) can be useful if you accidentally create solder bridges between adjacent solder joints.

Decorator's masking tape.

2.3 Other items you will need.

The XTERNA module is powered by 3 X AA Batteries. We recommend high quality branded batteries for the longest service life between battery changes.

3. LIST OF COMPONENTS

3.1 Table of Electronic Components

PCB Designation	Part Description
Resistors	
R1 – R3	10 KΩ, ¼ Watt
R4	390 KΩ, ¼ Watt
R5	10 KΩ, ¼ Watt
R6	1 KΩ, ¼ Watt
Capacitors	
C1, C2	1uF Ceramic
C3	100nF Ceramic
Transistors	
Q1	2N7000
Diodes	
D1	1N4148
LED1	RGB LED 5mm Common Cathode
Integrated Circuits	
IC1	PIC16F1823
IC2	DS18B20
IC3	DS3231 (Pre-soldered)
Miscellaneous	
Tx	4 way 0.1” female header
GPS Module	4 X Turned Pin Sockets
IC1 Socket	14 Way narrow IC socket for IC1
BH-331P	3 X AA Battery Holder

3.2 Parts list / Packing Sheet

Part Description	Quantity
Resistors	
1 KΩ, ¼ Watt	1
10 KΩ, ¼ Watt	5
390 KΩ, ¼ Watt	1
Capacitors	
1 uF, Ceramic	2
100nF Ceramic	1
Transistors	
2N7000	1
Diodes	
RGB LED 5mm Common Cathode	1
1N4148	1
Integrated Circuits	
PIC16F1823	1
DS18B20	1
Miscellaneous	
4 way 0.1" female header	1
Turned Pin Sockets	4
14 Way narrow IC socket for IC2	1
M3 X 4mm screw	2
M3 X 6mm Female / Female Spacer	1
433 MHz Tx Module	1
Self tapping screw	5
20cm cable for Antenna	1
4 X 0.1" turned pin header for GPS	1
Double sided foam square	1
Neo-6M GPS Module	1
3 X AA Battery Holder	1
Hammond Case with screws	1
PCB with pre-soldered IC3	1

Due to part availability, you may alternatively receive two 7-way socket strips rather than an entire 14 way IC socket

It is recommended that the kit is checked against the list above, to ensure all parts are present before commencing assembly. Don't be alarmed if there are some extra components, as some component bags are shared between different kit types.

The resistors used in the kit are 1% tolerance metal film. They are marked with 4 coloured bands to identify the value. However it is sometimes unclear in which direction the bands should be read. **Therefore, we recommend that the resistors be identified with a multimeter.**

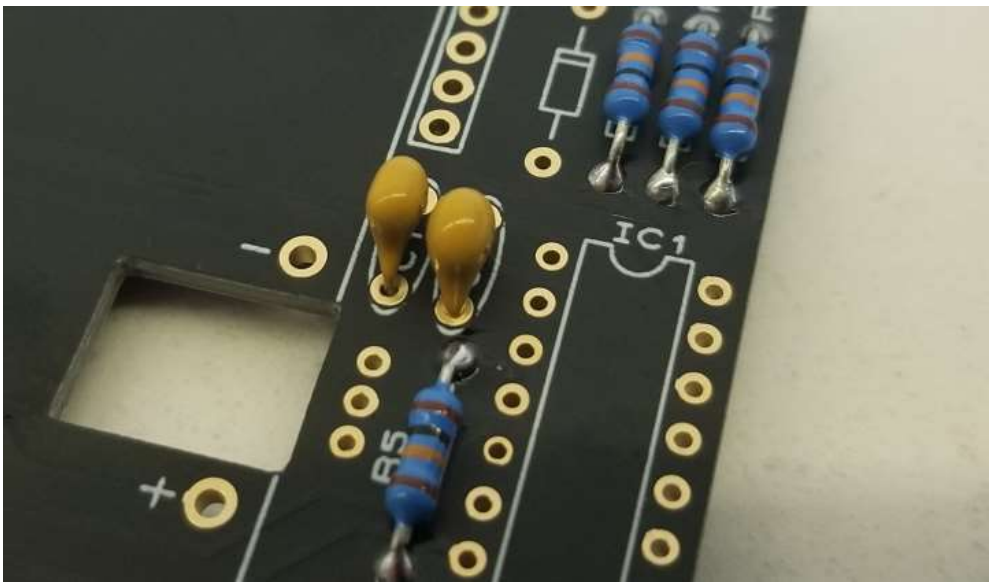
4. ASSEMBLY OF THE PCB

4.1 R1 – R3, R5 (10 KΩ)
R4 (390 KΩ)
R6 (1 KΩ)

solder the six resistors as shown. It is easier to solder the top pad of the PCB, rather than the bottom pad. Then clip off the remaining leads, as you should for all subsequent components after soldering.

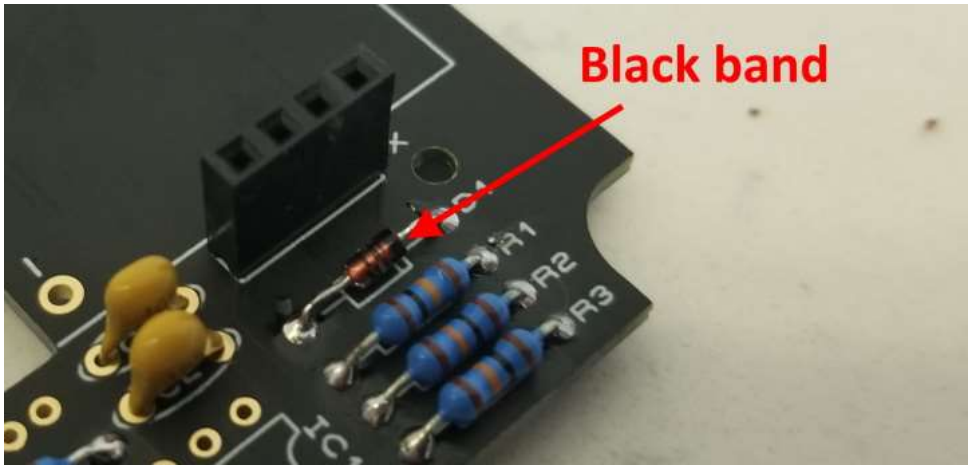
4.2 C1, C2 (1uF)

These capacitors are not polarized, so the orientation does not matter.



4.3 D1 (1N4148)
Tx (4 Way female header)

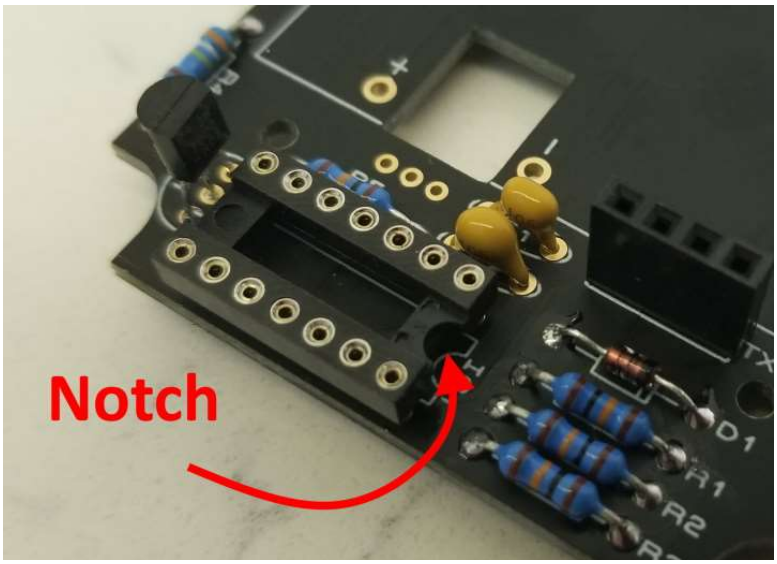
Pay attention to the orientation of the black band on D1



4.4 Socket for IC1
Q1 (2N7000)

Ensure the small notch on the socket is oriented as shown. However if after you solder the part you realise the notch is at the wrong end, DON'T try to desolder it! Actually, so long as the IC has the correct orientation, the socket does not really matter.

Due to part availability, you may alternatively receive two 7-way socket strips rather than an entire socket

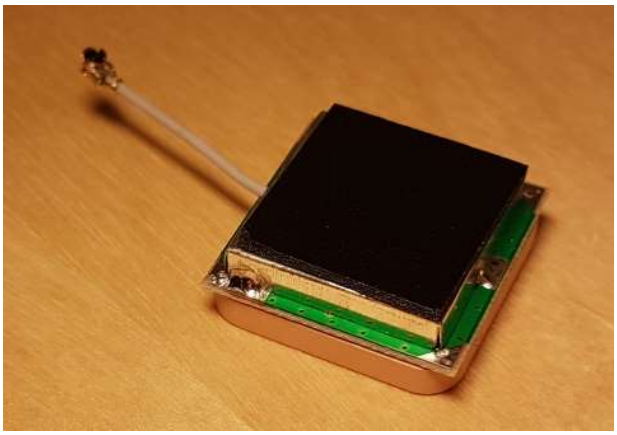


4.5 C3 (100nF Ceramic)

Trim the leads a little shorter, then form the leads so the capacitor can be soldered to the 2 pins of IC2's socket on the underside of the PCB as shown:

4.6 Prepare the GPS Module

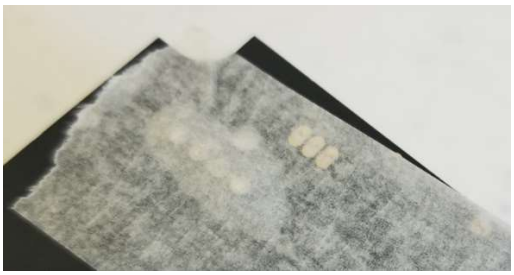
First, apply the self adhesive foam pad to the back of the antenna, then stick onto the plain PCB side of the GPS, oriented so that the antenna cable can pass through the hole intended for it.



Now clip the antenna connector into the small matching connector on the component side of the GPS module. It helps to press with a hard surface, such as a small block of metal.

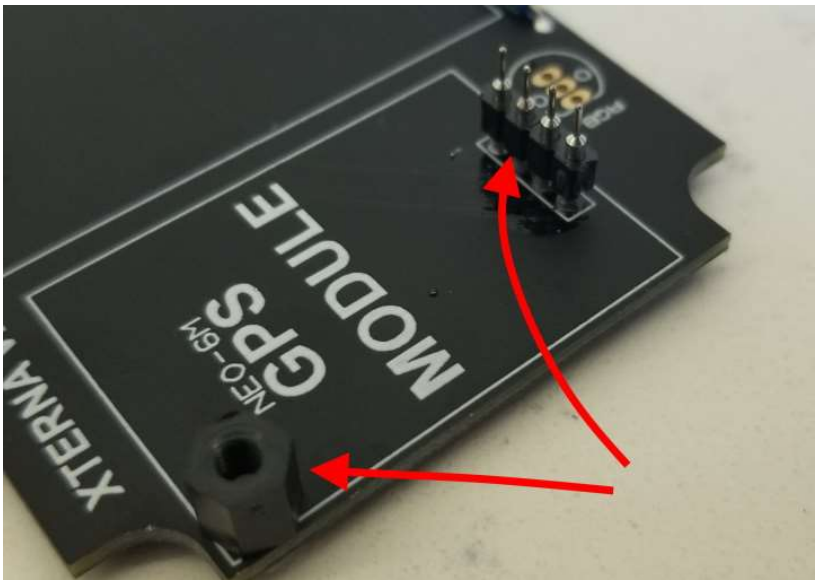
4.7 Attaching the GPS.

From the SOLDER side of the PCB, insert the four socket receptacles and secure with decorator's masking tape.

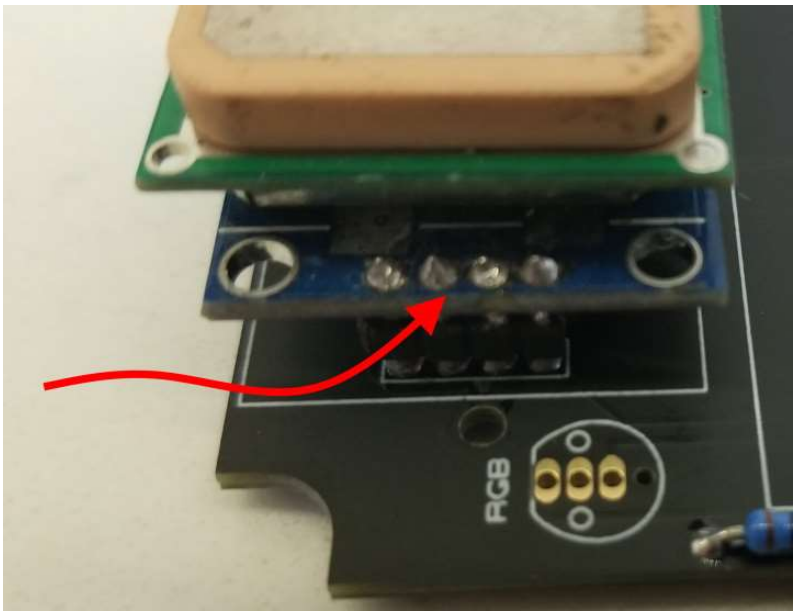


Flip over the PCB and solder the four sockets with minimal solder, as shown below. As soon as you see the solder flow around the annulus, you can withdraw the solder and iron.

Now plug the four way header strip over the pins and also screw on the 6mm spacer as shown below, using a M3 X 4mm plastic screw.



Now place on the GPS assembly, over the four connector pins and screw in place with the other M3 X 4mm plastic screw, then solder the four pins to the GPS. Keep the GPS level and pushed down as you solder.



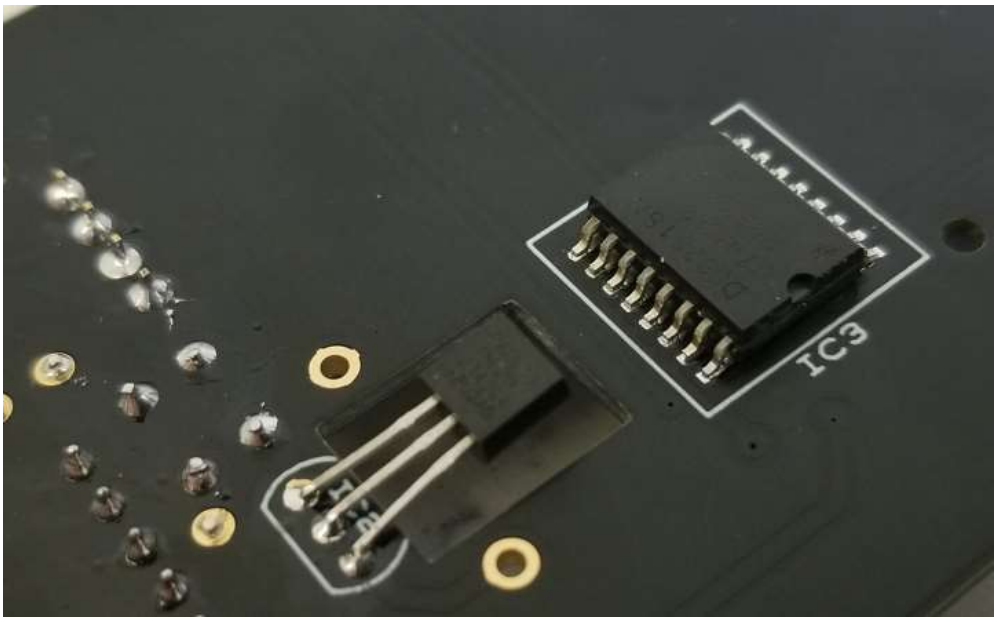
Once the pins have been soldered, unscrew the top plastic screw and withdraw the GPS. Don't forget to put it back again later!

4.8 LED1 (5mm RGB LED)

The longest lead of the LED goes in the marked hole. Take care you orient correctly.

4.9 IC2 (DS18B20)

From the solder side of the PCB, insert approx 1cm, then bend over as shown and solder. The flat, engraved front surface should be showing.

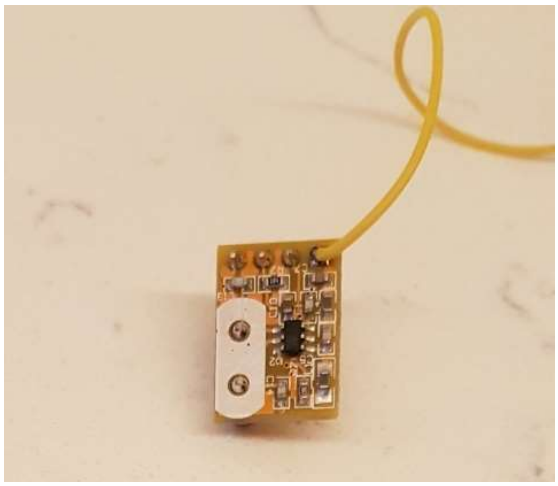


4.10 AA Battery Holder

Insert the battery holder, and first screw it to the PCB with two self-tapping screws. Then solder the two wires.

4.11 Transmitter Module

Cut 17cm of the cable supplied, strip off 3mm of the insulation from one end and tin the wires. Then attach to the end pad of the Transmitter module as shown.



4.12 Final Assembly

Re-attach the GPS module, not forgetting the M3 X 4mm screw. Orient the notch on the IC with the corresponding marking on the PCB and push into the socket. Push in the Transmitter module, with the three pins in the three holes closest to IC1. Feed the antenna wire around the battery holder. Finally screw the PCB to the base of the case with the remaining three self-tapping screws.

5. USING XTERNA

5.1 CONFIGURING YOUR CLOCK OR THERMOMETER

Usually, the clock or thermometer will be pre-configured to receive the 433MHz broadcasts. All you need to do is set the time zone of any clock for your offset from UTC. (Usually parameters 14,15,16)

5.2 POWERING UP FOR THE FIRST TIME

For the first use, configure your clock, and then position the XTERNA module as close as possible to the clock, but with a good view of the sky. Insert three NEW, top quality AA batteries. Keep the top cover open, so you can follow the progress on the RGB LED, in case of issues.

After inserting the batteries, the module will follow a pattern of calibration and GPS seek, which can be followed on the RGB LED. In case of issues, it will be helpful to follow the sequences, and make notes of the timings. Initially, just follow the LED. Only make timing notes if you have issues.

5.3 RGB LED SEQUENCE

1. Power up
2. LED off for 5 seconds
3. Start initial GPS seek. Red/Green flashing for up to 120 seconds
4. Hold on Green for 5 seconds = GPS module found
5. LED Off for 5 seconds
6. First GPS calibration. Red/Green flashing for up to 120 seconds
7. LED off for 5 seconds
8. GPS calibration. Red/Green flashing for up to 20 minutes
9. LED off, followed by burst of green flashes (data transmission)

Follow the above sequence, and check for the final (stage 9) burst of green flashes - the first transmission. The LED will then go blank. There will be further data bursts every 10 minutes for about 1 hour, and then the LED will light no more. If you reach the point that you have the first burst, this means all is OK. You should now leave the module alone. Don’t be tempted to re-insert the batteries – this just uses up a lot of battery power.

Now you should configure and COLD RESTART your clock, then wait for it to synchronise. See the next page for how to cold start your clock.

5.3 Troubleshooting

If the module's LED turns solid red after 120 seconds, this means the GPS cannot be found. Check the antenna is well pushed in, and also check the module is well pushed into its sockets on the main board.

If the Module's LED is off and batteries are in, then this means the module is working correctly. Don't be tempted to re-insert the batteries – this just uses up a lot of battery power. Instead, cold start the clock (the digit cycling) and wait for the next tranmission for synchronisation.

5.4 Invoking Cold Start Tube Test of the Clock

A cold start is when the clock's Supercapacitor is discharged. On a cold start, time and date are lost and the clock will perform the ascending tube test on power up. You can either power off for 4 hours or more, or follow the method below:

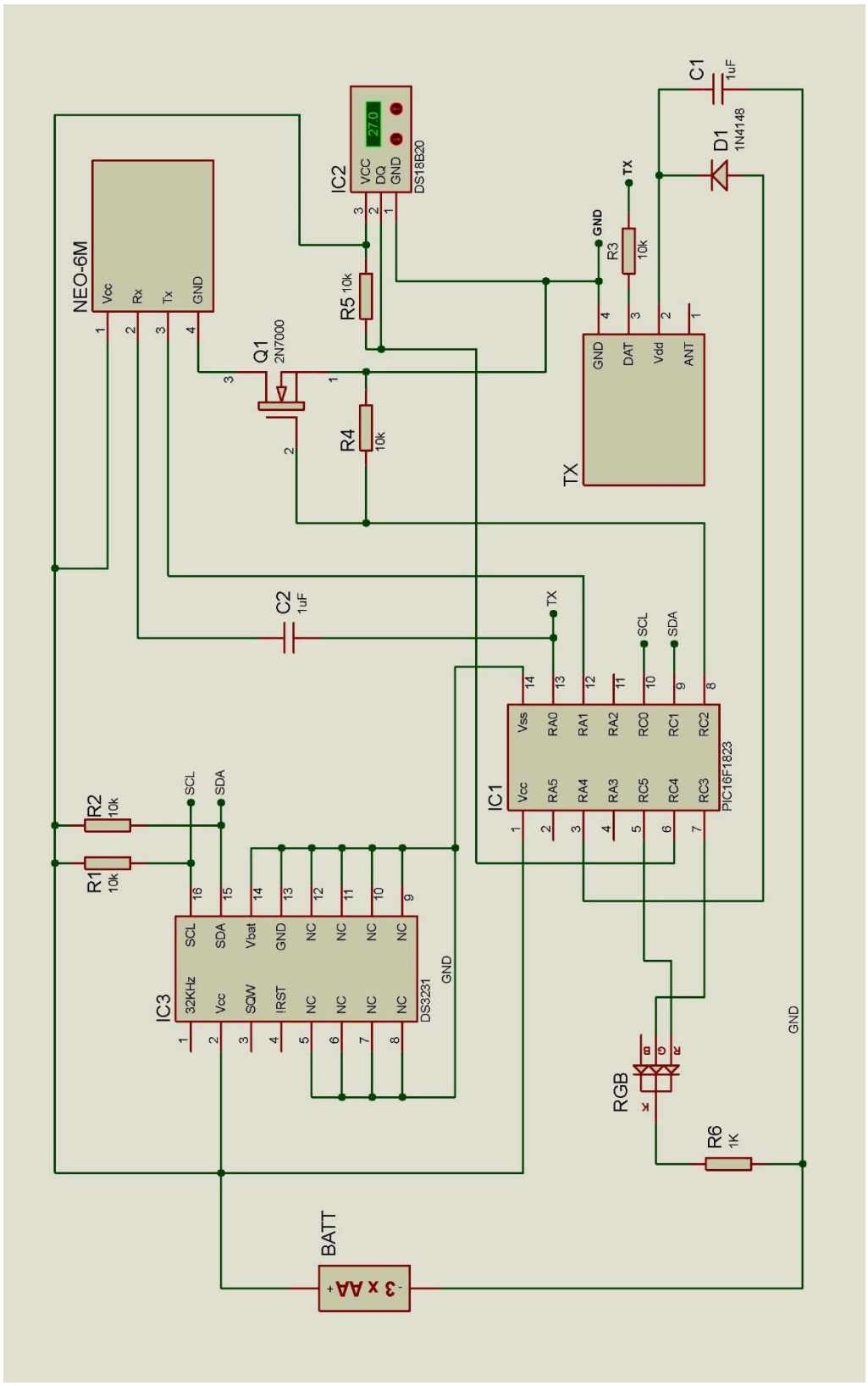
To force a Cold Start, do the following:

- Toggle the DST on by pressing the DST button if necessary
- From time display, press ALARM once.
- Press ADJ once to illuminate the ALARM LED
- Immediately disconnect power.

The power sensing / sleep routine is not called from within the Alarm setup, so the clock will drain the supercapacitor via the DST and ALARM LEDs. Wait 2-3 minutes until the LEDs are fully off. On powering up again, you will get the cold start tube test.

If the Module's LED is off and batteries are in, then this means the module is working correctly. Don't be tempted to re-insert the batteries – The initial calibration just uses up a lot of battery power.

6. CIRCUIT


C1
1uF
D1
1N4148
IC2
DS18B20
VCC
DQ
GND
NEO-6M
Vcc
Rx
Tx
GND
R5 10k
Q1
2N7000
R4
10k
GND
R3
10k
TX
GND
DAT
Vdd
ANT
TX
C2
1uF
SCL
SDA
IC1
PIC16F1823
Vss
RA0
RA1
RA2
RC0
RC1
RC2
Vcc
RA5
RA4
RA3
RC5
RC4
RC3
R2
10k
R1
10k
IC3
DS3231
32KHz
Vcc
SQW
IRST
SCL
SDA
Vbat
GND
NC
GND
RGB
R6
1K
BATT
3 x AA