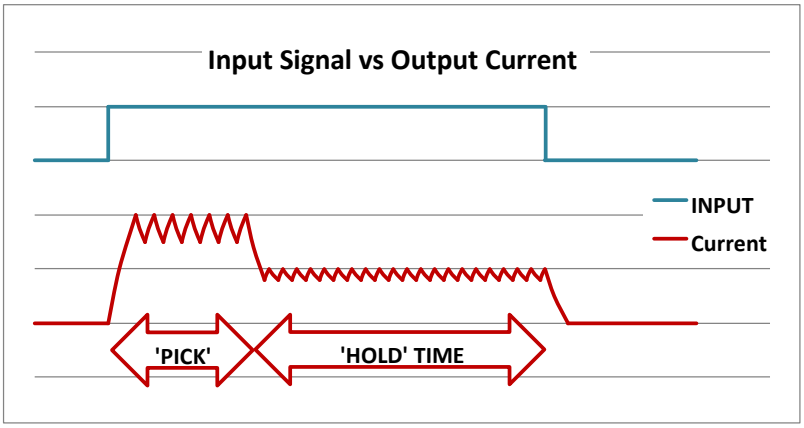
CONTROL CIRCUITS

PHu Pick & Hold Module

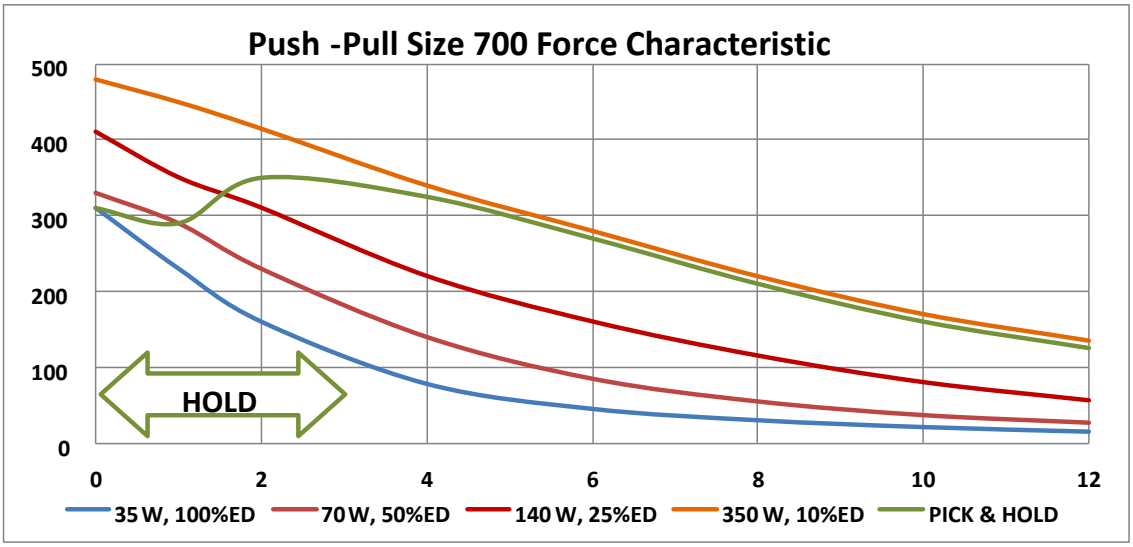
DESCRIPTION

A Pick & Hold circuit regulates current applied to a solenoid or motor, applying high initial current (PICK) to develop high initial force/torque for fast response, then reducing this after a preset time (PICK TIME) to a lower level (HOLD) to maintain operation. It can be used to reduce power consumption in applications with restricted power supply (eg battery or line-powered systems), to reduce heat and power dissipation (systems handling temperature-sensitive materials, or susceptible to thermal distortion), or to stabilise the performance of systems against fluctuations in supply voltage or ambient temperature.

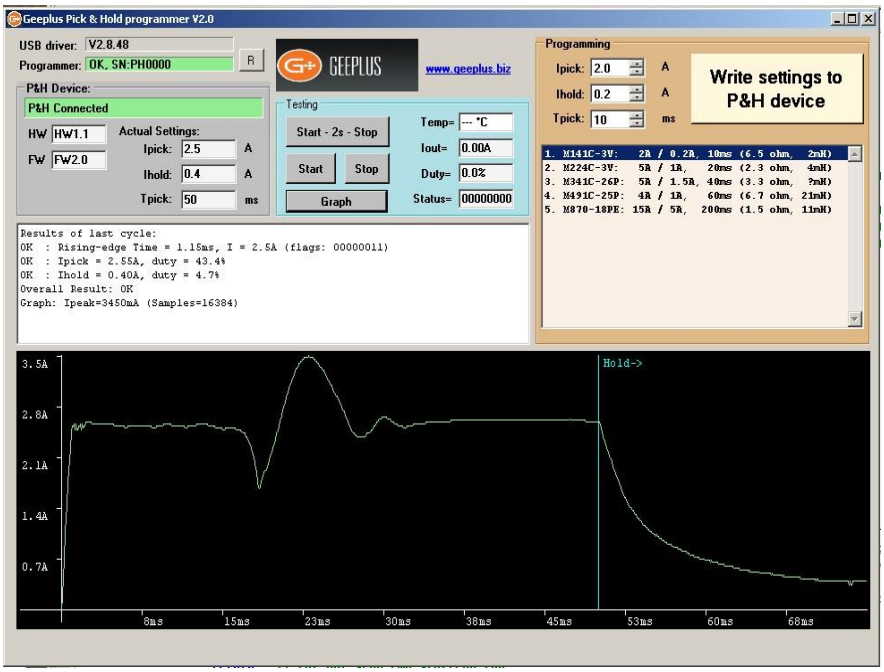


Geeplus PHu modules are microprocessorcontrolled pick & hold modules which use intelligent algorithms to control a wide range of devices with simple user control of current and time parameters.

The graph below shows the characteristic force curves for a push-pull solenoid (the curves at different excitation power showing greater force with increasing excitation power, and the shape of the curve with force increasing as displacement reduces towards zero are similar for most linear solenoids), the use of a pick and hold circuit enables force to be realised at the extended position similar to an intermittent duty curve, with continuing excitation power comparable to (or even lower than) that of the 100% duty curve.



The PHu modules can be used to implement control of large solenoids in an end-user application, the userfriendly interface also makes them a superb development tool to explore the maximum performance achievable from a wide range of solenoids during product development.



When connected to a PC/Laptop a clear graphical display of the excitation current waveform can be observed. This helps users select an appropriately sized solenoid for the application and optimise the excitation current conditions to achieve the required force or speed with minimum power consumption and heat dissipation.

The PHu fulfils the PWM current regulator and oscilloscope functions, with ease of use via a simple USB connection to a PC.

While setting up parameters, the solenoid can be switched On or Off from the PC. The ‘Start-2s-Stop’ button energises the device for 2s only, this provides a degree of protection to small devices which can overheat rapidly if energised with excessive current.

The ‘Graph’ display shows the current vs time for an interval of 1.5x the chosen ‘Pick’ time. The graphical display allows the user to visualise the following parameters:

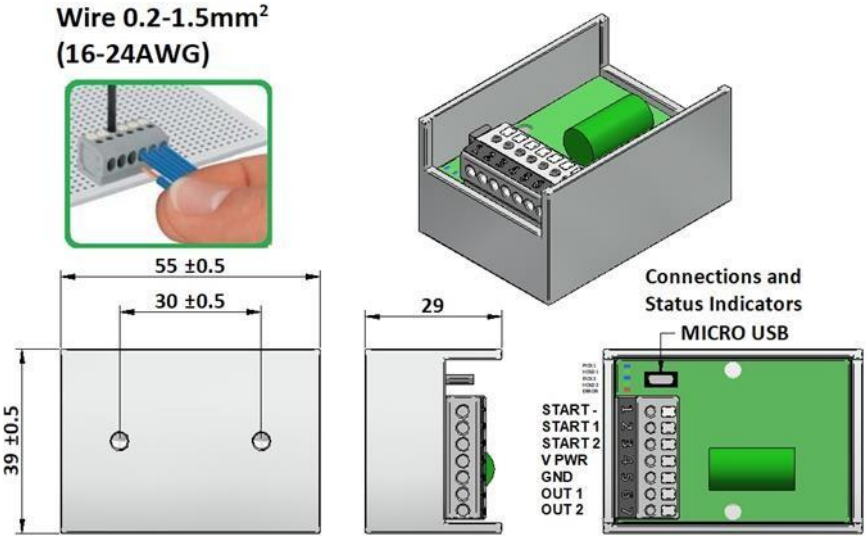
- Electrical rise time of the current.
- The ‘spike’ represents the impact at the end of the stroke so allows stroke time to be monitored.
- The reduction of current from ‘Pick’ to ‘Hold’ value can be monitored.

The text data shows the achieved current values and shows the duty cycle of the PWM current control in the Pick and Hold conditions. It provides some limited diagnosis of problems such as no load, and inadequate source supply.

When switched on for long periods, the screen also shows the duty cycle of PWM control, and the junction temperature of the power device in real time.

PHu Product Configurations

Phu50 – Mechanical Dimensions



The standard module configuration is mounted in a die-cast box and potted (encapsulated) with resin.

The Phu-50 module operate with supply voltage from 8vDC to 50vDC and has 4 different modes of operation as follows:

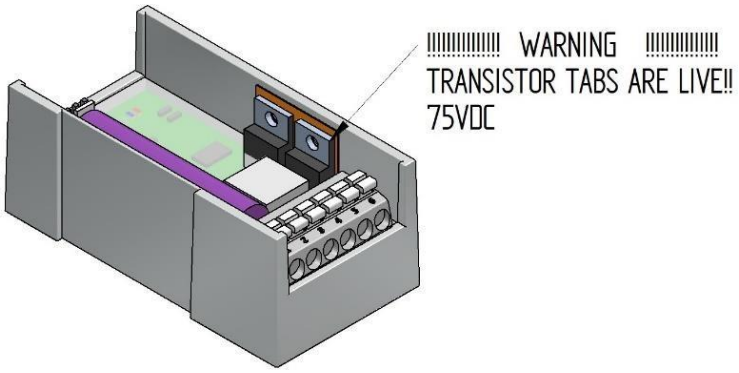
1. Bipolar mode (default): Able to deliver current in a forward or reverse polarity to a single load device.
2. SingleOut mode: Single output to a single device.
3. DualOut mode: Able to drive 2 unipolar devices independently or as a single output device with second output functionality not used with similar capability to the 2-output operation.
4. ParallelOut mode: Both outputs are connected in parallel to one unipolar device to reduce power loss or to deliver higher continuous current.

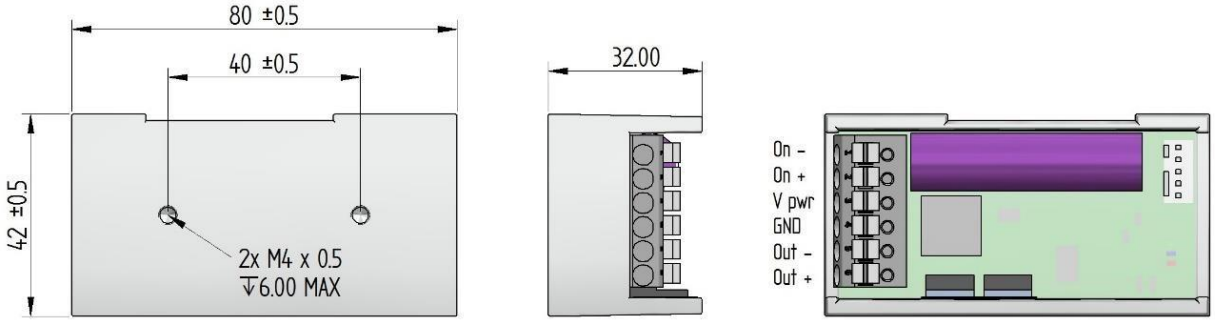
Connection to a PC for programming, or for control by the PC is via a micro-USB connector and in addition to the feature mentioned above the, the Phu 50 also allows the following:

- High speed camera synchronization to allow capture of high-speed movement.
- Actuation cycling and counting for life testing (and external sensor is recommended to ensure the device operates).

PHu150 – Mechanical Dimensions

Standard module configuration is mounted in a die-cast box and potted (encapsulated) with resin.





The standard module configuration is mounted in a die-cast box and potted (encapsulated) with resin.

The Phu-150 module operate with supply voltage from 35vDC to 75vDC is a unipolar device able to deliver current in one direction.

Phu REQUIREMENTS

To use/program a PHu device the following will be required:

Included

- PHu module
- Software PHprogrammer.exe V8

Not Included

- USB-Micro cable.
- PC/laptop.
- Load device – such as a solenoid.
- Power Supply - Appropriate to the application requirements and within the limitations of the PHu module being used.

Product Table

Available versions are detailed below.

Module P/N	Supply Range (V)	Load Constraints	Pick Current (Max)	Hold Current (Max)	Pick Time (ms)	Input	Mating Connector
PHu-50	10-50 VDC	1mH MIN	0.1-24 Amps	0.1-24 Amps	2-512 ms	5-24V isolated	Not Required
PHu-150	16-75 VDC	2mH MIN	0.1-24 Amps	0.1-24 Amps	2-510 ms	3-30v isolated	Not Required
PHu-50-PCB	Bare Phu-50 PCB, REQUIRES HEATSINKING to achieve maximum current output						
PHu-50	Module - Comprises PHU-50-PCB potted in die-cast heatsink case						
PHU-150-PCB	Bare PHU-PCB - REQUIRES HEATSINKING to achieve maximum current output						
PHu-150	Comprises PHU-150-PCB potted in diecast heatsink case						

Please note that the continuous excitation (Hold) current may be limited by heat dissipation.

Warning – if maximum Supply Voltage is exceeded by more than 10% permanent damage may be caused to the module.

Setup

Both modules should be set up before use, using the Pick and Hold software and a micro-USB cable (Not included) which is included in the kit ver. A user-friendly interface allows current and time parameters to be set up and saved and allows monitoring of the switching device temperature to confirm operation is within safe limits in a wide range of ambient conditions.

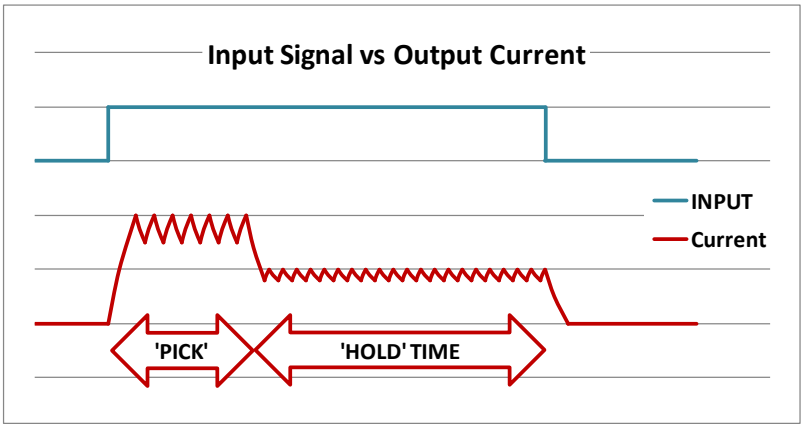
Further information on our website - www.geeplus.com/control-circuits/

PHu Pick & Hold Module

Contents

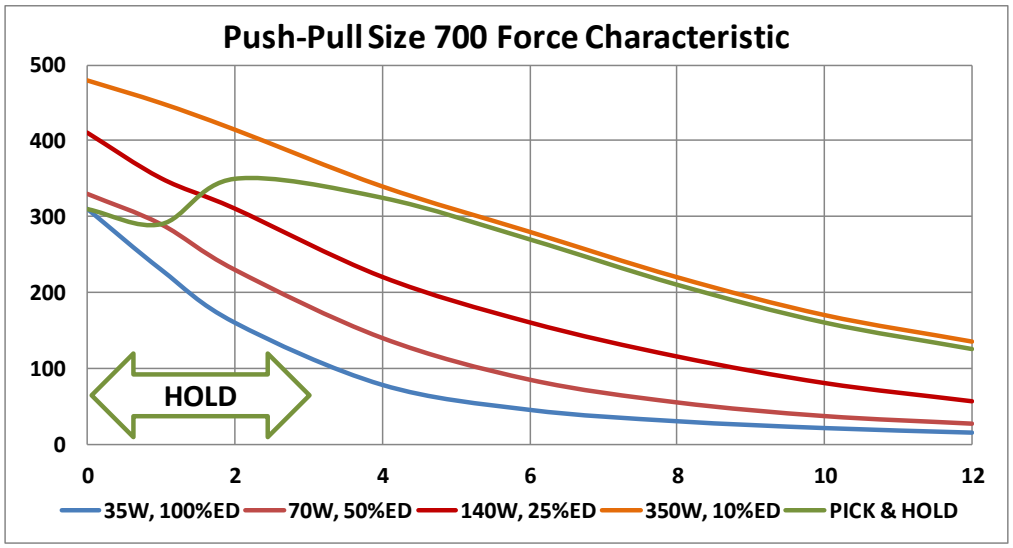
DESCRIPTION

A Pick & Hold circuit regulates current applied to a solenoid or motor, applying high initial current (PICK) to develop high initial force/torque for fast response, then reducing this after a preset time (PICK TIME) to a lower level (HOLD) to maintain operation. It can be used to reduce power consumption in applications with restricted power supply (eg battery or line-powered systems), to reduce heat and power dissipation (systems handling temperature-sensitive materials, or susceptible to thermal distortion), or to stabilise performance of systems against fluctuations in supply voltage or ambient temperature.



Geeplus PHu modules are microprocessor-controlled pick & hold modules which use intelligent algorithms to control a wide range of devices with simple user control of current and time parameters.

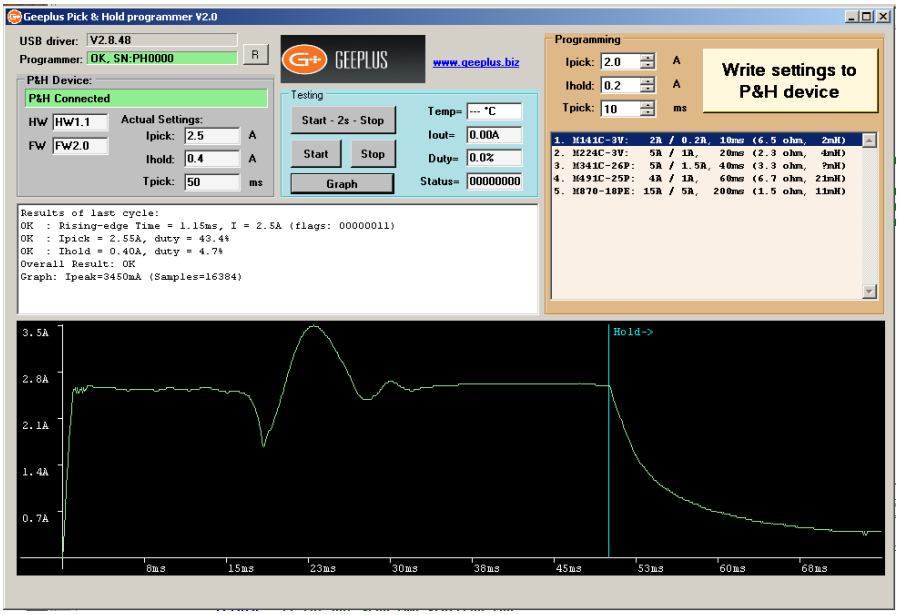
The graph below shows the characteristic force curves for a push-pull solenoid (the curves at different excitation power showing greater force with increasing excitation power, and the shape of the curve with force increasing as displacement reduces towards zero are similar for most linear solenoids), the use of a pick and hold circuit enables force to be realised at the extended position similar to an intermittent duty curve, with continuing excitation power comparable to (or even lower than) that of the 100% duty curve.



The PHu modules can be used to implement control of large solenoids in an end-user application, the user-friendly interface also makes them invaluable as a development tool to explore the maximum performance achievable from a wide range of solenoids during product development.

A clear graphical display of the excitation current waveform. It helps the user to optimise excitation conditions for a solenoid device, to achieve required force and speed with minimum excitation power, and to see the response speed of the device. It fulfils the functions of PWM current regulator and oscilloscope, with ease of use and a simple USB connection to a PC.

Connected to a PC running the analytical version of programmer software, the PHu-ANA kit allows the user to define ‘Pick Current’, ‘Pick Time’, and ‘Hold Current’ parameters for excitation of the evaluated device.



While setting up parameters, the solenoid can be switched On or Off from the PC. The ‘Start-2s-Stop’ button energises the device for 2s only, this provides a degree of protection to small devices which can overheat rapidly if energised with excessive current.

The ‘Graph’ display shows the current vs time for an interval of 1.5x the chosen ‘Pick’ time. The graphical display allows the user to visualise the following parameters:

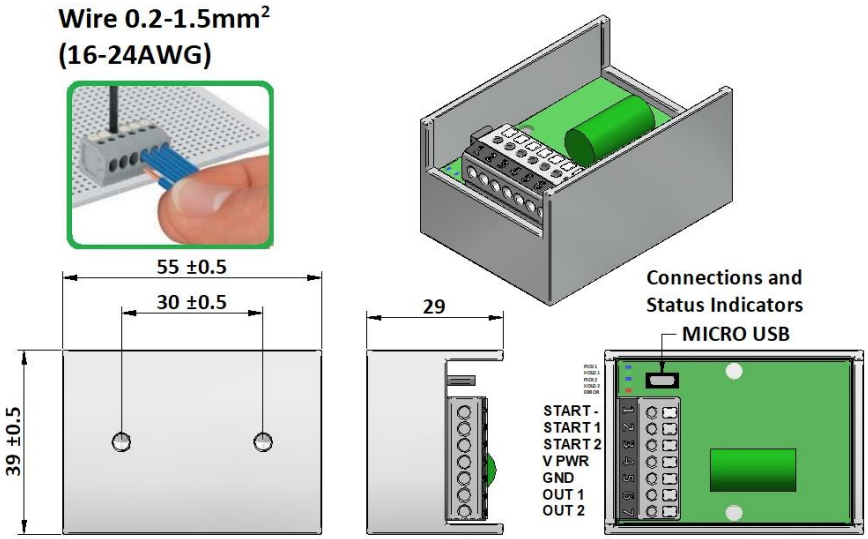
- Electrical rise time of the current
- The ‘spike’ represents impact at the end of stroke so allows stroke time to be monitored
- The reduction of current from ‘Pick’ to ‘Hold’ value can be monitored

The text data shows the achieved current values and shows the duty cycle of the PWM current control in the Pick and Hold conditions. It provides some limited diagnosis of problems such as inadequate current capacity of the power supply.

When switched on for long periods, the screen also shows the duty cycle of PWM control, and the junction temperature of the power device in real time.

The PHu-ANA helps you to select an appropriately sized solenoid for your application, and to optimise the excitation current conditions to achieve required force or speed with minimum power consumption and heat dissipation.

PHu-50



Standard module configuration is mounted in a die-cast box and potted (encapsulated) with resin.

The Phu-50 module can be configured as a bipolar device (able to deliver current in a forward or reverse polarity to a single load device), as a 2-output device able to drive 2 unipolar devices independently, as a single output device with outputs connected in parallel to reduce power loss or to deliver higher continuous current, or as a single output device with second output functionality not used with similar capability to the 2-output operation.

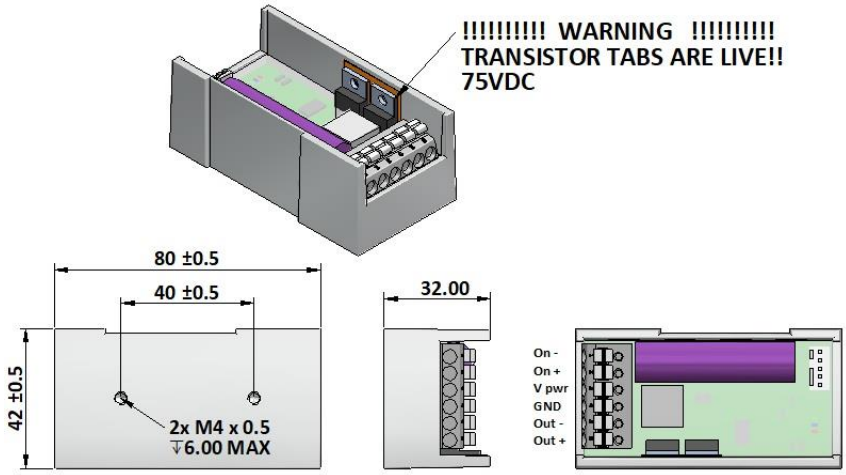
In Bipolar mode, the load device is connected between OUT 1 and OUT 2, the input START 1 initiates a positive current excitation, START 2 initiates a negative current excitation.

In 2-output mode the load devices are connected between V PWR and OUT 1 (Output current initiated by START 1), and between V PWR and OUT 2 (Output current initiated by START 2).

Phu-50 can operate with supply voltage from 8vDC to 50vDC.

Connection to a PC for programming, or for control by the PC is via a micro-USB connector.

PHu-150



Standard module configuration is mounted in a die-cast box and potted (encapsulated) with resin.

The Phu-150 module is a unipolar device able to deliver current in one direction.

REQUIREMENTS

To use/program a PHu device the following will be required:

Included

- PHu module
- Software PHprogrammer.exe V6.1+

Not Included

- USB-Micro cable.
- PC/laptop.
- Load device – such as a solenoid.
- Power Supply - Appropriate to the application requirements and within the limitations of the PHu module being used.

SOFTWARE INSTALLATION

The folder containing software should be copied to the PC being used for programming. It is recommended that the complete folder is copied as it is important that all the programmes are in the same folder on your PC.

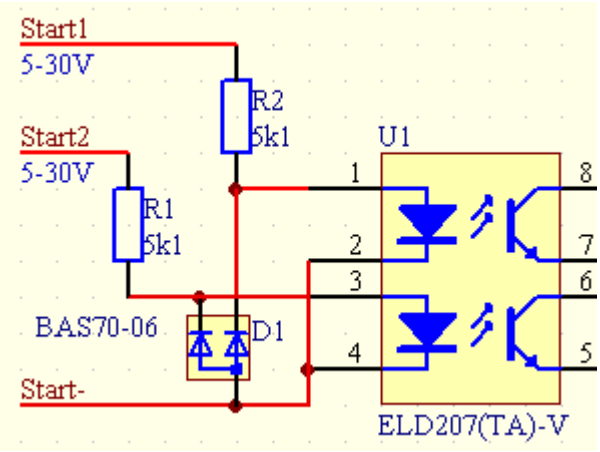
The Setup program "CDM212364_Setup.exe" should be run to install the USB drivers required to use the PHu-50 module. The latest driver is downloadable from
https://ftdichip.com/drivers/
Double clicking the 'PHprogrammer' icon will start the programming software.

PHu-50 CONNECTION

The PHu-50 module has 7 connections on a WAGO terminal block, to connect to these simply push down the white button on top of the terminal block as stripped lead is inserted in the corresponding hole.

The positive supply (+Vpwr) is connected to terminal 4, and ground to terminal 5, and should be in the range of 8-50V. ***DO NOT apply voltage greater than 50V DC as this will damage the module.***
Reverse voltage protection is provided via reverse diodes, but they allow a high current to flow. This means the module is protects for only a short time (depending on applied voltage) as is overheating occurs this may damage the module.

Terminals 1 (Negative), 2 (Start1) and 3 (Start2) are the opto-isolated control inputs. The input circuit is as shown below, applying 5v-30v to this will switch the circuit 'ON'. Higher control voltage may be used if appropriate serial resistor is inserted to limit the input current to 6mA.

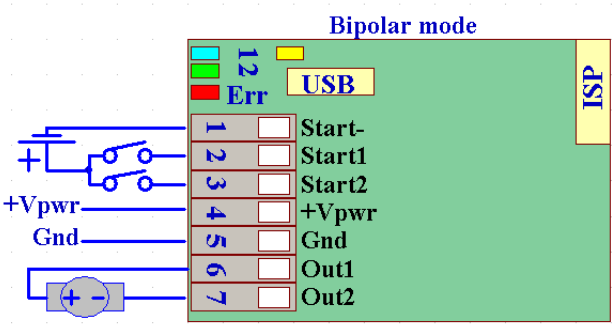


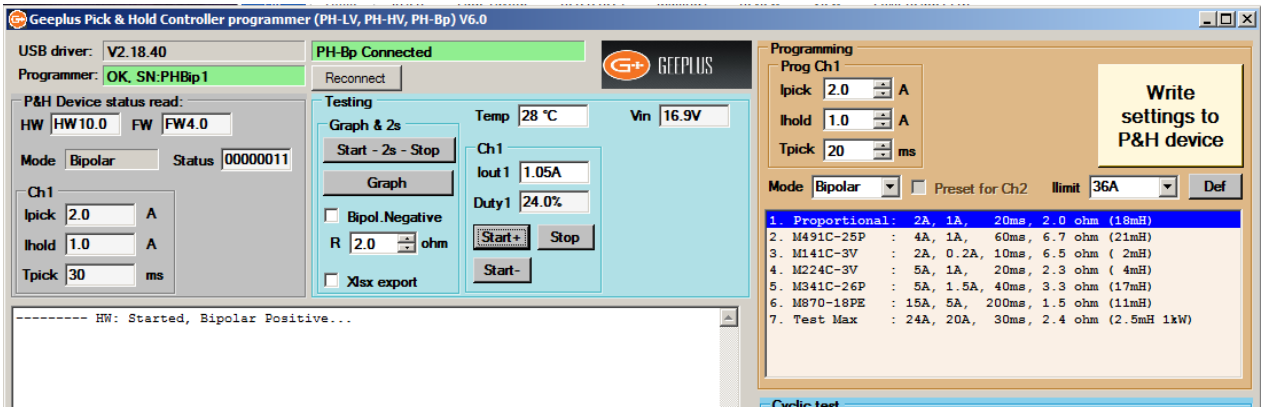
PHu-50 Operating modes

The PHu-50 module has 4 operating modes. Each of them requires appropriate wiring of the load(s). The appearance on screen of the programmer software is different for each mode, the different options are described below together with the wiring diagrams.

1. Bipolar mode (default):

The module drives one bipolar solenoid, connected between terminals 6-7 (Out1-2).
The Start1/2 inputs controls the solenoid to positive/negative directions, respectively.
LED1(Blue) indicates Active-Positive, LED2(Green) indicates Active-Negative.

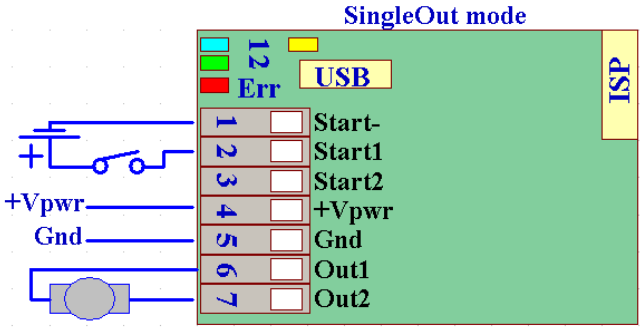


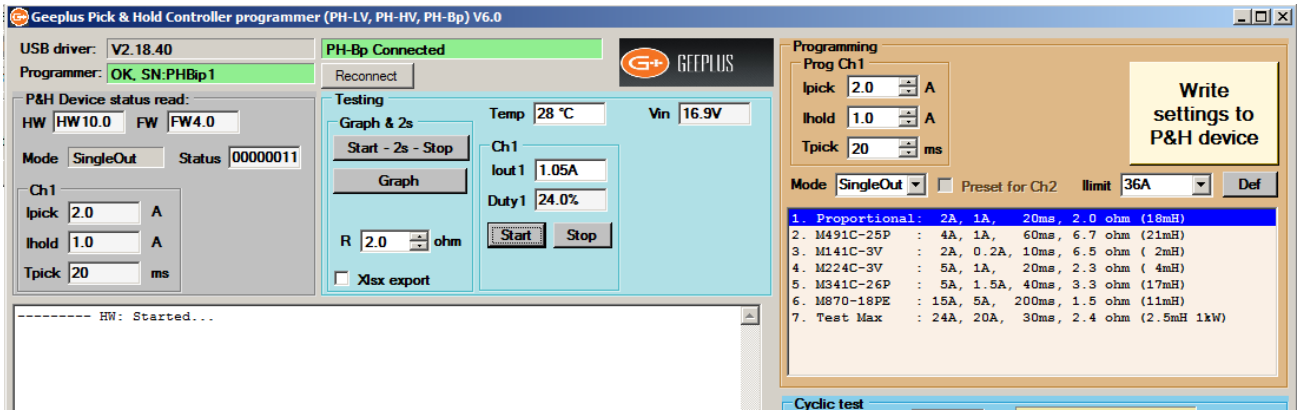


In Bipolar mode, the polarity of excitation with the 'Start – 2s – Stop' function or the 'Graph' function is determined by the checkbox 'Bipol.Negative'. Checking or unchecking this box reverses the excitation direction of subsequent cycles.

2. SingleOut mode:

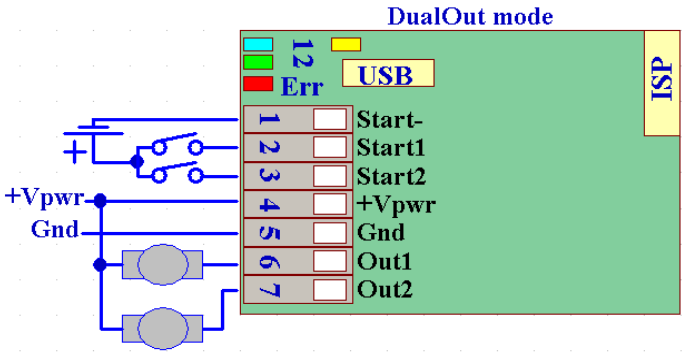
This is like the Bipolar mode acting in the positive excitation direction.
LED1(Blue) indicates Output Active.

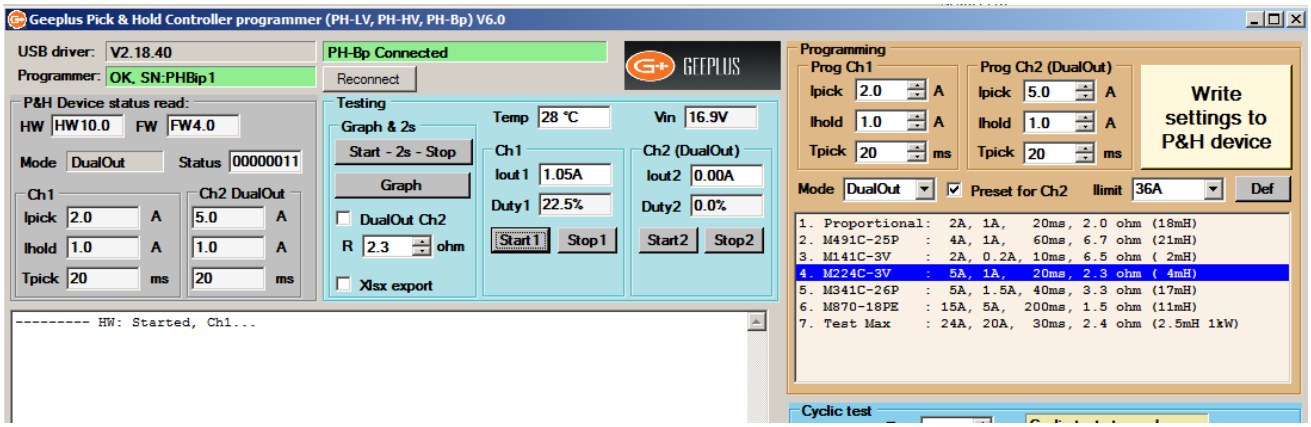




3. DualOut mode:

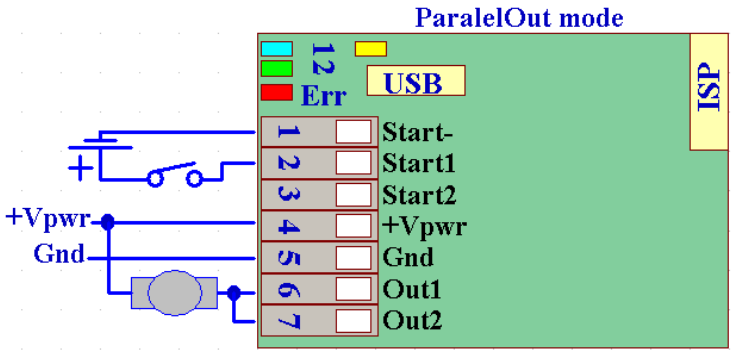
The module can drive two solenoids in this mode.
They should be connected between +Vpwr and Out1, +Vpwr and Out2.
The Start1/2 inputs controls the solenoids.
LED1(Blue) indicates Out1-Active, LED2(Green) indicates Out2-Active.
Both channels have their individual current and time settings.

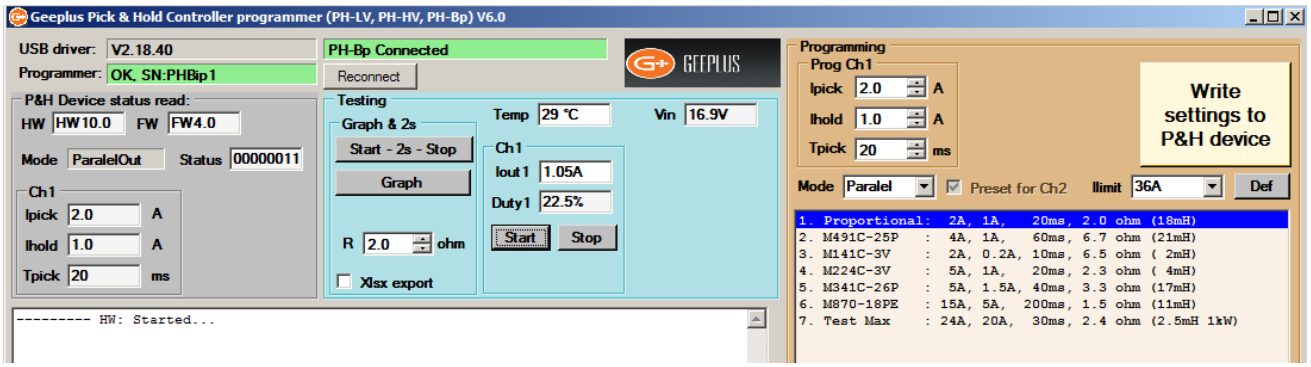




4. ParalelOut mode:

If only one solenoid will be driven, the two outputs (Out1/2) can be connected in parallel.
This operation reduces the power lost on the output stages, allowing higher continuous current, and less temperature rise.
The load should be connected between +Vpwr and Out1-Out2 as shown.
The Start1 input controls the solenoid.
LED1(Blue) indicates Out1-2 Active.





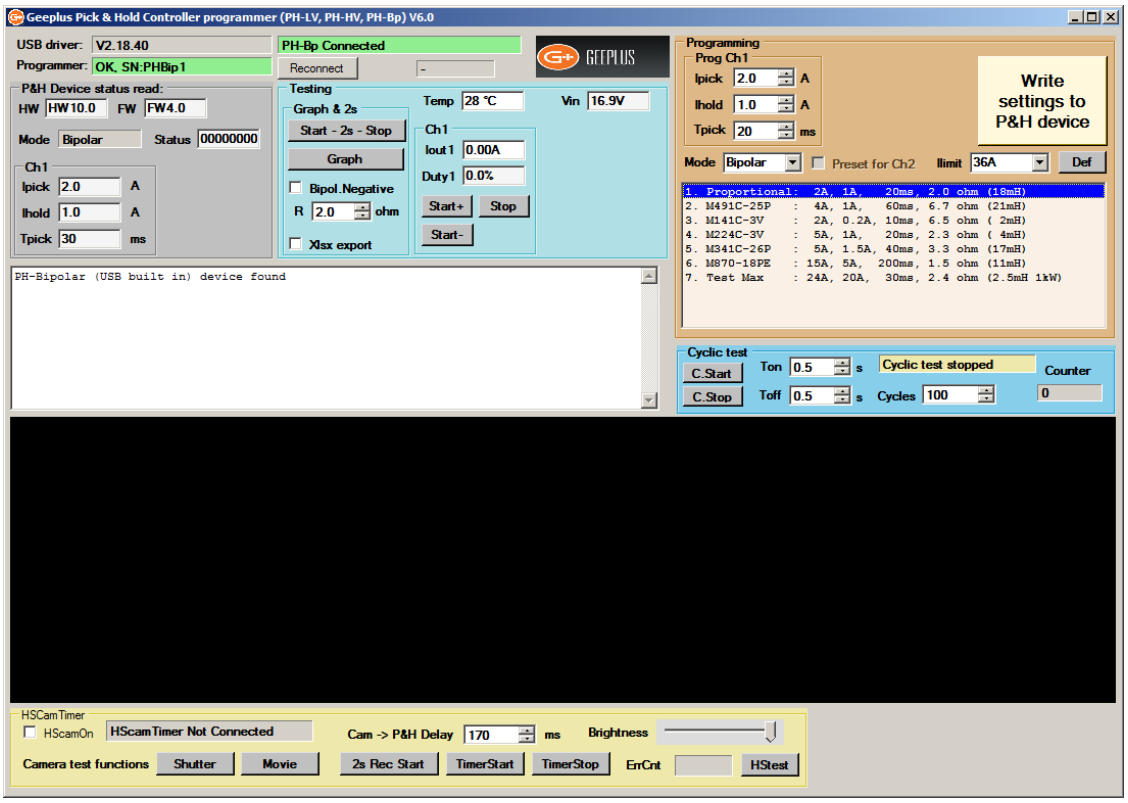
For setup & testing while the module is connected to a PC it is possible to switch the solenoid on ('START') and off ('STOP') from the PC without using the control input.

In addition to 'START' and 'STOP' control buttons, the software also has a timed BUTTON 'START – 2s – STOP' which energises the test device for 2 seconds only. This function is recommended for initial testing of force as the timed pulse limits the amount of energy delivered, and so limits the self-heating and reduces the possibility of overheating and damaging the solenoid'. Once it has been established that sufficient force can be developed, the thermal behaviour of the system should be considered to ensure the chosen device will not overheat.

PROGRAMMING

The Phprogrammer V8 supports all of the PHu modules, it will recognise which module is connected. Features that are not support on the connected device will not functions as follows:

-PHu24, Phu-HighVoltage (Older modules require special USB programmer cable (Included), new versions use a standard micro USB cable)



-Phu-50-Bipolar (built-in Micro-USB port, Standard USB-Micro cable is us for communication)

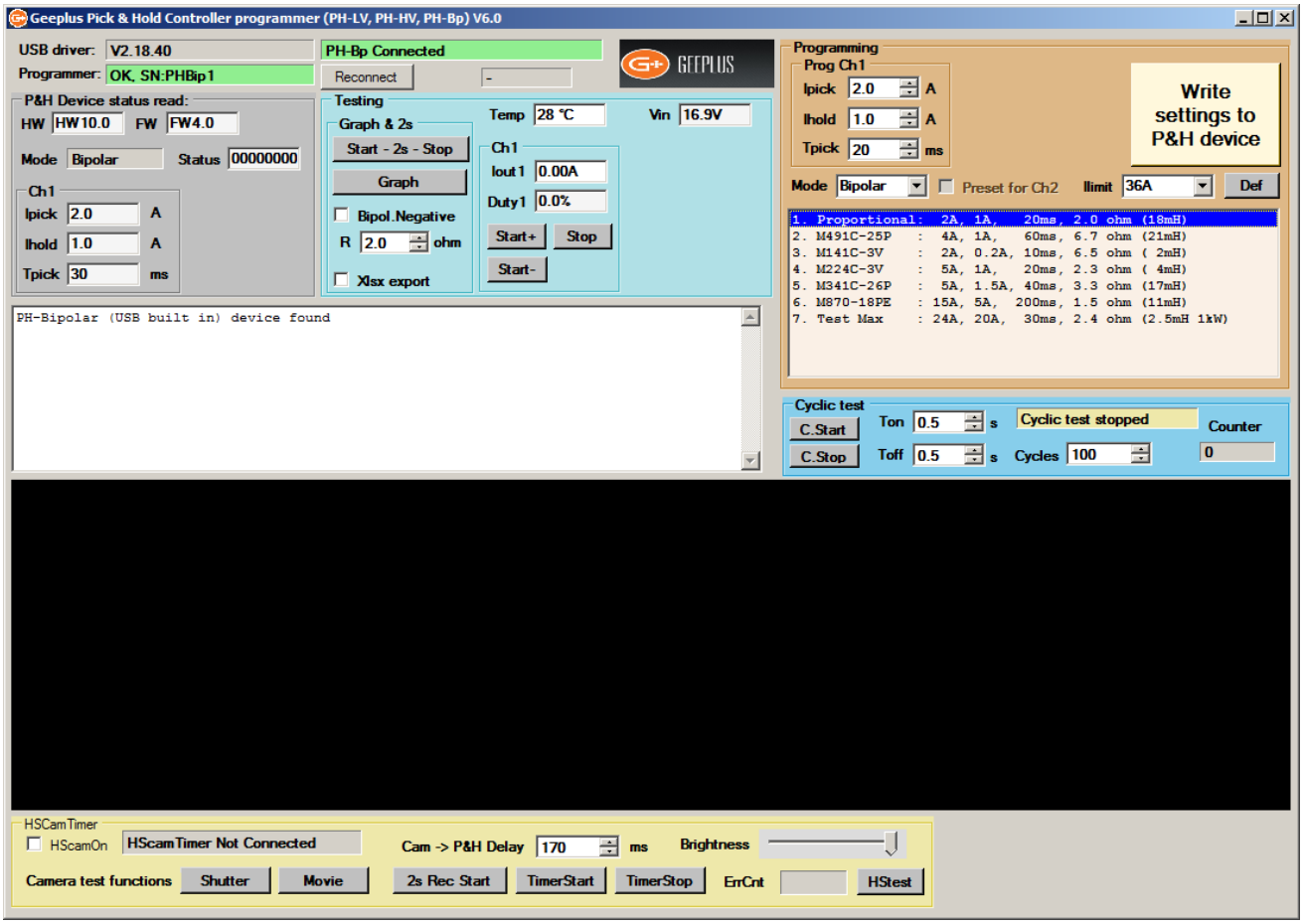
The Phu-50 module has more operating modes than the other version and so these will be described here. When using a PHu-24 or PHu-150 the software operates as the Phu-50 in SingleOut mode.

The USB cable plugs into the USB-Micro socket above the WAGO terminal block.

If a Phu-50 Bipolar module is connected for the first time to this PC, the Windows will install the USB driver for it in the background, this may take 10 s.

With a load and power supply connected and turned on, the programming software is run. The programme should recognise if a PHu module is connected and powered, if this is not recognised click on the button labelled 'Reconnect' to reconnect.

You should see the screen as below:



Note: the programmer reads the actual settings from the module, and it will appear with different controls regarding the actual Mode (above showing Bipolar).

As it opens, the programmer defaults to the smallest values for safety, you can pick a device of appropriate size as a starting point, press the button 'Write Settings to P&H Device' to store these settings in the module.

You can edit the 'Pick' and 'Hold' current settings and 'Pick Time' as desired before writing settings to the module.

For setting up current values, you can use the grey buttons to switch the load device 'On' and 'Off' without using the control input connections.

MONITORING

While the solenoid is energised ('ON' condition), the programme interface monitors the operating conditions.

Temp – this is the internal junction temperature of the switching device; this should not exceed 120 Deg.C when the module is being used in worst-case conditions. If the junction gets much hotter than this internal protection will shut the device down

Vin – The +Vpwr input voltage (Only on Phu-50 Bipolar modules)

IOut – the output current

Duty – The duty cycle of PWM waveform

After de-energising the solenoid ('STOP' condition), the operating current and duty cycle for both pick and hold conditions of the last 'ON' cycle are summarised in the white text box.

If the programmed current is too high, then the current will not be able to reach this value as it will be limited by supply voltage and / or coil resistance of the load. Either a lower resistance device, or higher supply voltage may be

required. It should be noted that although a device may work OK in the cold condition, as it heats up the coil resistance will rise. In the cold condition, the duty cycle should typically be 70% or less to allow for this.

STATUS INDICATORS

Three LED's provide status indication.
The **BLUE** and **GREEN** LEDs indicates The Active status, detailed above for all modes.
The **RED** LED indicates an 'ERROR' conditions: Overcurrent or Overtemperature.

SELECTION OF SOLENOID FOR PICK & HOLD

This is a general guide as requirements of an application may dictate other constraints on Pick and Hold current levels.

As a very rough guide, a solenoid should be selected which is operating at about 5-10% duty cycle at the system voltage. If the solenoid coil is specified by voltage (at 100% ED), then the coil voltage chosen should correspond to V_{supply} / √10, if the solenoid coil parameters are presented in a table, then pick a coil which provides operation at 10% ED at the rated supply voltage.

Ideally, the solenoid should be mounted in the end application, and set up with worst-case operating conditions (maximum ambient temperature, minimum supply voltage).

With the circuit connected to a PC, the 'Pick' and 'Hold' currents and 'Pick Time' duration can be adjusted to determine conditions which satisfy the force, speed, and power requirements of the application.

For applications where high force is required to overcome a large load, the pick time may need to be sufficiently long for the solenoid to pull into the energised position and settle before current is reduced to the holding level.

For applications requiring high speed, it may be preferable to drive with maximum possible power for a very short 'pick' time, as the initial acceleration has greatest influence on the overall response time.

When the device is switched off, the text box in programming software will display the current and duty cycle for both pick and hold operation. Ideally the duty cycle should be within the range of 10-90%, the module can operate outside this range but this leaves some leeway for variation in supply or temperature conditions.

The junction temperature of the power MOSFETs is displayed, this should not exceed 120°C max under worst case conditions.

PHu Pick & Hold Module

Application areas where pick and hold circuits offer benefits include the following.

Distributed Systems

Locking systems for railway carriage doors would be a good example of a distributed system, the actuators are distributed through the length of a train, with large voltage

fluctuations possible and big variation in ambient temperature conditions. The Pick and Hold circuit stabilises performance due to these fluctuations, and reduces power consumption and heat dissipation. Other examples could be mail sorting, fruit sorting, or car stacking parking systems.

Fast Actuation

Cash sorting equipment requires very fast actuation and frequent cycling. A high current is applied to achieve high force and rapid acceleration and current is then reduced to avoid excessive heat dissipation.

Reduce Heat Dissipation

Pinch valves are used to control flow of blood in dialysis equipment, or chemical reagents. High force is needed to clamp shut the tubing in these devices. Because blood products and chemicals are very sensitive to heat, pick and hold drive helps maximise the force obtainable with minimal heat generation.

Development Tool

The extreme ease of use of Geeplus PHu module makes it invaluable as a development tool, it allows device excitation conditions to be easily adjusted without hardware changes to establish suitability of a particular device in a customer application.