A joystick for the Tiger

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1. Basics

There are many ways in computer technology to convert analog movement into data that is understandable for the computer, thinking about e.g. computer mouse, graphic tablet, encoder or joystick. All these devices basically work as analog-digital converter with mostly multiple channels (e.g. x-y-direction), however often with completely different principles. In this application we will see that also the joystick, very popular with computer players, can work with the BASIC-Tiger and that its use makes sense in many cases. First we deal with the principle of converting the joystick position into an electric variable as well as the construction and the connection to the computer.
The computer joystick has its origin in the control stick of earlier airplanes. The pilot could navigate his airplane both upwards and downwards as well as to the left and to the right with one single control element. The pilots of model airplanes coming into fashion a short time later also wanted that. You could find the typical cross sticks in their remote controls already long time before the arising of computers, with which you had control of two coordinates with only one control element. No question that the first flight simulators of the computer world also wanted to offer this “feeling of flying” – the computer joystick was invented. Just some additional functions, like “fire buttons”, thrust control, separate rudder and aileron functions – that’s the joystick standard used until today. What came next is the tribute to multimedia in the PC world. Joysticks with many special functions up to the generation of vibrations (Force feedback) and sound, with innumerable weapon buttons and new connection methods (USB, infrared, radio etc.), but also some that are hardly recognizable as control sticks, are available. We will concentrate on the standard joystick, its typical wiring as well as its use with the BASIC-Tiger.

1.1. The standard joystick

To start with, each standard joystick has at least one cross stick as well as 2 buttons. The cross stick is a gimbal mounted stick, its upper end is provided with a handle and its lower end moves two potentiometers. Figures 1 and 2 show this by the example of a cross stick of a common remote control for model airplanes. The PC supports two standard joysticks, which can be connected separately with a Y-adapter. But it is also possible to equip one single joystick with extended functions, which then has 8 input variables (4 x analog with 4 potentiometers, 4 x digital with 4 buttons) in total. Such a device is connected to the PC through a so called game port, a 15-pin SUB-D socket which is available either directly on the motherboard of the PC or on a sound card. Just in the PC the resistance values of the potentiometers are converted to numerical values, so a normal joystick itself has no “intelligence”. The wiring of the individual joystick components and the pinout of the SUB-D plug, which is attached to the game port, is shown in fig. 3.

Fig. 1 Cross stick, top view...

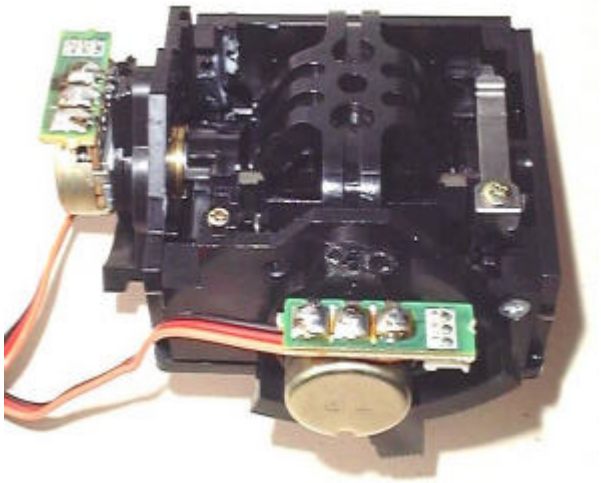

Fig. 2 ...from below with both potentiometers

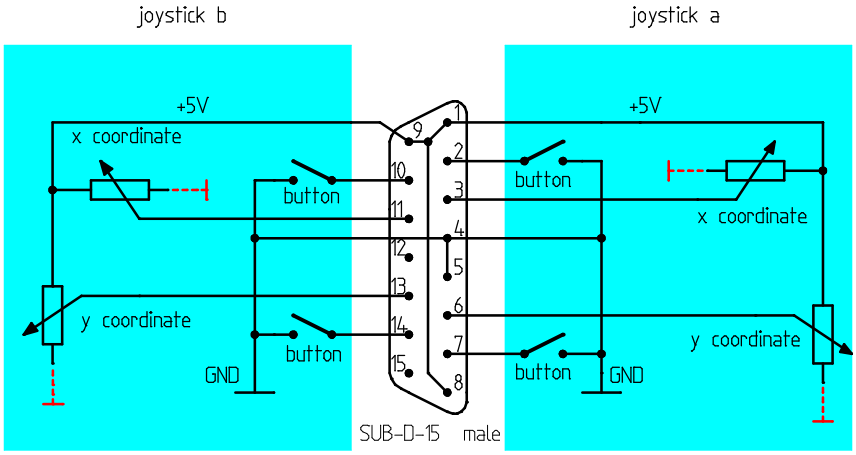

Fig. 3 Wiring of a PC's game port with 2 standard joysticks. The ground connections at the free potentiometer ends (Red broken lines) are needed for use with BASIC-Tiger and do not exist at a standard joystick!

You see that both joysticks are identically built up. Two joysticks on one socket are operated through a Y-adaptor cable. It is also important to know that the game port is likewise used from so-called MIDI devices. This is a system of electronic music instruments, which communicate with the PC.
Now what does a PC do with the connected joysticks? With the buttons it is relatively simple, these are logically interpreted as open or ground connected lines (1 or 0). The position of the resistors can't be evaluated that simple. The with one end to +5V (VCC) connected resistors are only one part of an evaluation circuit here, whose other components are in the PC. Looking there, you find an IC that inside contains several, mostly four, NE555 (a well-known timer chip). These timers, with a solid capacitor and our joystick resistance, form an oscillating circuit, whose frequency only depends on the value of the connected resistor. The

PC now evaluates the clock frequency of the 4 timers and calculates from this the position of the sticks. Sometimes these circuits are integrated within bigger ICs, so that they are not that easy to find, the principle however is always the same.
For mechanical reasons you can't go through the full resistance area of a potentiometer with a simple lever, but always only a small range. Now it's not easy, considering the quite complicated stick mechanics, to have all resistors of a joystick in the same range. It becomes even more difficult with joysticks from different manufacturers. An alignment can be made by mechanical actuators (see fig. 1), but also electronically at the PC (calibration), either in the game or in the operating system. For this the sticks or sometimes also sliding controls or steering wheels are first moved into their respective end positions. The PC remembers the appropriate frequencies of the corresponding timers. Then it's back into neutral position, usually such control sticks are self-neutralizing, i.e. they move back into central position by themselves. The PC also records this value for all 4 coordinates. A calibrated joystick can now be used very exactly for flying in the flight simulator, but also for controlling machines and precise appliances.

2. The game port for the BASIC-Tiger

While a PC needs four additional AD converters to get the potentiometer settings of the joystick into a usable format, the BASIC-Tiger is already completely prepared for it. It already has four AD converter inputs, which we can directly use for our project. We remember that the potentiometers of the joystick are with one end connected to VCC and their four sliding contacts are lead directly to the 15-pin SUB-D plug (see fig. 3). In its origin the other ends of the potentiometers are open. If you now want to achieve to a large extent linear dependency of the measured voltage from the potentiometer position, a small supplement in the joystick is necessary. **The until now free ends of all potentiometers must be connected to ground**. Then the sliding contact voltage is measured directly at the AD converter inputs. Who wants to use the joystick on the PC as well as on the BASIC-Tiger, should do the ground connection of the potentiometers e.g. with jumpers.

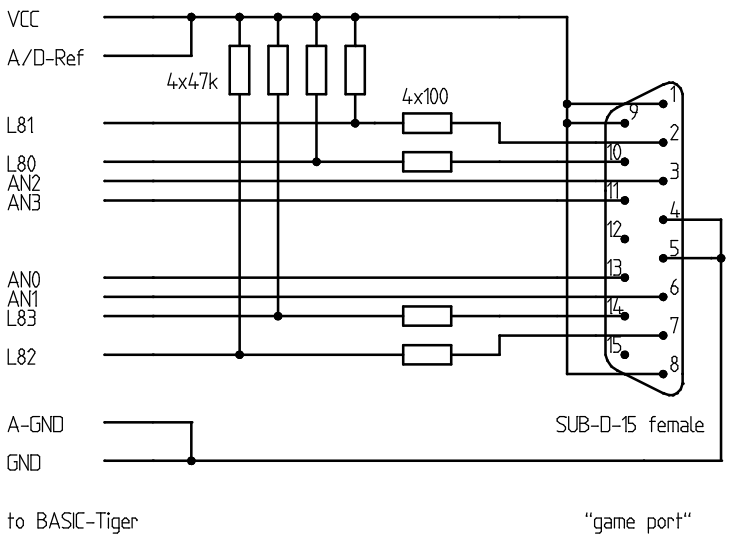

Fig. 4 Joystick adaptor for BASIC-Tiger

The joystick buttons are, as shown in fig. 3, low active. A pull-up resistor to VCC has the effect, that a logic input of the BASIC-Tiger definitely reads High when the button isn't pressed. Pressing the button generates Low; the protective resistor of 100Ω is only to prevent "catastrophes" from wrong wiring or programming. As logical inputs here the BASIC-Tiger pins L80 to L83 are used, you can of course use others, too. The complete circuit of our joystick adapter is shown in fig. 4.

As you can see, the joystick adaptor is laid out for totally 4 potentiometers and 4 buttons, what can either be 2 standard joysticks with an adaptor cable or one joystick with extended functions (e.g. a so called flight-stick). Then such a joystick has e.g. in the flight simulator the following functions:

Function	Symbol	Control	Neutra-lized	Value range in JOY01.TIG	BASIC-Tiger connection
Throttle	G	Separate potentiometer	no	0%...100%	AD 0
Elevator	H	Cross stick up/down	yes	+50%...-50%	AD 1
Aileron	Q	Cross stick left/right	yes	+50%...-50%	AD 2
Rudder	S	Separate potentiometer	yes	+50%...-50%	AD 3
Button 1	T1	Button		1 / 0	L80
Button 2	T2	Button		1 / 0	L81
Button 3	T3	Button		1 / 0	L82
Button 4	T4	Button		1 / 0	L83

Tab. 1 the functions of the joystick

The symbols are used in our demo program JOY01.TIG to show the current positions of the joystick as well as the status of the buttons.

3. Software

Actually you wouldn't have to put in much work. In the Tiger-BASIC online help under index → Analog1 there is a demo program ANALOG1.TIG that immediately shows the analog values of the four potentiometers.

Attention! The identically named program in the Device driver manual V5.0 is not identical with the one in the help and is not working.

But you have more fun if the values are not, like in the simple measurement, somewhere between 0V and 5V, but as in table 1 are displayed normalized in percent. Therefore the "right" program ANALOG1.TIG is used as a basis. The buttons are read and the analog values are assigned to the symbols shown in table 1.
After installation of the drivers and declaration of the variables the joystick is calibrated first. The user is requested to bring the stick and both sliding controls several times to both of their end positions. The program records all maxima and minima and normalizes the value range to a percent base. Once all ranges are recorded, any button is pressed and immediately all potentiometer values are available in percent. The states of the buttons are shown as 1 or 0.

With this the joystick for the BASIC-Tiger is ready-to-use and can be used as analog input device.