EC/PPM/TDS Meter

Outputs measured EC value in volts. Can be connected to meter or A/D input.

Oscillator

V+ = 12V
V- = -12V

Adjust V1: starting with no
output turn slowly untill
oscillation occurs

V1 100KΩ
1N4733A D2
D1 1N4733A
R3 56KΩ
R4 33KΩ
U1a TL074
C1 .015µF
R1 1KΩ
R2 1KΩ
C2 .015µF

U1-Pin1 Oscilator Out:
  Vo = 20Vpp (Change D1,D2 to change Vo.)
  Fo = 10Khz

Values of R1,R2,C1,C2 may be changed but follow this guide:
  R1 = R2, C1 = C2, Fo should be > 1Khz
  Fo = 1 / (2 * PI * R * C)
  R = value of R1 and R2
  C = value of C1 and C2

Gain Loop

Probe Wires

R7 6.8KΩ
U1b TL074
R5 100KΩ
R6 1KΩ
V2 2KΩ

VACout

U1-Pin5: should have
about .2Vpp input
If much higher offset is
difficult to null out
Change R5 & R6 if needed.

AC to DC Converter

R9 1KΩ
MDA? D3
C3 .22uF
R8 22KΩ
U1c TL074
R14 100KΩ
V+
R11 220KΩ
R12 220KΩ
R10 220KΩ
V3 100KΩ
R13 100KΩ
R15 82KΩ
22KΩ
U1d TL074

ECv out
To Voltmeter or
microcontroller A/D

Multiply ECv by 500 to get ppm

V-

V2: Range
V3: Offset
Wipe probe surface with paper towel to dry then
adjust V3 for 0Vout. Place probe into 2Kppm solution
adjust V2 to 4Vout. (Or to 2Vout with 1Kppm solution).
Repeat process untill consistant readings are obtained.

Microcontroller A/D Interface

Low pass filter averages out voltage to be more readable..
Keeps A/D or microcontroller from frying due to under/over voltage.

Vcc
1N150 D200
R200 3.3KΩ
C200 10µF
1N150 D201

ECv In   To A/D input

A/D conversion stuff:
  Using 10bit A/D like those found on PIC microcontroller where 0v
  on A/D input reads 000 and 5v reads 1024 you can multiply the A/D
  value by 24 then divide by 10 to display PPM value.

EC = Electrical Conductivity between two small probes 1cm apart, measured in units
called microsiemens. Siemens are aka Mhos, which is Ohms (unit of resistance) backwards.
Conversion between EC, PPM, and Resistance (in ohms).

Mhos = 1/Ohms
Ohms = 1/Mhos
EC = PPM / 500
PPM = EC * 500
R = 1 / EC * 1E-6

What PPM/TDS/EC meters are measuring the conductance of salts in solution.
With water, 1mg of salt into 1L of water = 1ppm. To Create Calibration
solution at 2Kppm carefully measure 1g of salt into 500ml of
purified water. Be sure to shake/stir well when mixing and before calibrating.
I used table salt (NaCl) however most calibration solutions have a mix of 2 or
more types of salt.

PPM/EC/Ohms Table

PPM	EC	Ohms
2K	4	250K
1K	2	500K
500	1	1Meg
250	.5	2Meg

Home made probes will probably have alot more surface area
causing the resistance value to be much lower. The component values
used in this circuit support a probe having an impedance of about
690ohms @ 4EC (aka 2Kppm). Value of R7 can be changed or
replaced with a pot to compensate for probes that are too weird.
Gold plated probes work best, a good source is gold plated audio
cables. Must be something exposing a small but consistant amount
of surface area to the solution being measured. Cleaning probe with
paper towel before and after using gives ALOT more consistant results.

Probe impedance can be determined by measuring gain of U1c stage.
  Measure Vin at pin 5, Vout at pin 7 using AC meter.
  Rf = Feedback resistor R7 which is 6800 ohms.
  Rx = Rf/((Vout/Vin)-1)
  So for example Vin=.2v Vout=2V probe impedance = 755 ohms

Possible Improvements??:
  Could I possibly consolidate U1b and U1c?
  Effects this would have on solution waveform?
  Effects of wave shape an EC value??
  Offset needs nullification BEFORE range adjustment

Co:	Place Company Name Here
Title:	EC Meter I
Board:	ppm-ec1.sch	Revision: A
Author:	Belladonna	Size: B