VALIANT DESIGNS

TITLE

TURTLE SYSTEM DESCRIPTION

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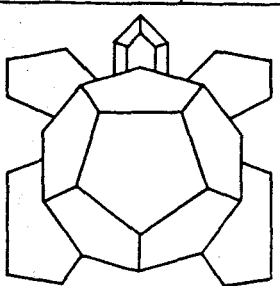

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1.0 INTRODUCTION

The Turtle hardware/software package comprises five items:

1. Turtle Robot
2. Communicator
3. Power Adaptor
4. Interface Lead to connect Communicator to Host Computer
5. Software Interface as required

The Turtle is a remotely controlled robot receiving commands from the Communicator via a one way infra-red data link.
It is fitted with two stepper motors, port and starboard, to provide linear motion, and a third DC motor to provide the lift and drop pen action.
A power pack comprising ten 0.5 Ampere Hour (SAFT VR0.5AA) batteries is contained in two base pods and is user accessible by means of removable covers.
The electronics control board provides all of the necessary infra-red reception circuitry, decoding and control tasks necessary to enable the robot to perform exactly according to the input command stream. An additional circuit on the same printed circuit board provides a fast/slow battery charge option. In this circuitry there is also a sensory cut-off system which turns off the fast charge current following attainment of full charge in order to protect the batteries from overcharge damage.
The base mounted resistor provides a rudimentary level of control over the fast charge current.
A base mounted fuse is incorporated to protect the system from overcurrents due to incorrect battery insertion, PCB faults and wiring shorts.

The rear mounted switch provides the unit ON-OFF control as well as the fast or slow charge selection option.
A DIL switch mounted on the underside of the unit provides the user with a one out of four Turtle ident (or address) selection option when using the Turtle in a multi-turtle environment.
The two red leds (eyes) mounted at the forward end of the unit provide indication of the current state of battery discharge.

The Communicator is the interface between the Host Computer and Turtle robot, translating electrical signals from the Host into an infra-red transmission.
The unit may connect to either parallel or serial output ports, the interface configuration being selectable via the side mounted DIL switches.
In serial mode, the unit will connect to standard RS232 or RS423 type interfaces.
Baud rate selection is automatic providing the transmission rate from the Host Computer lies between 2k and 5k.
In parallel mode, the system may be operated in single or multi-turtle configurations depending on the software (LOGO).

The Power Adaptor, consisting of a free standing transformer and DC rectification pack, provides both the power to the Communicator and charge supply to the Turtle.

The Interface Lead depends both on the Host Computer and the interface type from which the system will run.
In many instances, the lead selection will be LOGO (or software driver) dependent.

The Software, supplied on either 5¼ inch floppy disc or cassette tape, provides the link between the LOGO software and Turtle hardware drive requirements.
In a number of instances, this interface software is imbedded into the LOGO type language, thus eliminating the necessity for a separate interface driver.

2.0 TURTLE OPERATIONAL DETAILS

2.1 Infra-Red Communication

The Turtle robot is a remotely controlled device that receives infra-red commands from the Communicator unit. The operational range of the infra-red link is typically 6 metres but may be more, depending on the physical (i.e. reflective) nature of the room in which the unit is operating. Alhtough it is recommended that the unit operates within the line of sight of the Communicator, it is possible, with smaller dimensioned rooms, to obstruct the line of sight while maintaining operation. There is also a near range limit, whereby the infra-red signal saturates the receiving amplifier - this may occur for ranges nearer than 1 to 2 metres. (This problem may be easily overcome by pointing the Communicator away from the Turtle so that the maximum power axis is orientated at the far 6 metre point. In this instance, it is recommended that the Communicator is above the Turtle operating plane by between 1 to 2 metres). Finally, the unit will not operate in strong sunlight, as again the infra-red amplifier becomes saturated.

Mounted at the rear end of the PCB is a red LED. The purpose of this LED is to indicate that the unit is correctly receiving infra-red commands - changing state for each command.
During motion, the LED goes on and off at such a rate that a dimming may be detected, rather than a toggling action: however, toggling may be detected at the beginning and end of motion.
Under one normal operational circumstance the LED will not toggle, even though commands may well be correctly

decoded. This relates to the situation whereby the Turtle ident (or address) does not correspond to the actual command ident transmitted.
For most systems, the Turtle is operating in a single unit environment, and as such the underside DIL switches should be set to the default ident setting of both off - Turtle Ø.

2.2 Motion

Motion is achieved by rotational activation of the stepper motor windings; each step produces a 1/3 millimetre movement.
The on-board processing capability is rather fundamental in nature, and requires an infra-red command for each stepper movement.
Each stepper motor is individually controlled within each transmitted command, so that reverse, forward, or freeze step movements may be produced.
This capability enables the unit to move linearly, rotate or even arc, depending on the host software capability.
At the end of each complete movement cycle (e.g. after moving forward 10cm) the motors are turned off to conserve power.
Typical power consumption in a non-motoring condition is 80 milliamps. The motoring power consumption increases to about 250 milliamps.
The linear speed is typically 140 to 150 steps per second, producing a velocity of approximately 5cm per second.
The mechanical performance of the unit is critically affected both by the wheelbase setting and the distance of each wheel from the pen tip. In order to optimise these settings, wheel position trimmers are provided for each wheel. The method for setting these up is detailed in Appendix A of this document.

2.3 Battery Stack

The battery pack of ten 0.5Ah batteries provides enough power for about 2 hours continuous motoring, or 3 to 4 hours of intermittent motoring.

The batteries are nickel cadnium rechargeable, with over pressure venting to release excess gases when subjected to overcharging - the gas released is oxygen.

This venting prevents battery rupture and the consequential electrolyte spillage in the event of gross overcharging due to a charge system failure.

The charge system is dual mode providing optimal fast and slow charge selection.

The charge current is provided by the voltage adaptor unit and connects into the socket mounted on the port stepper motor housing.

The charge mode selection is made by a combinational sequencing of 'CHARGE' switch selection and power-adaptor application.

Setting the rear switch to the 'CHARGE' position in advance of applying external power will set the unit into a fast charge mode, and is signified by the illuminated yellow LED on the PCB. Reversing this sequence will cause the unit to adopt a slow charge condition with the yellow LED extinguished.

The fast charge rate is typically 0.5Amps, roughly regulated by the base mounted 5.6ohm resistor, and will normally charge the batteries to 70% full capacity in one hour, from a discharged condition. The fast charge will continue for typically another hour, after which time the unit will adopt a slow charge condition, signified by the yellow LED going out.

The time at which the fast charge system cuts out is

dependent on the battery stack voltage and temperature, the temperature being the dominant factor: the temperature is continuously monitored by the charge circuitry by means of a battery pod mounted thermistor, and cuts off at about 40°C.
The slow charge rate is around 50 milliamps and will be maintained indefinitely by the unit.
The life span of the batteries is generally in the order of 500 cycles, yielding an average of well over one year's use before replacement.
Battery replacement, when required, may be carried out by the user by removing the base caps.
The boards are protected from incorrect battery insertion (e.g. voltage reversal), although the internal fuse may blow, requiring repair by a service agent.

At the front of the unit are two series connected red LEDS. Apart from their decorative appeal, they also serve a more practical function as battery charge state indicators. They will remain illuminated until the batteries are nearly discharged. However, depending on the battery circuit resistance, which will vary between units, some amount of flickering will be detected before they remain permanently off.
This flickering is caused by power surges at the beginning and end of movements and pen actuations.
The final cut off voltage is typically 11 volts and it is expected that mechanical functions are maintained at least to this point.

2.4 Pen System

The pen system obtains its lift, drop action by means of a bi-directional DC motor drive system.

The motor drive current is typically 0.5 Amps and is applied for approximately one second following reception of a single change state command; the pen drive will not be activated if either a received pen command does not call for a change in pen state, or if the unit is in an existing motor drive mode.
In later models, the current limiter resistors R39 and R40 (22ohms) found at the rear of the PCB, may be replaced by thermistors. This replacement was found necessary to protect the circuitry from invalid processor modes which could occur under certain conditions of unit misuse.
The recommended pen type is the BEROL (except Fineline and Highlighter) and it is inserted into the pen holder receptacle from the underside of the unit.
The pens should push fully home, with the top protruding out of the top most end of the tube by about one millimetre.
The pen is retained within the holder by a plastic pressure clip action.
Removal of the pen is by exerting similar forces but in the reverse direction.
It should be possible to remove the pen by clipping on its cap, and then pulling against this.
There are, however, manufacturing tolerances, both in the pens themselves and in the holder, which may not always make this possible.
The pen 'lift to drop' movement is typically 7 millimetres.

2.5 Multi-Turtle

On the underside of the unit may be found a small DIL switch.
The purpose of this switch is to define the Turtle ident between 0 and 3, yielding a facility to drive up to 4

Turtles individually, within a confined area. However, most LOGOS are only capable of driving single Turtles, such that the Turtle should always be configured to recognise the default ident.

3.0 COMMUNICATOR OPERATIONAL DETAILS

3.1 General Description

The Communicator provides the interfacing between the Turtle and Host Computer, converting either serial or parallel data into an infra-red output signal.
The electronics is contained on a single printed circuit board within the 30mm x 100mm x 130mm enclosure. At the rear end of the unit are three sockets: a 5 pin DIN type serial connector, a 15 pin 'D' type parallel connector and a power socket.

3.2 Power Up and Initialisation

Turning the unit on is simply by means of plugging in the power adaptor supply: there is no separate on/off switch.
The plugging action should be a firm push action to ensure that the unit powers up correctly - the processor reset depends on a reasonably clean supply power up waveform. In circumstances where the power jack is plugged in in a faltering manner, the processor may not reset correctly, causing the unit to refuse to initialise. There will be no resulting damage to the unit and a re-powering will normally remove the incorrect condition.

The unit should always be turned on according to the user instructions. This is because the unit requires a number of check characters to set it into an operational mode, and powering up at the wrong moment may cause the unit to receive these characters incorrectly. Accordingly, the unit should be powered up as the last act prior to initialisation - such that all preliminary activities, like powering up the host machine, connecting

cables, and setting the Communicator switches should be completed prior to this. In many systems, the host computer will inform the user when to power the Communicator.

3.3 Mode Setting

The Communicator will connect to either parallel (centronics) or serial (RS232, RS423) interfaces.
A set of DIL switches are provided on the unit side to configure the Communicator for the interface type.
The first two switches configure the firmware into one of three modes: serial, single byte parallel or double byte parallel - the fourth configuration is also a serial mode, but not used.
Both the serial and single byte parallel modes are for single Turtle systems. The second byte of the double byte configuration is an address or ident byte which defines the Turtle ident. This latter mode relates to multi-Turtle logos such as Acornsoft.
The Communicator automatically defaults the ident to Turtle Ø for single Turtle operating systems.

3.4 Serial Mode

When configured for serial mode operation, the Communicator requires a specific serial data form for initialisation, normally 'carriage return', in order that it may synchronise its receiving baud rate sampling to the transmitted rate.
A second byte is transmitted following this and is used as a check character; if the Communicator receives this character correctly, then it is set up and, as a user indication, turns off the red LED at the front of the unit. (The red LED should always be illuminated prior to initialisation to indicate that the unit is powered).

Usually, the serial data interface of the host computer is set up via the interface software, but generally the unit will operate on any serial data rate between 2K and 5K. The unit will operate on both 7 and 8 data bit serial systems, as all characters following the first 7 data bits are ignored, including parity and stop bits. Thereafter, each command received from the host computer will be encoded prior to infra-red transmission; for each command transmitted, the red LED at the front of the unit will change state, such that for continuous move operations, the LED will appear permanently illuminated, but dimmed.

3.5 Parallel Mode

When configured into a parallel mode, as defined by the user instructions, data is transferred via the parallel data highway into the 15 pin 'D' type connector.
There is no comparable rate set up condition for parallel operation, although for consistency, the same data words are transferred, enabling the unit to check and respond by extinguishing the red LED as a system integrity check. In this instance, the functioning of the red LED is identical to the serial mode of operation.
Again, the first two side mounted DIL switches are used for firmware mode selection, but in this case the last two switches are used to set up the STROBE signal logic level. This strobe is used to indicate to the Communicator that data is being transferred via the eight bit highway to its data buffer latch, and it is important that it is set up correctly. However, all systems to date have been set up so that the switch settings are identical.
For single Turtle systems, only one transfer per command is required, with the ident bits being defaulted by the

Communicator to Turtle Ø prior to infra-red transmission. For multi-Turtle systems, a second byte is required for each transmission and defines the Turtle ident, selectable by the operator, between 0 and 3, according to the LOGO facilities.

3.6 Multi-Turtle Parallel Mode

For multi-Turtle operation, two methods of system set up are possible.

The first method concerns a single host computer system, which can transmit to one or more Turtles at a time or in a sequential manner, depending on the LOGO and capabilities of the machine. In this instance, only one Communicator is required - connecting to the host machine in the normal manner. Transmission interlacing is organised by the host machine.

The second set up method concerns the situation where it is required to drive more than one Turtle in an enclosed area but from separate machines. In this instance, the Communicators cannot be allowed to transmit without some form of interlacing control: this control may be exerted by an external unit which interconnects between each of the Communicators.

3.7 Handshake

For both interface types, a handshake line, which indicates the presence of a functional Communicator, is provided. However, this system is not rigorous and may not inform the user, via the host machine, that the Communicator is not operative.

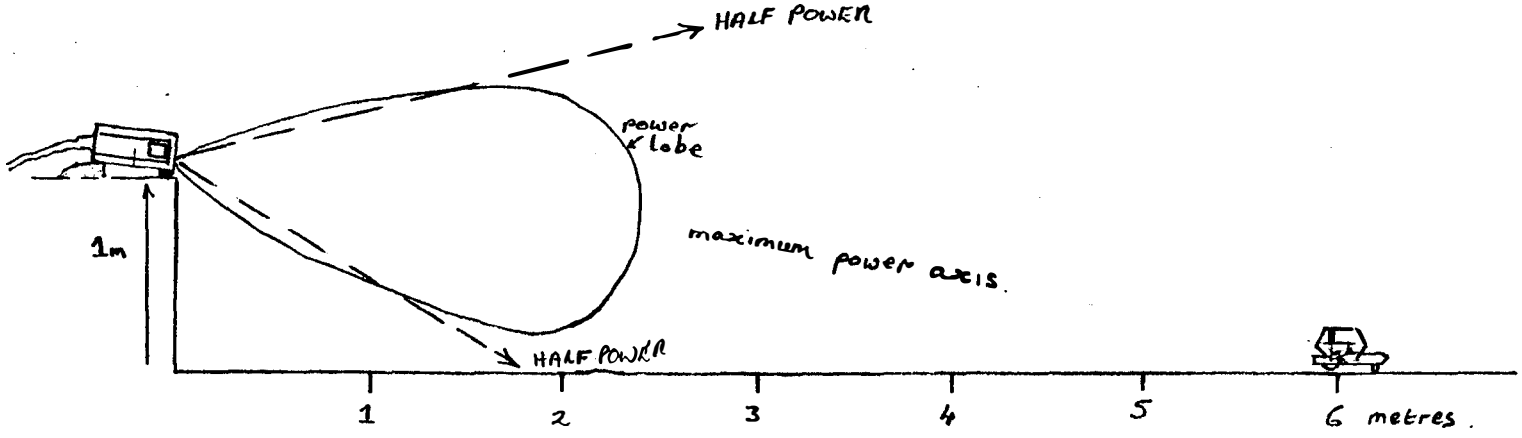
The necessity for the handshake line only becomes apparent in multi-Turtle systems where it is used to hold transmissions from the host computer in order to realise the interlacing control over infra-red outputs.

3.8 Infra-Red Beam

The infra-red transmission beam is essentially a solid angle about a central line of axis taken from the Communicator window. The solid angle is approximately 50^{o} between half power points. Accordingly, the maximum power is along the central axis and it is this axis that should be directed at the far operational point some 6 metres distant from the source.

It is recommended that the Communicator be raised by some 1 to 2 metres from the Turtle plane of operation, in order to avoid Turtle infra-red receiver saturation at near range.

Depending on the nature of the room, a considerable amount of infra-red signal may be bounced off ceilings and walls, reducing the requirement for unobscured line of sight transmission.



Infra-red Power Output lobe

4.0 POWER ADAPTOR

4.1 General Description

The power adaptor is a dual purpose unit, acting as a voltage supply to the Communicator and a charger unit to the Turtle.
There is no conflict in use between these two modes.
The item is a free standing durable plastic box which converts mains input voltage to a low level DC output.
The unit is designed to satisfy current safety standards and has been cleared by a number of evaluation bodies.

4.2 Protection

The unit is built to double insulation standards with overheating protection in the form of a thermal fuse incorporated into the mains winding of the transformer. This provides additional user protection from overload damage.
For UK systems, it is also recommended that the mains plug be fitted with a 3 Amp fuse.
The main unit is sealed, offering no service access.

4.3 Output Voltage

The no load output voltage is typically 26.5 Volts DC, with the centre pole of the jack plug positive.
Under Communicator loading, the output reduces to approximately 23 Volts, with a typical loading of 145 milliamps for that unit.
Under Turtle fast charge loading, the output further reduces to approximately 19.5 Volts at the typical loading of 0.5 Amp: the unit output rating is 20VDC at 0.5 Amp.

5.0 INTERFACING LEADS

Each Turtle System is provided with an interface lead according to type of interface required (serial or parallel) and computer, as appropriate.
Although the interface types may be roughly categorised as RS232, RS423 and Centronic, the total lack of standardisation in connector types used and wiring configuration means that there are a large number of different cables, with little commonality between machines.

Serial lead interfaces comprise three connections: the data line, the return (handshake) line and OV reference.
Parallel lead interfaces comprise eleven connections: 8 data lines, the strobe line, busy (handshake) line and OV reference.

In order to rationalise the grounding requirements for the basic three interfaces, the serial OV connection is approximately 6 Volts above the parallel OV connection within the computer, so that on no account should both parallel and serial cable interfaces be connected at the same time.

6.0 SOFTWARE

Each Turtle System is supplied with a software pack relating to the host computer.
A single software pack is normally supplied, which permits interfacing to any one of the Valiant specified LOGOS.
Some attention is required to ensure that, when supplying software for a particular machine, the correct cable is enclosed according to the LOGO interface requirements.
Where possible, optional interfacing has been supplied enabling the user to choose between serial and parallel interface types, according to the computer and personal requirements. However, where build up computers are encountered, such as the Apple 2e, the optional interfacing is dependent on the add-on cards incorporated and it may be necessary for the user to purchase the appropriate card from his local computer dealer.
Details of interfacing requirements and software availability are enclosed in the S/W and H/W Interfacing Record documents produced for each computer.