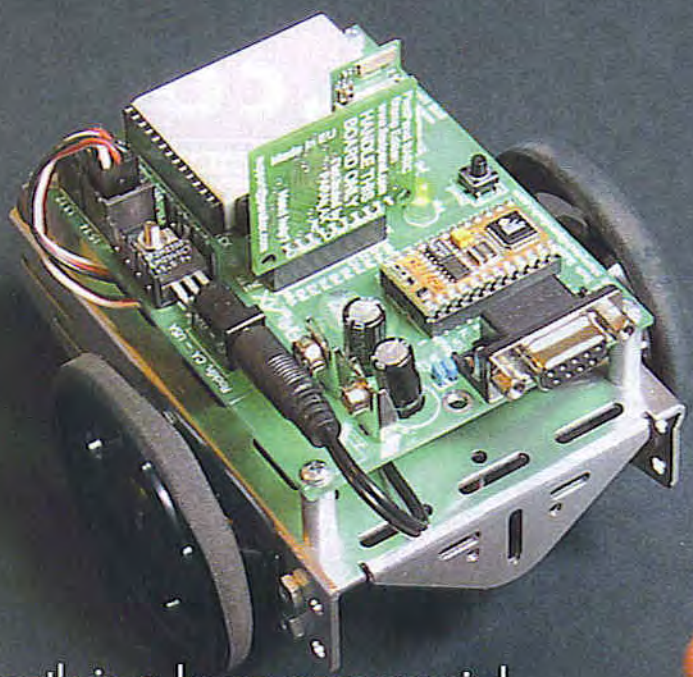
Bluetooth Remo

Richard Hoptroff



Bluetooth is a huge commercial success but so far hobbyists and lab workers have been barred from access to ready-made modules for this wonderful new medium. The reason is simple: manufacturers like to treat their products as black boxes and are only interested in their 100-k/day production lines in the Far East or China. We oppose this attitude by publishing this article, written using the motto: Bluetooth modules for everyone! A tracking robot does the trick.

te Control from your PDA or mobile phone

Flick through any electronics magazine – professional or hobbyist – and you will see a wide range of single-board computers and microcontroller boards. For many applications, they make product development so much simpler than it used to be, say, 5 or 10 years ago. Attach a few auxiliary components and a control panel, write the computer program, and you're finished.

What makes the process easier is that the computer board is programmable, so one off-the-shelf component can be applied to many tasks. Could this concept be taken even further? A few auxiliary components will always be needed in any product, but what about the control panel (user interface)? Couldn't an off-the-shelf programmable component be made to replace custom control panels on electronic devices like PDAs, GSM, but also custom-made microcontroller systems?

The 'FlexiPanel BASIC Stamp Edition' module from FlexiPanel Ltd. could provide the answer. In this article we'll concentrate on the Bluetooth version of Flexipanel, see the **Device Pinout inset**. Using Bluetooth radio (at 2.4 GHz), it asks a remote device within range — say, a mobile phone, a notebook PC, PDA or another handheld computer — to create the required control panel (or, if you like, 'GUI') on its display. The module has a Class-1 radio, so the remote device can be up to 100 m away. The module operates at TTL levels, and we are informed that a standalone RS232 device will soon also be in production.

A user within radio range of the Flexipanel-Bluetooth module may connect to the appliance at any time using any Bluetooth-enabled device. The device will display the required control panel, but the panel's appearance may vary according to the remote device used. Some examples will be shown later.

The software on the remote devices is the same for each application and does not require customization or re-installation. It is freely downloadable from www.flexipanel.com. At the time of writing, Pocket PCs, Windows PCs, and Smartphones (e.g. SPV E200 from Orange) software are supported. Software for Palm Operating System and Java phones supporting the JABWT standard (e.g. Nokia 6600 and Sony Ericsson P900) has also been released.

Projects with Bluetooth control

Let's not get carried away by new-fangled technology like Bluetooth-enabled GSM phones and PDAs. Using an example we will demonstrate that applications can be developed for the FlexiPanel-Bluetooth combination that are simple enough to be tackled by relative beginners. The example, a simple tracking robot, employs a specially adapted version of the **Elektor Electronics Board of Education** originally featured in the September 1999 issue and the world-famous **Parallax BS2p BASIC Stamp**. Parallax Inc., who supply the Basic Stamp, also distribute the FlexiPanel module through their authorised dealers (in the UK: Milford Instruments).

In case you didn't know, the BASIC Stamp can be programmed using the BASIC programming language from any PC computer using a serial cable. The same link is used to program the control panel into the FlexiPanel-Bluetooth module used as part of the project: a robot controller with route tracking.

The BASIC programs and FlexiPanel designer data files used in this and two more projects are available from *Elektor Electronics* as free software downloads. The other two projects are an access system and a temperature logger, they are not discussed in this article.

Modified BoE

The circuit diagram of the modified BoE (Board of Education) is shown in **Figure 1**. The 'brains' are a BS2p (BASIC Stamp 2) module which is plugged into the 24-way socket. Like its 1999 predecessor, this BoE has an RS232 connector (K2) and a prototyping area enclosed between K7, K3, K6, K8, K4 and K5. We'll use the area later to fit a couple of components the robot needs to be able to tell you its whereabouts.

The Flexipanel Bluetooth module is plugged straight onto a dedicated socket, K9.

The BoE has its own voltage regulator, IC2, and when used on its own (for example, during programming sessions) can be powered from a 9-volt battery. The programming utilities and the BASIC editor are available from Parallax Inc., just look for Board of Education on their website www.parallax.com and you'll find a mass of (free) information.

The component mounting plan of the new BoE is given in **Figure 2**. Hoorays and applause at this point because the board is **single-sided**.

Tracking robot

If your friends sniff at yet another buggy-style little robot, tell them that this remote controller differs from many others in being able to *send information back to the handheld device using data over a radio link*. By using an electronic compass mounted on the robot, a route trace is recorded and reported back to the handheld unit.

Figure 3 shows what to add to the BoE to make it suitable for our experiment. First, there is the combined FlexiPanel-Bluetooth module hooked up to the BS2p by five lines. The two units employ bidirectional serial communication with handshaking. As you will have surmised, the FlexiPanel is also a

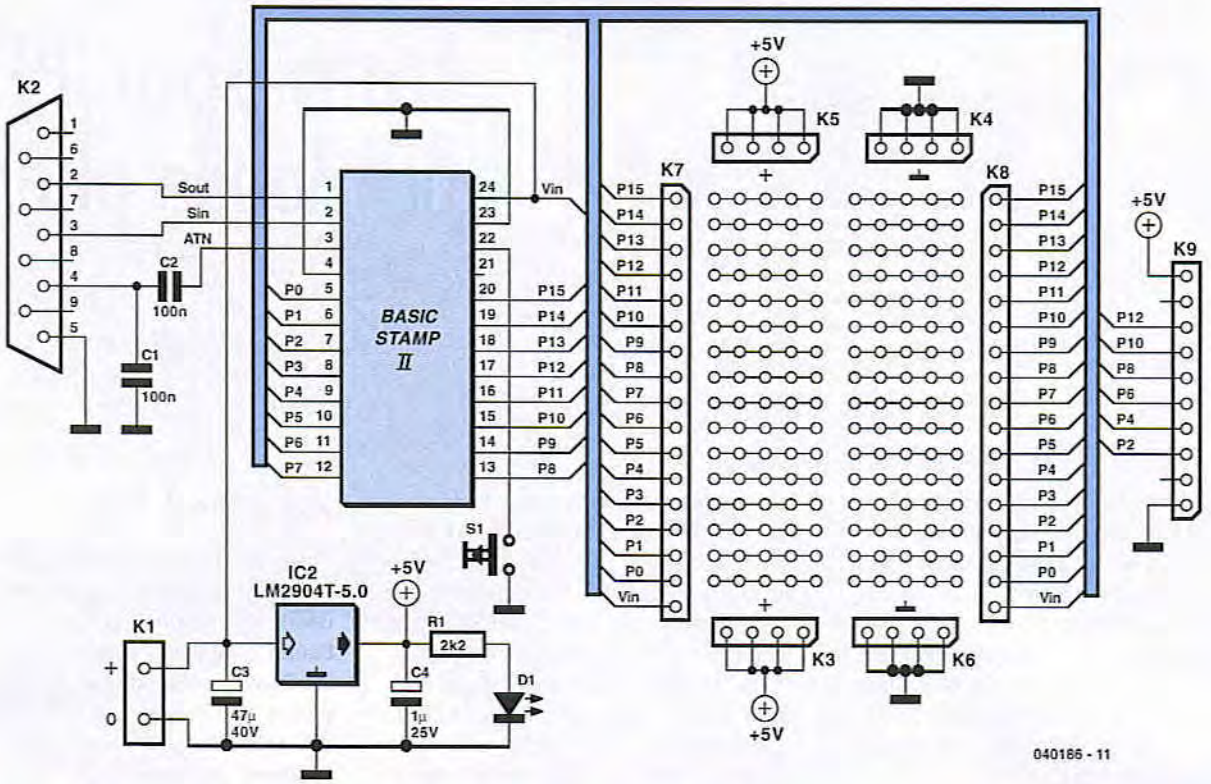


Figure 1. Circuit diagram of the Board of Education (BoE), specially adapted for the Flexipanel-Bluetooth module from Parallax.

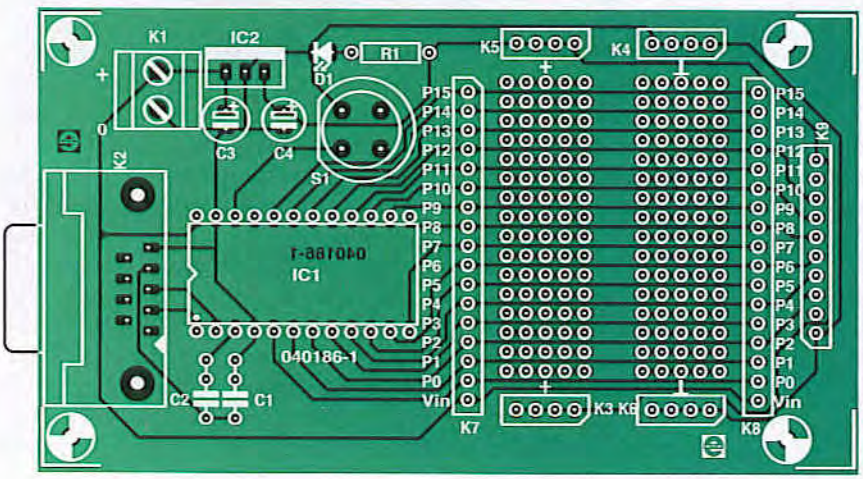


Figure 2. PCB design for the modified BoE.

COMPONENTS LIST

Resistors:
R1 = 2kΩ2

Capacitors:
C1,C2 = 100nF
C3 = 47µF 40V radial
C4 = 1µF 25V radial

Semiconductors:
D1 = LED, red, low current
IC1 = Basic Stamp (BS2, BS2sx, BS2e or BS2p) (Parallax Inc, Milford Instruments)
IC2 = LM2940T-5.0

Miscellaneous:
K1 = 2-way PCB terminal block, lead pitch 5mm
K2 = 9-way sub- D socket (female) angled pins, PCB mount
K7,K8 = 17-way SIL connector (header or socket)
K9 = 10-way SIL socket
S1 = pushbutton, 1 make contact, PCB mount, e.g., D6R

microcontroller system (and an intelligent one, too)! The BS2p runs software capable of sending commands that request or modify FlexiPanel values, content or status information. Moreover, FlexiPanel can request BS2p attention when a client device has changed a control via Bluetooth. This is done using a kind of interrupt conveyed via the Data line which in our case is monitored by an LED.
The electronic compass module type CMPS03 is an I²C device from Devantec. It is available from, among others, Milford Instruments.
The BoE with its extension circuitry crammed in the prototyping area is mounted on the BoE-Bot robot superstructure available from Parallax Inc. This has motorized wheels which may be controlled by pulsewidth modulation direct from the BASIC Stamp as indicated in Figure 3. The tracking robot, ready to start on its journey, is shown in the introductory photograph. Note that the photo shows the Parallax BoE.

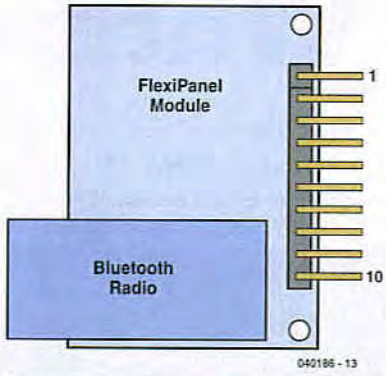
FlexiPanel and BS2p programming

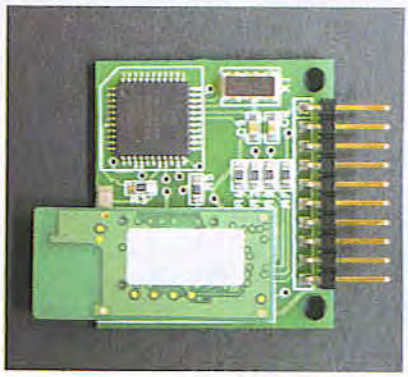
Using *FlexiPanel Designer*, a programming utility supplied by Hoptroff, a user interface is created containing:
– compass bearing display;

Device Pinout

Pin	Name	Purpose
1	Vss	Connect to 0 V
2		Not connected
3	RxD	Serial data input from BASIC Stamp for serout operations
4	TxD	Serial data output to BASIC Stamp for serin operations
5	RTS	Serial flow control output to BASIC Stamp for serout operations
6	CTS	Serial flow control input from BASIC Stamp for serin operations
7	Mod	See text.
8	Data	Data output high when a control has been updated by a FlexiPanel client.
9		Not connected
10	Vdd	Connect to +5 V.

Care must be taken to insert the module into the correct side of the AppMod slot and in the correct orientation. Make sure Vss connects to Vss and Vdd connects to Vdd (not Vin!). Failure to do so may damage the module.





- latching pushbuttons for stop, forward, reverse, left and right;
- a table showing the route traced by the robot.

Flexipanel Designer generates a program for PBasic that allows the FlexiPanel hardware to be programmed. Using the PC and Basic Stamp Editor, this piece of software is downloaded onto the Stamp where it is executed.
It may happen that FlexiPanel has to be reset first, for example, when an earlier attempt at programming went wrong. In that case, the circuit supply voltage has to be switched off and on again — the reset button on the BoE having an effect on the Stamp only and **not** on the FlexiPanel! When the circuit is switched on, the programming will recommence automatically — the program still being available in EEPROM, it does not have to be loaded again from the PC. It should be noted that FlexiPanel needs about 10 seconds to boot so you can stir your tea or coffee before programming actually commences. To have at least an indication of what's happening during the boot-up phase, a low-current LED may be connected between the Data line and ground, not forgetting a 1-k resistor — see Figure 3. After switching on the supply or after a soft reset of the module (which happens automatically after programming), the LED will light up for a few seconds and then go out once booting is finished. The LED will also light briefly when FlexiPanel receives a command over Bluetooth (interrupt request).
The result of the using *FlexiPanel Designer* may be seen in the **What do I with it** inset: simple buttons to press on a pocket PC or GSM phone, and a map returned by the robot telling you where it went!
When the user interface has been programmed into the FlexiPanel module, the BASIC Stamp is loaded with the runtime program shown in **Listing 1**.

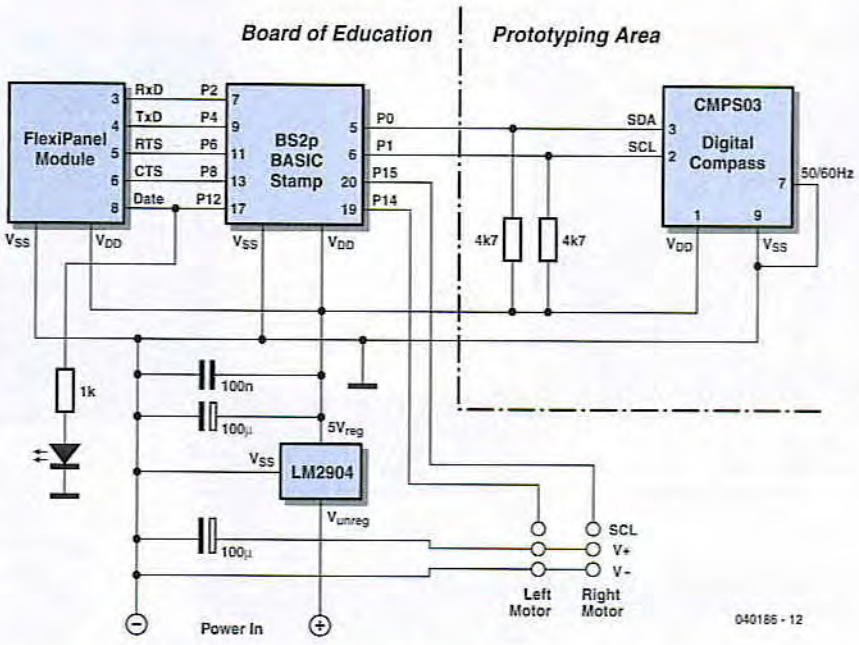
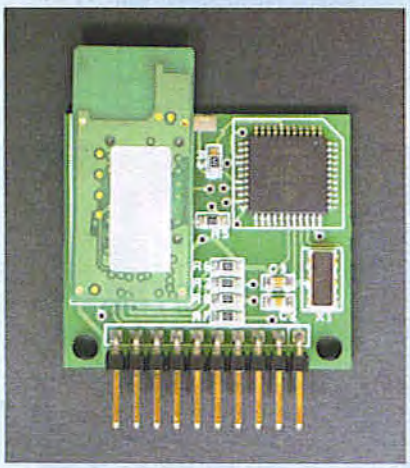


Figure 3. The add-on circuitry for the Tracking Robot consists of an electronic compass module.

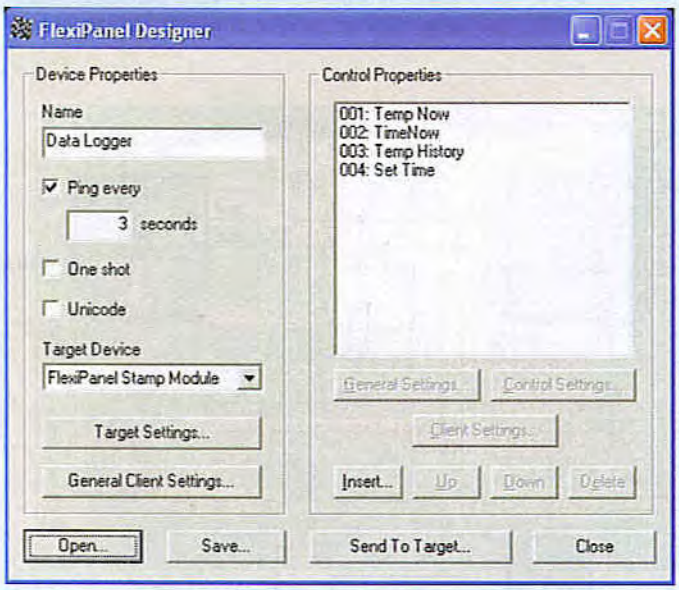
What can I do with it?

The purpose of this inset is to provide incentives to developing projects using the FlexiPanel-Bluetooth module from Parallax. Have look what can be done with it! The project documentation and software are available as free downloads.

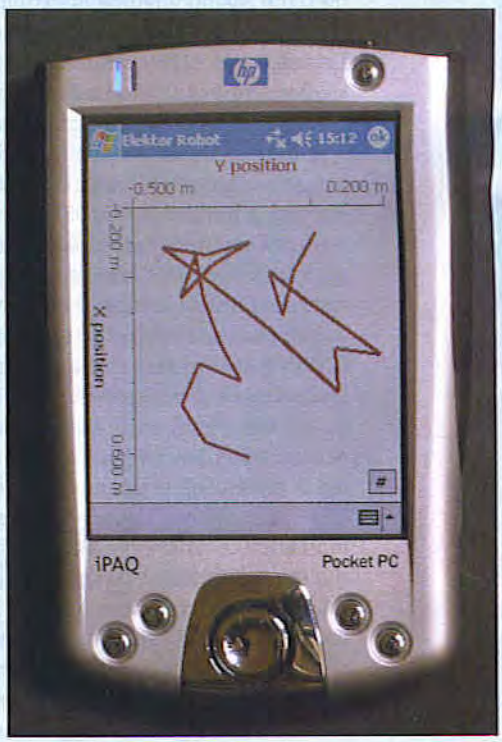


FlexiPanel with the piggy-back mounted Bluetooth radio sub-board. You have the pin-out and datasheets — nothing to stop you from hooking up a microcontroller.

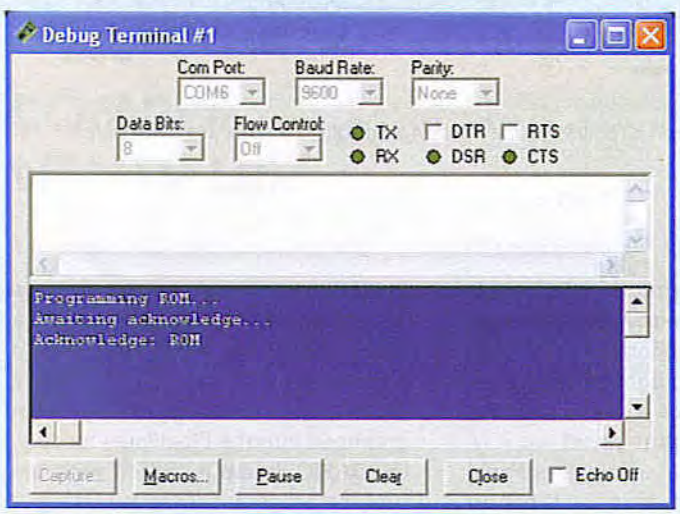
Tracking Robot user interface on a Pocket PC.



FlexiPanel Designer for a Data Logger project. Design your own control buttons as they appear on Bluetooth devices.



I'm sure we missed a turn somewhere, dear! The Tracking Robot route trace displayed on a Pocket PC.



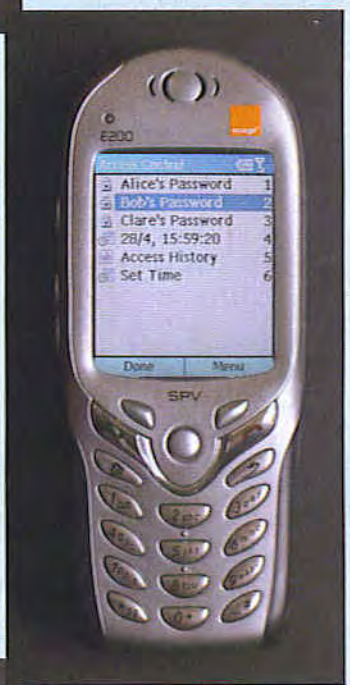
BASIC Stamp Editor busy programming the FlexiPanel module (old version, now replaced by drag 'n drop).

Temperature history on a Smartphone.

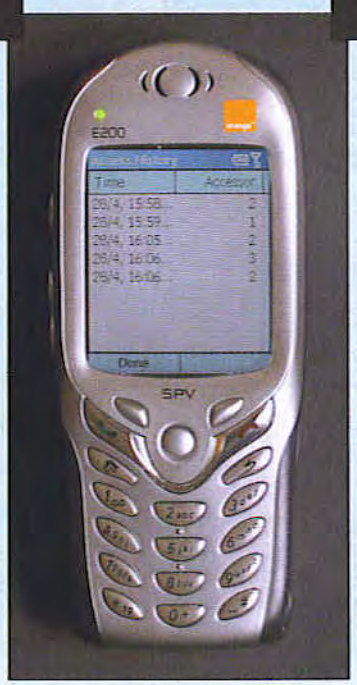
We're lost, aren't we? Tracking Robot route trace displayed on a Smartphone.

Temperature Logger graphic user interface on a Smartphone.

Access Controller graphic user interface on a Smartphone.



Tracking Robot graphic user interface on a Smartphone.



Access Controller log displayed on a Smartphone.

A Bluetooth Protocol

Bluetooth is a 2.4GHz digital radio communication protocol developed and licensed by Ericsson. Serving the 'personal area network', Bluetooth devices can come and go ad hoc. In contrast, the WiFi protocol, operating at the same frequency, is more suited to longer-term wireless infrastructure, with each individual node needing to be assigned a fixed IP (internet protocol) address.

Thanks to Bluetooth headsets, Bluetooth is now solidly entrenched in the mobile phone market. Intel intends to incorporate Bluetooth into its Centrino 2 chipset, to be launched in Autumn 2004. Not only will this allow PCs to connect wirelessly to printers, etc, but it will boost the growth of VoIP (voice over internet protocol), i.e. phone calls over the internet.

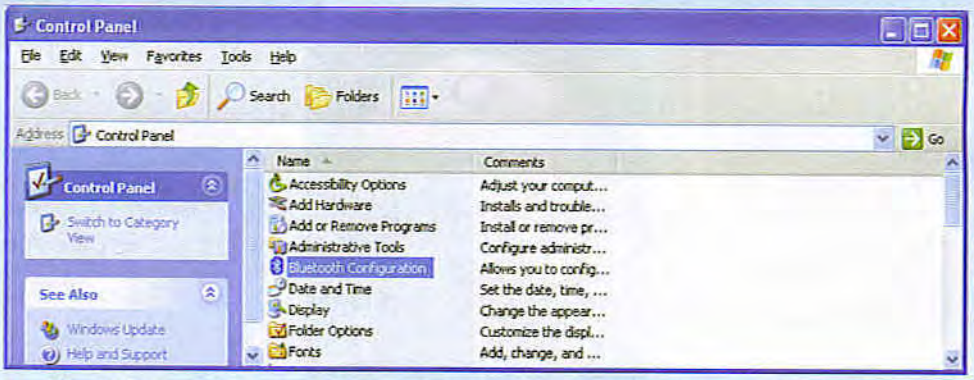
The Bluetooth standard provides interfaces for a wide range of communications protocols, from a simple serial port to audio. Like many higher-level protocols such as OBEX file exchange, FlexiPanel sits on top of the serial port emulation layer of the Bluetooth protocol stack. It is not part of the 'official' Bluetooth standard. However, the standard is relatively open in that anyone is free to create software for remote devices, and product-side components such as the FlexiPanel module are manufactured under license, just like any Bluetooth radio module. The first FlexiPanel products were software libraries to provide remote control for Windows applications and high-end embedded systems.

From the electronic product's perspective, the FlexiPanel module is a peripheral providing graphical user interface services. It maintains a list of the controls required by the product, and the current state of the controls. The product can update a control at any time and if a user modifies a control, the product is notified!

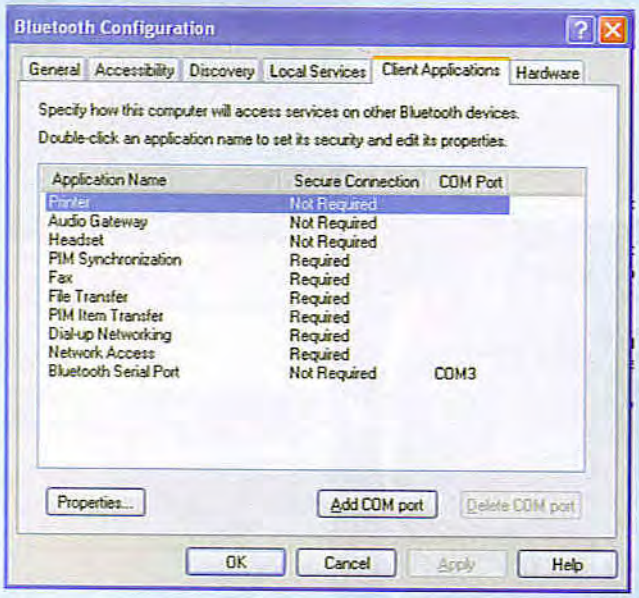
Installing a Bluetooth adapter

Desktop PCs will typically employ external Bluetooth adapters to communicate with devices like FlexiPanel. Usually, the installation of such adapters is a breeze using the supplied software, however in the case of the FlexiPanel some fine tuning is required.

For these adapters a series of COM ports is installed that look after the link to other Bluetooth devices. These links are normally protected against non-authorised access to the PC by the installation software. However, FlexiPanel does not employ a protected link and that's why you need to tweak the PC's COM port settings. You start from the Control Panel where the Bluetooth configuration may be found.



Double-clicking on this option takes you to the next window (tab: Client Applications)



Inspect the COM port properties and make sure Secure Connection is unchecked.

For these and other niggling details on Bluetooth see the FAQ at
www.flexipanel.com/comports/index.htm

Listing 1. BS2p code for Tracking Robot (extract)

```
BackUp:
        PULSOUT lPort, lMaxZ
        PULSOUT rPort, rMaxZ
        PAUSE 20
        FwRvSp = 2
        GOSUB CheckCompass
        IF DataPin = 1 THEN ReadControls
        GOTO BackUp

CheckCompass:
        ' only check every 50 pulses
        CmpCount = CmpCount - 1
        IF CmpCount > 0 THEN GoBack
        CmpCount = 50

        ' Get compass direction in binary radians and in tenths of a degree
        I2CIN  SerPt, CmpIn, 1, [brad, degs.HIGHBYTE, degs.LOWBYTE]

        ' Send degrees value to bearing control (code generated by FlexiPanel Designer)
        SEROUT TxPin\CTSPin, BaudM, [SetData, ID_Bearing, degs.LOWBYTE, degs.HIGHBYTE, 0, 0]

        ' Calculate position with Send binary radians value to bearing control
        ' (code generated by FlexiPanel Designer & cut'n'pasted)

        IF FwRvSp = 1 THEN
          xloc = xloc + COS( brad )
          yloc = yloc + SIN( brad )
        ELSEIF FwRvSp = 2 THEN
          xloc = xloc - COS( brad )
          yloc = yloc - SIN( brad )
        ENDIF

        ' if moving, send to trace
        IF NOT FwRvSp = 0 THEN
          SEROUT TxPin\CTSPin, BaudM, [AddRow, ID_Route_trace, yloc.LOWBYTE, yloc.HIGHBYTE,
                 xloc.LOWBYTE, xloc.HIGHBYTE ]
        ENDIF

        ' return to motor control
GoBack:
        RETURN
```

After initialization, the program tests to see what kind of motor control pulse it is supposed to supply. Then it reads the compass and writes the bearing to the bearing display and the route tracker.

More about the project software

To get started with this project you will need the following:

1. Windows 2000 or later
2. FlexiPanel Software Development Kit (SDK)
3. Basic Stamp Editor (BSE)
4. FlexiPanel

Some notes: the FlexiPanel Software Development Kit SDK (previously known as FlexiPanel BASIC Stamp Developer's Kit) only works on recent versions of Windows.
The SDK allows the GUI to be designed on a PC, i.e. you decide on the controls necessary for the final product, and their 'look' as they appear on the Bluetooth device, see 'FlexiPanel Designer' above.
Regarding the BSE, only the Bs2, Bs2sx, Bs2e and BS2p are supported. The –p version is preferred because of its speed and memory size. Note that the 40-pin Bs2p40 will not fit on any BoE as only a 24-pin socket is available.
A version of FlexiPanel for Windows 95/98 is available as a free download, as well as versions for MS Smartphone, Pocket PC, Java JABWT devices and Palm OS.

Closing notes on the tracking robot project

The BoE-Bot is powered by four AA batteries which, in practice, will only last a few tens of minutes before they are exhausted or their voltages start dropping to levels where the electronics start 'browning-out'.
The FlexiPanel module can generate a signal indicating when a remote unit is connected. The robot could automatically halt if it went out of range of the remote unit.
The operation of the electronic compass is significantly influenced by the surrounding metal and direct currents. These effects may be counteracted by local calibration of the compass.

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Web pointers

Parallax: www.parallax.com
FlexiPanel: www.flexipanel.com
Milford Instruments: www.milinst.demon.co.uk

Free Downloads

Basic stamp (.bsp) and Flexipanel (.FxP) programs for Tracking Robot, Datalogger and Access Controller projects. Full project documentation (.doc). File number: 040186-11.zip
PCB layout in PDF format. File number: 040186-1.zip
www.elektor-electronics.co.uk/dl/dl.htm, select month of publication.