Time to revisit the Schools Chips?

Figure 1 is a picture from SSERC Bulletin 175 which was published towards the end of 1992. It shows four Schools Chips. This was a major project at the time, designed to address the lack of teaching materials for microelectronics. Four types of chip were created, each with a window on top through which the layout of its innards could be seen.

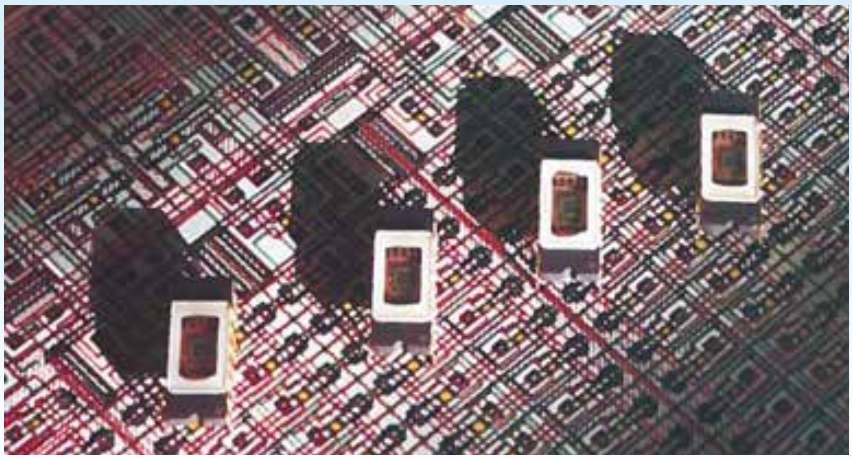

Figure 1 *- Four Schools Chips.*

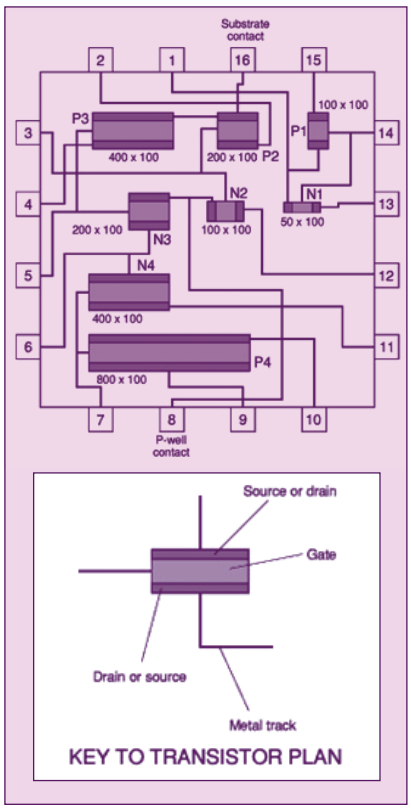

Figure 2 *- Layout of Chip 2.*

A fair number of investigations could be carried out with the chips but we suspect that few ever were, at least initially. The chips had to be mounted on breadboards and connections made through short pieces of wire and crocodile clips. Setting up circuits was fiddly and time consuming. A diagram of Chip 2 is shown in Figure 2.

Physics teacher Alex Munro, who runs JJM Electronics, came to the rescue with some socketed boards for the chips, complete with overlays (Figure 3). These boards are still available, though the chips are becoming harder to find. There is, however, a good chance that many schools have stocks. Given that there are a number of relevant core practicals and some innovative investigation work that can be done with the chips, it is worth having another look at them. An example is shown below.

Chip 1 can be used to investigate the Hall Effect. This phenomenon is mentioned in the current (2017/18) Higher Physics Support Notes. It could also form part of an Advanced Higher Investigation.

If there is a flow of electrons through a material and a magnetic field is applied at right angles to the direction of flow, there will be a force on the electrons as shown in Figure 4.

There will be a depletion of electrons on one side of the conductor and an excess on the other. This means there will be a potential difference across the conductor, at right angles to both the electron flow and the magnetic field. This potential difference is known as the Hall voltage.

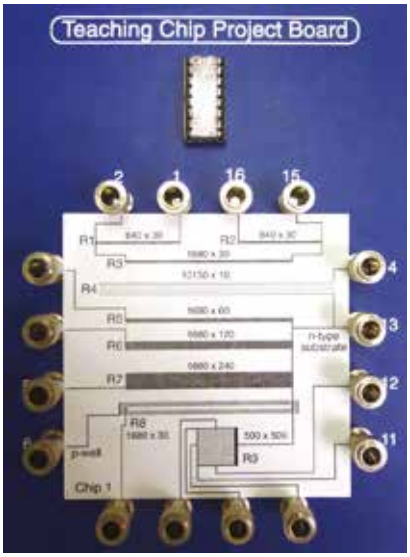

Figure 3 *- Chip in a board.*

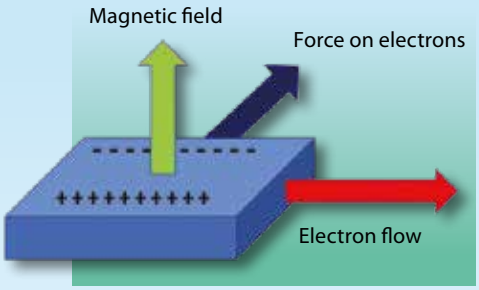

Figure 4 *- The Hall Effect.*

The circuit shown in Figure 5 can be used with Chip 1 to investigate the Hall Effect.

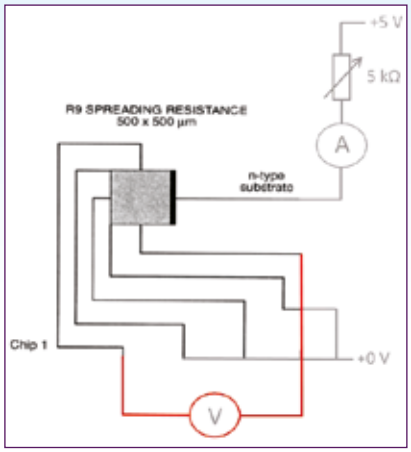

Figure 5 *- Hall Effect circuit.*

- Pins 9, 10 and 11 are connected to 0 V.
- Pin 13 is connected via an ammeter and variable resistor to + 5 V. This allows you to vary the current in a square slab of doped silicon.
- Pins 8 and 12 are connected to a voltmeter. This allows you to measure the p.d. across the silicon - the Hall voltage.

The relationship between the Hall voltage and current can be studied for different magnets placed on top of the chip. Note that we got a small Hall voltage that varied linearly with current even with no magnet in place. We are still investigating this. It does not appear to be due to the earth's magnetic field.

Other chips, other investigations

There are four chips in the set as shown in Table 1.

Notes

As mentioned, all chips have a "window" through which individual structures may be seen (Figure 6). With the advent of USB and smartphone microscopes, this feature may have come of age.

Figure 6 *- Chip, showing "window".*

The chips present opportunities for Advanced Higher investigative work, and perhaps also experiments for the new Assignments.

Chip	Name	Notes and possible investigations
1	**Resistor Chip**	See SSERC Bulletin 175. R1, 2 and 3 are the same width but different lengths. R5, 6 and 7 are the same length but different widths. R4 is a metal resistor. R9 is used for the Hall Effect demonstration and investigations. R8 is an n-type resistor whereas the others, except for R4, are p-type. The relationships between length/ width and resistance can be studied. Polarity is important for some resistors.
2	**MOSFET Chip**	See SSERC Bulletin 189. Contains four n-channel and four p-channel transistors with different aspect ratios. Under the current curriculum, the above investigation on the variation of drain current with gate voltage is the one most likely to be of relevance to schools.
3	**Optoelectronics Chip**	See SSERC Bulletins 172 and 193. Contains 13 p-n junctions, 10 of which are light sensitive. A variety of lengths and widths are incorporated. Once linearity of response has been demonstrated, the inverse square law can be investigated.
4	**Ring Oscillator Chip**	Very little teaching materials seems to have been developed for this chip. There is the possibility of using it to investigate RC time constants at Advanced Higher.

Table 1 *- Four chips in the set.*