DIY Kit 2. TEMPERATURE METER

The Intersil chip 7106 is an amazing chip. We are so used to a constant stream of new and improved IC's that it is a surprise to find a chip which was launched in 1977, has remained unchanged during that time and yet sales of the chip today are actually increasing. What is the reason for this popularity?

The 7106 was the first IC to contain all the active circuitry for a 3 1/2 digit panel meter (DPM) in a single chip. It was designed to interface directly to a liquid crystal display (LCD). (The 7107 IC is intended for LED - light emitting diode - displays.) So the chip contains BCD to seven segment decoders, display drivers, clock and a reference voltage as well as the necessary analog to digital (AD) circuitry to convert the input voltage to a digital form. The AD system also indicates the polarity of the input voltage.

Voltage is the most frequently measured electrical quantity. In temperature meters, current meters, wind speed meters and resistance meters what is actually being measured is voltage, or more correctly, the potential difference between two points. After calibrating the meter for its particular purpose then the potential difference measured will give an accurate (digital) reading of the (variable analog) quantity being measured.

With less than 10 external passive components the 7106 chip may be made into an easy to use meter for any of these purposes especially multiple range digital volt meters. See the Kit 127 documentation enclosed with this kit for more details.

Digital displays have many advantages over analog meters which use a pointer and moving coil. Firstly they are easier to read especially by unskilled labour. In the majority of applications it is better hat the value displayed is exactly the value being measured, for example, 13.6V. To use an analog display with its many graduated scales (some going up and others going down) and switches requires considerable practice. But a simple LCD which reads '13.6' can be understood by everyone.

Second, the DPM built using the 7106 is physically stronger and more robust than analog meters because it has no moving parts. Thirdly, for the manufacturer the assembly of the complete DPM unit can be done by relatively unskilled labour. Fourthly, the 7106 by its very nature can be adapted to so many uses at such a low cost that it has actually created markets for itself. All of these factors add up to a better, cheaper product which everyone can afford.

In this kit we have supplied the 7106, the LCD and the components necessary to build it into a temperature meter. A printed circuit board (PCB) is supplied with the kit. It has a printed overlay on it so that the position of all the components is clearly indicated and construction only takes a few minutes.

The PCB has a large breadboard area so that once you have become familiar with the module and used it as a temperature meter you can easily advance to build other metering devices such as a digital voltmeter, resistance meter, current meter and even an AC voltmeter. Used with a photodiode a light meter can be built. Applications are limited only by the availability of transducers and changing the circuit slightly to convert the external signals to a 0 to 199.9 mV DC signal. Copies of some ofthe circuits to do this are provided.

The kit is constructed on a single-sided printed circuit board (PCB). A computer aided design (CAD) program is used to design the board.

CIRCUIT DESCRIPTION

The potential difference (PD) across a silicon diode is dependent on its temperature and current through it. Its temperature coefficient is negative, that is, the voltage falls with increasing temperature. This fall is approximately linear and is typically -2.2mV/oC. That is, there is the same drop in voltage when the diode cools from 88 oC to 87 oC as there is when it cools from 23 oC to 22 oC. Better sensors have better linear characteristics. In this Kit we have used a transistor as a diode (base and collector shorted together) which has a more linear temperature response over a bigger range than a diode does.

The temperature meter measures the PD across the diode after an offset voltage which is available from pins 1 and 32 of the 7106 has been added. The two 100K 10-turn trimpots are used to calibrate the sensor at two known temperatures. The calibration is easily done using water with ice in it to calibrate zero degrees Centigrade and putting the sensor in a jet of steam from a boiling water kettle to calibrate for 100 oC. The decimal point has been hard-wired on. (The enclosed literature shows you circuits of how to obtain a variable decimal point.)

ASSEMBLY INSTRUCTIONS

There are several important points to watch.

1. The LCD (liquid crystal display) is mounted on **two** 40 pin IC sockets which you must cut apart using your side cutters. This allows the LCD to sit above the 7106 chip and save space. Make sure you get the LCD and the 7106 chip around the correct way. Look for the notch at one end of the LCD and match it to the notch shown on the PCB overlay (it goes to the lefthand side of the PCB.) Similarly, match the notch on the 7106 (opposite to the LCD notch – it goes to the right.) These two components should be the last items added to the PCB. Use the filled-in IC socket (if supplied) for the 7106 IC itself.

2. Mount POT 1 and R1 in the sockets provided and not directly into the PCB. Solder the single mounting socket pins into the PCB (After breaking them apart.). The values of these two components will change when the meter is used to build other projects. For the temperature meter R1 is 1M and POT1 is 100K (104).

3. It is best to attach the battery snap on the bottom side of the PCB so that the battery is contained inside the box.

DIY Kit 2. TEMPERATURE METER

4. Note the LINK to make on top of the PCB.

The PCB has been marked on both sides to help you in using the kit to build other circuits. Abbreviations refer to the Intersil/Harris documentation.

After the kit is assembled and the battery is connected the display should show some random readings or indicate out-of-range '1'. The unit now needs to be calibrated. You will need some ice and water to adjust the Zero Adjust pot to zero degrees centigrade and a jet of steam from boiling water to adjust the Scale Adjust pot to 100 degrees centigrade. The order of calibration does not matter. You may have to adjust both pots when you do the first calibration in order to get a reading other than '1'.

If you hear a 'click, click' when you turn the trim pot then you are at one end of the winding and you should turn it the other way.

Depending on the distance of the sensor from the meter you may need to use thin shielded coaxial cable between them. The 7106 has excellent noise limiting haracteristics. The sensor attached six inches from the PCB using the hookup wire provided should not have any noise roblems. The sensor transistor may be mounted on the breadboard area of the PCB with jumper leads connected from T+ and T- to it.

WHAT TO DO IF IT DOES NOT WORK

Poor soldering is the most likely reason. Check all solder joints carefully under a good light. Next check that all components are in their correct position on the PCB. Thirdly, follow the track with a voltmeter to check the potential differences at various parts of the circuit.

A check list of other items includes:

- did you add the jumper LINK on top of the PCB.
- are the IC and LCD in the correct way. Check no pins are
- bent up. This is very easy to do with a 40 pin IC.
- is the battery flat.
- is POT1 and the 1M resistor properly fitted into the sockets.

WHAT TO LEARN FROM THIS KIT

The Kit shows how much of electronics today can be contained in a single chip. Commercial low cost digital volt meters are nothing more than this kit, some switches and passive components and a nice plastic case. The main reason today for the failure of meters is more likely due to switch and mechanical failure rather than failure of the electronics itself.

Our Kit 127 uses the 7106 and is a double-sided PCB version of Kit 2 without the breadboard area. It contains more information about how to use the 7106 in different types of meters. Get the documentation from

www.kitsrus.com/pdf/k127.pdf

The data sheet for the 7106 may be downloaded from the Intersil website at

www.intersil.com

or you can get it from our website at

www.kitsrus.com/pdf/7106.pdf

You can get the pinout information for the LCD at

www.kitsrus.com/pdf/vi302_dp.pdf

You may download a detailed Application Note for the 7106 at

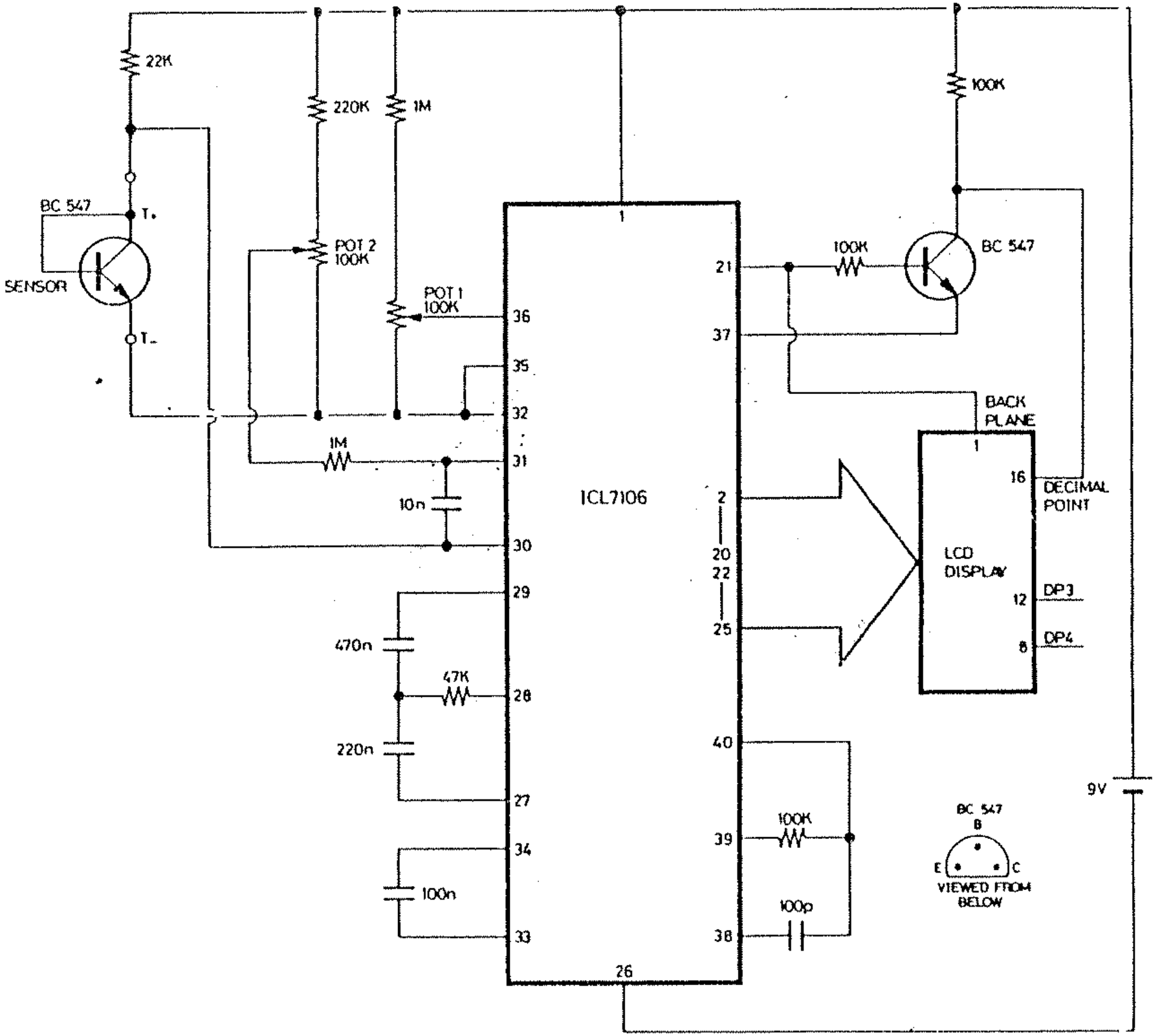
www.kitsrus.com/pdf/7106_an1.pdf

This kit is basically the circuit shown in Figure 20 of this Application Note.

(Documentation: November 2002)

COMPONENTS

Resistors 1% metal film:	
1M brown black black yellow	2
22K red red black red	1
47K yellow violet black red	1
100K brown black black orange	3
220K red red black orange	1
Capacitors:	
100p 101 monoblok	1
220n 224 metallized	1
10n 103 mylar	1
100n 104 mylar	1
470n 474 metallized	1
BC547 or BC548	2
10 turn trimpot	2
40 pin IC socket	3
7106 IC	1
hookup wire	
9V battery snap	1
Box #2 and screws	1
LCD VI302-DP-RC	1
Kit 2 PCB	1


22K
220K
1M
100K
BC 547
T+
SENSOR
T-
POT 2
100K
POT 1
100K
1M
10n
470n
47K
220n
100n
ICL7106
1
21
37
36
35
32
31
30
29
28
27
34
33
26
2
20
22
25
40
39
38
100K
BC 547
100p
BACK
PLANE
1
16
DECIMAL
POINT
LCD
DISPLAY
12
DP3
8
DP4
9V
BC 547
B
E
C
VIEWED FROM
BELOW