

0-5V range when the programmed gain is 1:1.

Two halves of the LF353 (IC4B and IC5B) are used as voltage followers to provide a low-impedance shifting voltage (V_{ref}) to the programmable amplifiers. This voltage must be precisely adjusted with two 4.7-kilo-ohm presets to measure precisely 2.5V level on the inputs of IC2 and IC3 when the input signals are grounded.

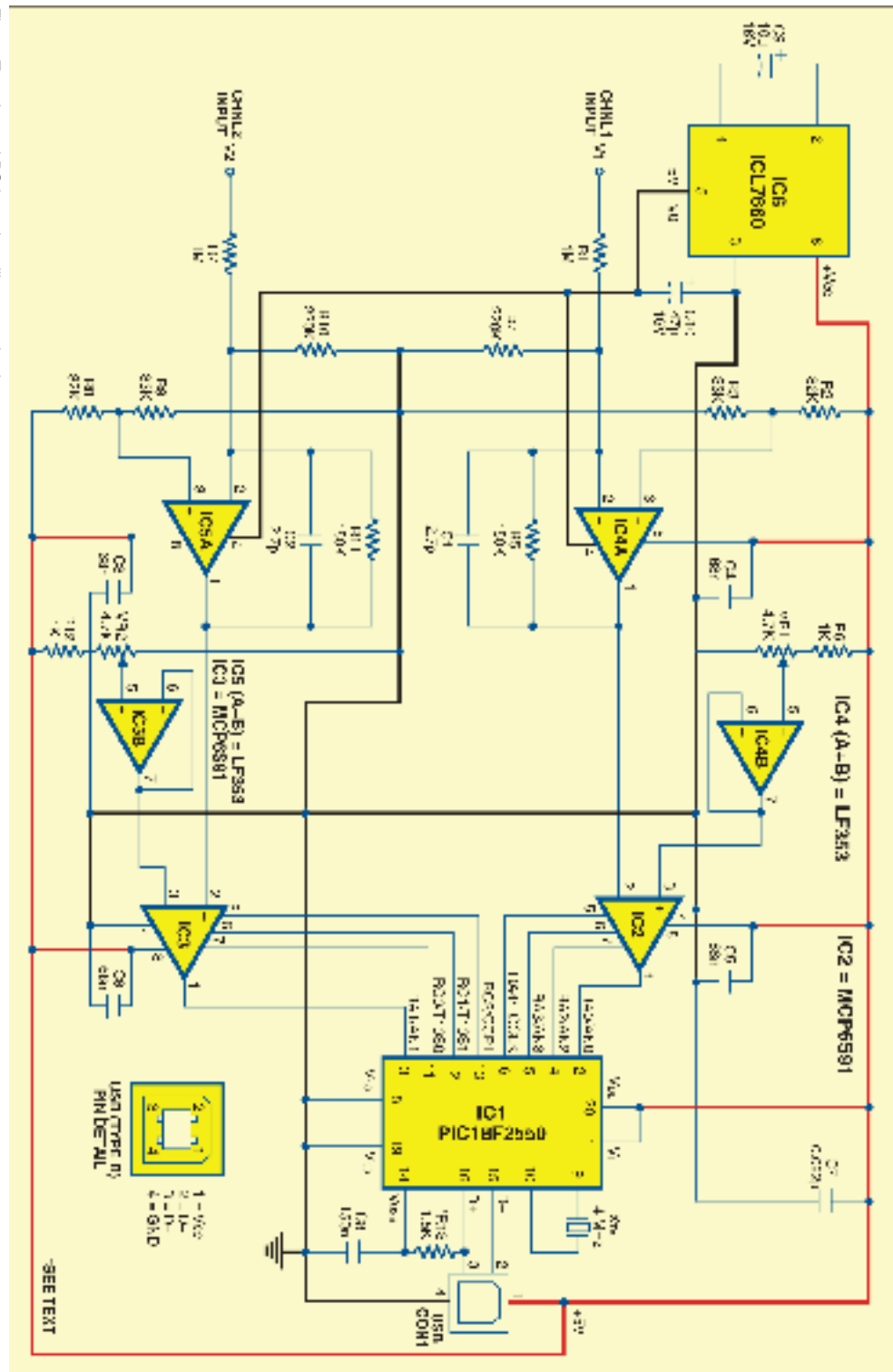
Because LF353 op-amps need a symmetrical supply voltage, a small DC-DC voltage converter ICL7660 (IC6) is used to feed -5V to LF353. With its small 8-pin DIP package, it needs only two polarised capacitors. ICL7660 can be replaced with a MAX1044. The MAX1044 and ICL7660 are monolithic, CMOS switched-capacitor voltage converters that invert, double, divide or multiply a positive input voltage. These are pin compatible with the industry-standard LTC1044.

Overview of the universal serial bus

The specifications of the USB can be found on website 'www.usb.org.' One of its major advantages is the ability to drive 5V, 100mA devices.

All the data is transmitted on the D+/D- symmetrical pins using a variable bit rate. The position of a resistor (R13) on D+ or D- allows you to choose between the full-speed (12 Mbps) and low-speed modes (1.5 Mbps). Note that the PIC18F2550/2455 devices have built-in pull-up resistors designed to meet the requirements of low-speed and full-

Fig. 1: Two-channel PC-based oscilloscope circuit



speed USB. The UPUEN bit (UCFG=4) enables the internal pull-ups. In this project, R13 is not used. External pull-up may also be used. The VUSB pin may be used to pull up D+ or D-. The pull-up resistor must be 1.5 kilo-ohms ($\pm 5\%$) as required by the USB specifica-

tions.

You can also 'hot-plug' a new device. When this is done, the host PC starts an enumeration process to identify the device. The device sends the information to the PC by way of different 'descriptors.' Each descriptor contains