ORIENTAL MOTOR U.S.A. CORP.

SUPER VEXTA

NEW-PENTAGON 5-PHASE UPD STEP MOTOR/ DRIVER PACKAGES.

INSTRUCTION MANUAL FOR UPD MOTOR/DRIVER

This manual covers the following models:

UPD PACKAGE MODEL NUMBER		STEP ANGLE	HOLDING TORQUE	ROTOR INERTIA	MOTOR DIA. x LENGTH
SINGLE SHAFT	DOUBLE SHAFT				
UPD564-NAA	UPD564-NBA	0.72°	31.9 Oz-in	0.55 Oz-in²	2.36"φ x 1.65"
UPD566-NAA	UPD566-NBA	0.72°	51.4 Oz-in	1.09 Oz-in²	2.36"φ x 2.32"
UPD569-NAA	UPD569-NBA	0.72°	105.6 Oz-in	2.19 Oz-in²	2.36"φ x 3.72"
UPD596H-NAA	UPD596-NBA	0.72°	163.9 Oz-in	3.83 Oz-in²	3.386"φ x 2.52"
UPD599H-NAA	UPD599H-NBA	0.72°	277.8 Oz-in	6.56 Oz-in²	3.386"φ x 3.82"
UPD5913H-NAA	UPD5913H-NBA	0.72°	527.8 Oz-in	9.84 Oz-in²	3.386"φ x 5.12"

UPD STANDARD SERIES

2.36 AND 3.39 in. VERSIONS

This package includes an innovative NEW-PENTAGON 5-phase chopper driver and a LOW VIBRATION, EASY-TO-CONNECT 5-phase stepping motor.

SUPER VEXTA

NEW-PENTAGON 5-PHASE UPD STEP MOTOR/DRIVER PACKAGES.

THANK YOU FOR CHOOSING ORIENTAL MOTOR

Oriental Motor's reputation for high quality, cost-effective products is well known among automation equipment manufacturers. Our Vexta and Super Vexta motion control products are built to these same exacting standards, and enjoy the same reputation.

Super Vexta's UPD motor drivers are built with the pride and craftsmanship of a century of manufacturing experience. Oriental Motor's ED Division has engineered and built this product to provide years of trouble-free service. Each driver is carefully and thoroughly tested prior to shipment, to ensure the same high quality you've come to expect from us.

Please read this manual carefully, and use this product according to these instructions. If you have any questions, please do not hesitate to call Oriental Motor for help.

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UPD → Unit=Pentagon+Driver

ORIENTAL MOTOR U.S.A. CORP.

FEATURES

- Conveniently packaged unit includes Step Motor, Driver and power supplies for the motor and driver logic.
- Driver is pre-adjusted to match the motor included in the package for fast and easy setup.
- UPD Standard Series versions provide 31.9 to 527.8 oz-in of holding torque for larger loads.
- Highly efficient chopper drive provides high torque at all motor speeds and excellent high speed response.
- Driver's "Overheat" and "Step B" signals are available to the host computer or programmable controller.
- For manual adjustment of the load, motor current can be shut off by applying a "High" signal to the A.W. Off (All Windings off) terminal.
- Phase current is balanced to eliminate "soft" step when half stepping.
- The special UPD step motor comes standard with extra long lead wires and flats on the shaft.
- The UPD driver has short circuit (miswiring)protection against the outputs being shorted and/or the motor not being connected upon power-up.
- Compact design uses custom ICs and MOSFET technology for high power from a small package.
- Optically isolated signal inputs for high noise immunity and TTL compatibility.
- Automatic current cutback at standstill reduces power consumption to 13% to 100% when motor is not moving.
- Automatic thermal cutout circuitry protects driver from damage from overheating.
- Chopper frequency of 50KHz virtually eliminates chopper noise at standstill.
- Self test capability to check for driver and motor miswiring.

This compact unit has greatly expanded the range of stepping motor applications with its high performance capabilities and ease of operation.

INTRODUCTION

The UPD motor/driver package was designed to make the automation systems engineer's life easier. Before the UPD motor/driver, the systems engineer had to assemble the various components into a step motor system. Because the UPD motor/driver combines so many of these required components into one small package, it saves valuable time and effort when designing a motion system. Additionally, hook up is simplified, and the step motor/driver system that used to occupy a large area has been squeezed down to a surprisingly compact size.

Each SUPER VEXTA UPD stepping motor/driver package combines a precision hybrid stepping motor with a matched high power constant current chopper driver to maximize torque and high speed performance. The UPD driver uses a MOSFET output stage for high efficiency, and custom integrated circuits for size reduction and ease of use. This lightweight slimline package is capable of driving the motor to speeds in excess of 80,000 steps per second! By applying step and direction pulses to the driver's optically isolated input terminals, the motor can be controlled to meet your exacting motion and positioning requirements.

MODELS AVAILABLE

UPD packages are available in 0.72 degrees per full step with single and double shafts. Choose the UPD unit type motor/driver package that best meets your performance needs from our lineup:

Table 1
MOTOR/DRIVER PACKAGES: 500 FULL STEPS PER REVOLUTION (1000 HALF STEPS)

UPD PACKAGE MODEL NUMBER		STEP ANGLE	HOLDING TORQUE*	ROTOR INERTIA	MOTOR SIZE DIA. x LENGTH
SINGLE SHAFT	DOUBLE SHAFT				
UPD564-NAA	UPD564-NBA	0.72°	31.9 Oz-in	0.55 Oz-in²	2.36"φ x 1.65"
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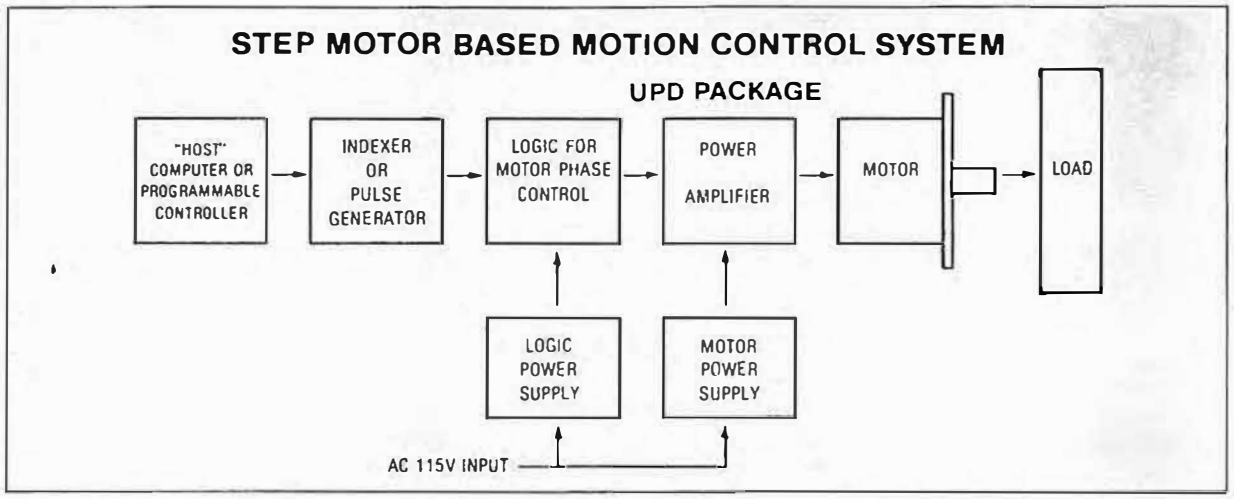
UPD5913H-NAA	UPD5913H-NBA	0.72°	527.8 Oz-in	9.84 Oz-in²	3.386"φ x 5.12"

*With Automatic Current Cutback at standstill, holding torque will be approximately 50% of the values shown.

Torque versus speed performance curves for each of the motor/driver combinations listed above are on pages 17 and 18.

ELECTRONIC MOTION CONTROL SYSTEMS

Figure 1



With the rapidly increasing need for factory and industrial automation, manufacturers large and small are turning to our new generation of easy-to-use electronic motion control devices for labor-saving and productivity-enhancing machinery.

Electronically controlled motion is one of the fundamental parts of automation. Increasingly, step motors have become the favorite method of implementing controlled motion. One of the many advantages of a step motor-based system is that it can be used "open loop". Since a step motor moves a fixed number of degrees for each input pulse, it can control position and speed without the additional cost of a feedback device and its associated electronics.

The basic components of an open loop step motor based motion system are shown in **Figure 1**. Sometimes the various parts of the system are referred to by different names, but all of these functions are still included:

HOST COMPUTER OR PROGRAMMABLE CONTROLLER: This is the "intelligent" part of the system. It usually controls other parts of the machine as well as the motion system. It can be programmed to respond to inputs from switches or other sensors, and may send information to the indexer to control the number of steps, the acceleration rate, and starting and top speeds.

INDEXER OR PULSE GENERATOR: A pulse generator is little more than an oscillator, sending pulses to the driver at a fixed speed. Indexers have the additional ability to count out a number of steps. An indexer may also control acceleration and deceleration. As a result the motor can be made to run above its self-starting frequency (fs), and thus decrease the time to make a given motion. The output from a pulse generator or indexer is usually in low level (TTL) step and direction signals. The step signal turns on and off for each step the motor is to take, and the direction output is held high or low depending on the direction (CW/CCW) the motor is to move. **(See Figure 2.)**

LOGIC FOR MOTOR PHASE CONTROL: This section translates the step and direction signals sent by the indexer into the correct motor winding On and Off combination, in order to make the motor rotate in the desired direction.

LOGIC POWER SUPPLY: This section supplies the low level DC power for the logic circuits.

POWER AMPLIFIER: The signals from the motor phase control logic are amplified from low voltage signals to a useful level that can run a stepping motor. This section can range in complexity from a simple transistor switch (L/R drive) with limited speed range, to a complex high power pulse-width-modulated (chopper) drive like the UPD driver, for high speed torque and outstanding performance.

MOTOR POWER SUPPLY: The motor requires higher voltage than the control electronics and much more amperage. The motor power supply provides this.

MOTOR: A stepping motor converts the electrical input from the Power Amplifier into rotational movements, or "steps".

LOAD: The load is whatever the user wants to move, whether it be powered through a leadscrew, gear timing belt, or directly driven by the motor. The load can be frictional, inertial or a combination of the two.

In the past, each of these separate components had to be wired together or inserted into a rack, and valuable time was spent in assembling, adjusting and trouble-shooting them. The UPD motor/driver package is SUPER VEXTA's solution to this unnecessary use of the systems engineer's time.

As shown in **Figure 1**, the UPD package combines the motor driver and power supplies into one Unit, and the driver is pre-set to match the motor included in the package. The driver's inputs are optically-isolated to allow for easy interface with a wide variety of controllers. This leaves only a simple hook-up operation – and with the application of step and direction signals, the result is precisely controlled motion.

MOTION CONTROL USING THE UPD STEP MOTOR/DRIVER PACKAGE

Using the UPD motor driver package, the system designer has total control over all of the important motion profile parameters. As shown in **Figure 2**, each step pulse received by the driver results in a motor movement of one step. This makes control of velocity, acceleration, deceleration and position simply a matter of controlling the frequency (pulses per second) and number of pulses sent to the driver.

A velocity of exactly one revolution per second can be obtained from a 0.72 degree motor by sending pulses to the driver at 500 pulses per second. Acceleration and deceleration of the motor can be regulated by adjusting the frequency of the pulses sent to the driver.

Position can also be readily controlled because the amount of motor movement is equal to the number of pulses applied to the driver, times the motor step angle. For example, a 0.72 degree motor can be made to rotate exactly one revolution by applying 500 pulses to the driver.

Figure 3 shows a typical motion profile. In the time between T1 and T2, the frequency of the pulses being sent to the driver increases, causing the motor to accelerate. Between T2 and T3, the driver receives pulses at a fixed rate, and the motor turns at constant velocity. The pulses to the driver decrease in frequency between T3 and T4, until they stop. This causes the motor to slow down and halt. The amount of shaft rotation in degrees is determined by multiplying the total number of pulses between T1 and T4 by the number of degrees per step of the step motor.

Figure 2
MOTOR MOVEMENT VS. INPUT SIGNALS
NOTE: The direction input signal should be changed only while the step pulse signal is not being sent and is "LOW" or "OFF".

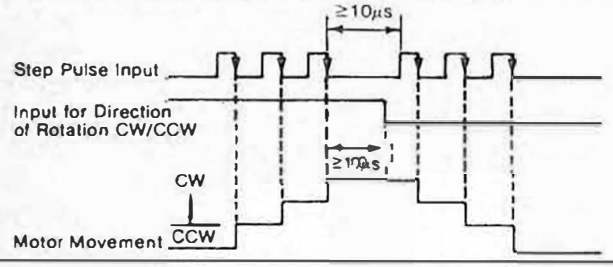
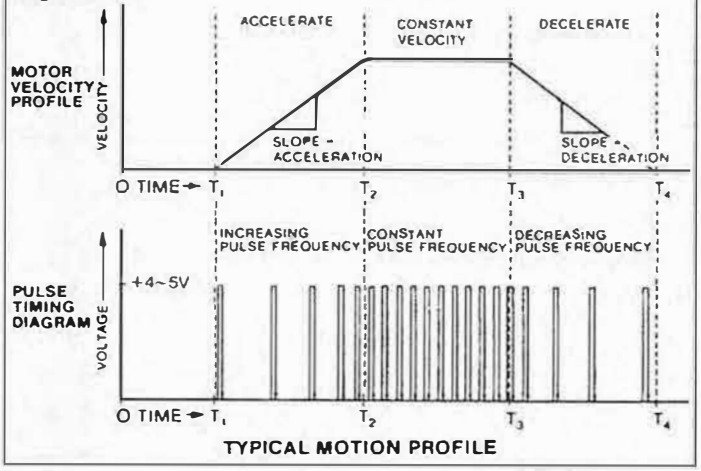


Figure 3



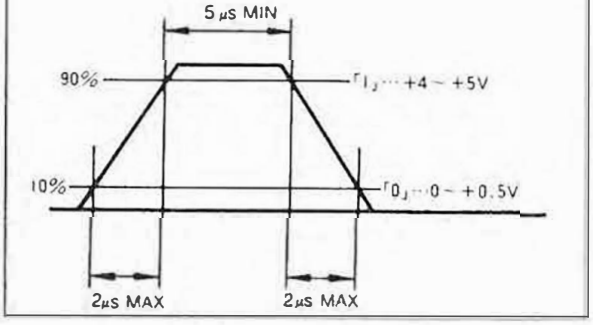
TYPICAL MOTION PROFILE

INPUT SIGNAL CHARACTERISTICS

The input pulse waveform is shown in **Figure 4**. A logical "ON" or "HIGH" is 4-5 volts, and "LOW" is between 0-0.5 volts. The input pulse should have TTL timing characteristics; (i.e., the pulse rise and fall times must be less than 1 microsecond). The noise filtering in the UPD driver requires that the input pulses be stable for a minimum of 10 microseconds.

In the "1 PULSE" mode, the motor will rotate one step for each pulse received at the driver's "PULSE" (STEP) terminal. The motor moves when the trailing edge of the pulse is detected. **(See Figure 2.)** The direction of rotation is controlled by the signal at the "CW/CCW" (DIRECTION) terminal of the driver. When the "CW/CCW" (DIRECTION) terminal is "HIGH", the motor will rotate one step clockwise for each pulse received at the "PULSE" (STEP) terminal. The motor will rotate one step counter-clockwise for each pulse received at the "PULSE" terminal when the signal at the "CW/CCW" (DIRECTION) terminal is "LOW", or the signal is absent. Care must be taken so the step signal is inactive when the direction signal is changed, or missed steps may result.

Figure 4
INPUT PULSE CHARACTERISTICS



The New-PENTAGON 5-Phase is a *Mover* not a Shaker

Accurate and reliable motion control is a fundamental key to successful automation of any kind. Step motors have become a vital link in this automation process with their ability to change computer-generated input into mechanical motion. They are highly accurate, reliable and simple to use because of their inherent ability to move a certain angle for each input pulse. Step motors are widely used in applications from medical equipment to computer peripherals, to office copy machines and factory machine tools.

With their ability to accurately move and hold loads, standard step motors are a boon to automation, but have two annoying drawbacks – vibration (resonance) and low speed. Until now, the most popular methods of overcoming these effects were to use either a microstep driver or some type of damping. Dampers are effective, but space restraints and the changing of their damping effects with temperature and time often preclude their use. Microstep drivers are a solution to the effects of resonance and vibration at very slow speeds (<0.25 rpm), but the losses in accuracy and torque, plus the fact that their vibration is the same as a standard step motor at faster speeds, are all far too costly to ignore.

A newer, more cost-effective method of overcoming the effects of resonance and vibration is to use a Five-Phase step motor. The Five-Phase stepping motor was originally patented by the West German company Berger-Lahr. Oriental Motor recognized the unique attributes of this product and saw its great potential. After obtaining a license, Oriental Motor introduced Five-Phase technology in Japan; it was a hit and "Five-Phase Fever" set in.

The engineers at Oriental Motor have elevated Five-Phase technology to a new level by developing the innovative New-Pentagon UPD series of Five-Phase step motor/driver. The New-Pentagon series step motor drivers have even lower vibration and lower current consumption at high speeds (above 3,000 pps). This new version is also very easy to hook-up due to having only five lead wires instead of ten.

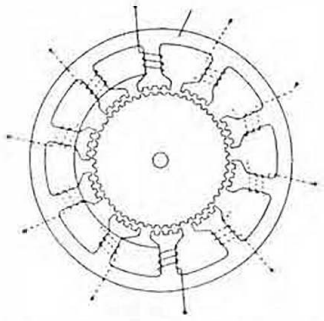
This New-Pentagon design provides more torque to much higher speeds with extremely low vibration. As compared to a standard step motor, the New-Pentagon Five-Phase step motor/driver has only a fraction of the torque ripple for a quantum reduction in vibration (see next section). Plus, the New-Pentagon driver can move the motor to speeds in excess of 6,000 rpm (100,000 pps), and has no torque drop-off to over 600 rpm (10,000 pps).

This new technology makes it possible for all of these advantages to be obtained at only 75% of the cost of equivalent microstep drivers. The New-Pentagon Five-Phase driver design also allows for half-stepping, for an excellent resolution of 0.36/step or 1,000 steps per revolution.

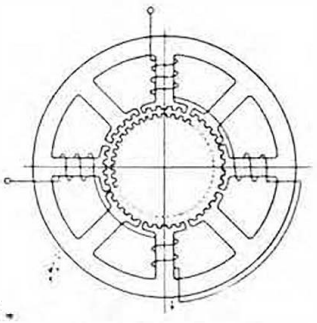
Five-Phase products are now used in everything from color copy machines to automated semiconductor manufacturing. The Five-Phase step motor's ability to move smoothly with little vibration and without the effects of resonance is the key to its selection for use in these applications.

KEYS TO THE 5-PHASE MOTOR'S EXCELLENCE

The difference in design between standard step motors and the Five-Phase is subtle, but the performance difference is *spectacular*. Because the Five-Phase design has an additional pair of magnetic poles, it runs substantially smoother with no noticeable vibration from resonances.



FIVE PHASE STATOR DESIGN



2 OR 4 PHASE STATOR DESIGN

As a comparison, for example, the car with ten-sided wheels provides a much smoother ride that its counterpart with square wheels. This is roughly analogous to the five pole pairs in a Five-Phase, and the two pole pairs in a standard two phase (or four phase) step motor.

(continued next page)

Motor and driver are covered by U.S. Patents.
Five-Phase motors are made under license of Berger-Lahr.

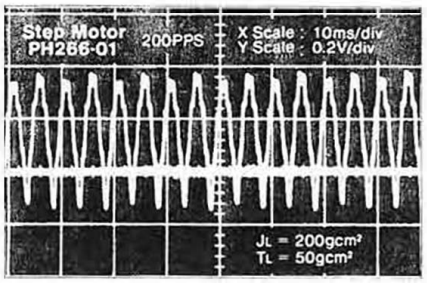
(Keys to the 5–PHASE cont.)

The figures to the right visually emphasizes the smoothness difference between a standard step motor and the Five-Phase motor. Both motors are running at 60 rpm. The oscilloscope photos are made by attaching a DC tacho-generator to the shaft of the step motor and then looking at the output voltage from the tacho-generator. If the step motor movement were perfectly smooth, the oscilloscope picture would show a flat line. The closer to a flat line, the smoother the movement.

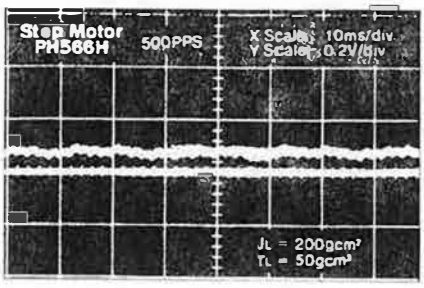
The next figure graphically shows the difference between a standard step motor and a Five-Phase motor. The graph is made by measuring the maximum peak-to-peak value from the tacho-generator at each speed. (Measuring the difference between the peaks and valleys in the previous figure at each speed). You can see Five-Phase clearly makes a difference.

The torque ripple in a Five-Phase versus a standard step motor is shown in figures to the right. The difference in lowest to the highest torque value of a standard step motor is 29%. The same value for a Five-Phase is only 5%. This six-fold difference is one of the reasons for the Five-Phase's super-smooth moves.

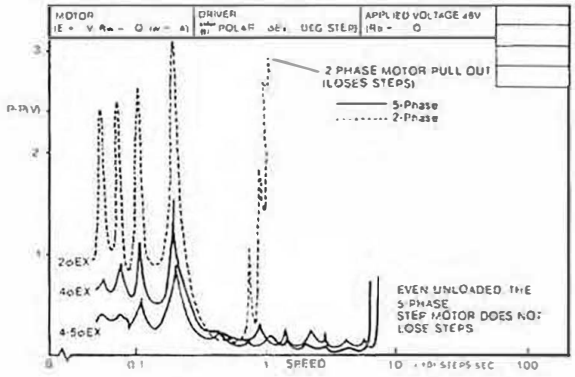
2-PHASE VIBRATION



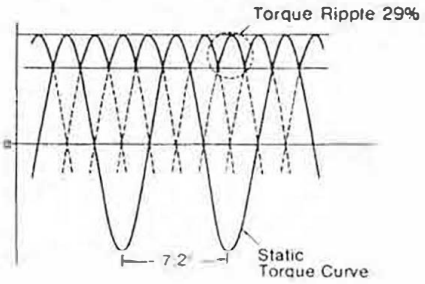
5-PHASE VIBRATION



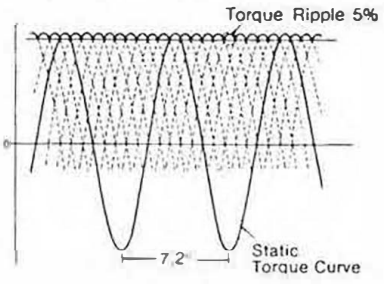
STEPPING MOTOR PERFORMANCE DATA



2-PHASE TORQUE RIPPLE



5-PHASE TORQUE RIPPLE



BASIC CHARACTERISTICS

E: excellent F: fair
G: good P: poor
A: average

These graphs are for comparative use only.
For actual performance data, please see page 14.

	VIBRATION	SPEED	RESOLUTION	STEP ACCURACY	RESPONSE	TORQUE	AUDIBLE NOISE
5-Phase	G	G	G	E	G	E	A
2-Phase	F	A	A	E	F	E	P
Micro Step (2-Phase)	G (Low speed)	P	E	F - P	G	G	A

The basic characteristics comparison chart above is a summary of the strengths and weaknesses of standard step motors, Five-Phase Pentagon-Drive and a 2-phase step motor driven with a micro-step driver. The Five-Phase and Micro Stepper both have good low vibration characteristics. The Microstepper is better than the five phase at very low speeds (less that ¼ rps) but the Five-Phase is better at higher speeds (over about 1 rps). Speed characteristics of a microstepper are poor, and their top speeds are 1000 to 1800 rpm, while the Five-Phase can go to 6,000 rpm. At 1800 rpm, a 25,000 step/revolution microstepper would be moving at 750,000 steps per second! This would need a very expensive controller indeed to run at this speed. Microsteppers have more resolution (number of stopping positions per revolution) than a five phase, but the accuracy of those positions is fair to poor, and becomes even worse under all but the lightest loads. Microsteppers have poor torque because neither phase in the motor is ever turned completely on at the same time. Current is related to torque, so their output torque is less for a given motor frame size.

FUNCTIONS AND DRIVER HOOK-UP

INDICATOR LAMPS:

POWER:	Indicator is lit when power is applied to the AC115V terminals.
PULSE AND CW/CCW:	Lights indicate when a signal has been received at the corresponding input terminal.
A.W.OFF:	All Windings Off, indicates that a signal has been received at the A.W.OFF input terminal.
TIMING:	STEP Ø Indicator: The polarity of the motor windings is repeated every ten steps in the full step mode, and every twenty steps in the half step mode. This phase sequence is numbered STEP Ø to 9 for full step and STEP Ø to 19 for half step. Each time the phases are energized in the STEP Ø condition, the TIMING LED indicator lights. When the driver is first turned on, the motor phases are energized in STEP Ø position.
OVERHEAT:	When the driver's internal temperature reaches 80° C, power to the motor is automatically removed. This indicator lights when the driver is overheated.

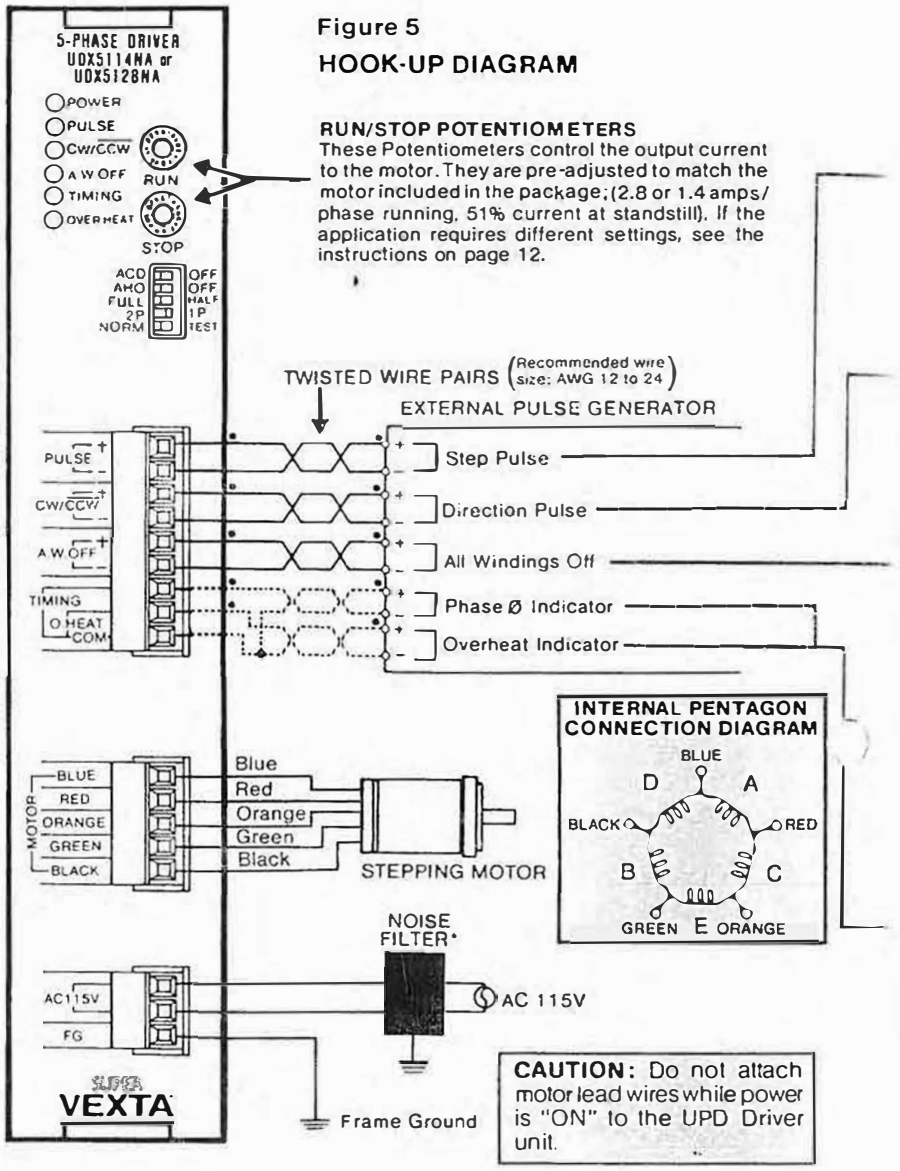
SWITCH FUNCTIONS:

The switches are pre-adjusted to match most customer requirements. If the application requires different settings, see the function descriptions on page 11.

A.C.D.	**Auto Current Down. Standard setting: ON (Current is cutback approximately 50% at standstill).** This switch turns the automatic current cutback at standstill off and on. When on, the current is reduced at standstill to approximately 50% of the running current.
A.H.O.	**Auto Heat Off. (Overheat Protection) Standard setting: ON (Power cutoff when overheat is detected).** When the driver's internal temperature reaches 80° C, power to the motor is automatically removed. In applications where the removal of drive current could pose a safety problem the A.H.O. switch can be used to disable this automatic power off function.
FULL/HALF:	**Standard setting: Full step (0.72°/step).** Selects full step (4 phase on) 0.72 degrees per step, or Half step (4-5 phase on) 0.36° degrees per step.
2P/1P:	**Standard setting: 1 PULSE MODE = STEP AND DIRECTION.** 1 PULSE MODE: A "HIGH" signal at the "CW/CCW" terminal causes the motor to rotate counter-clockwise for each pulse received at the "PULSE" terminal. A Low Signal causes the motor to rotate clockwise. 2 PULSE MODE: Motor moves one step clockwise for each pulse detected at the "PULSE" terminal and one step counter-clockwise for each pulse detected at the "CW/CCW" terminal.
NORM/TEST:	When the switch is in the test position, the driver's internal pulse generator is activated and the motor will move at 3pps. This is used to check the driver and motor wiring.

Figure 5

HOOK-UP DIAGRAM



*A noise filter is recommended in applications where a relay, welding equipment or other electrical noise producing equipment is used.

INSTALLATION

The UPD driver should be wired as shown in **Figure 5**. Use twisted pair wire for the input signal wiring to reduce the chances of inductive noise pickup. Size 24 wire is adequate for cables of up to 25 feet in length. Motor wiring should be kept as short as is practical for best performance. If a longer hook up wire for the motor is necessary, use at least size 18 wire.

The DC power supply for the motor and driver is contained within the UPD driver. Electrical hook-up is accomplished in three easy steps – couple the motor to the driver, connect the driver to your external pulse source, and plug the unit into the AC power supply.

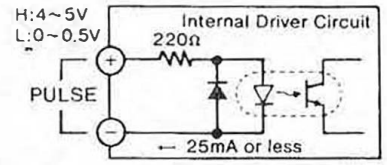
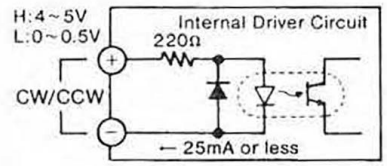
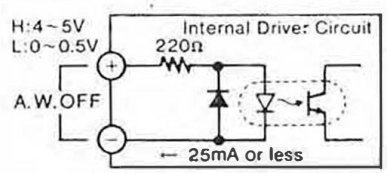
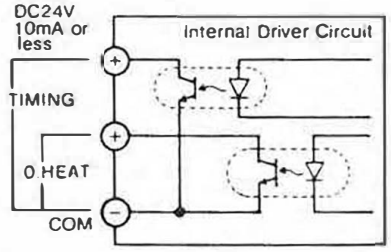
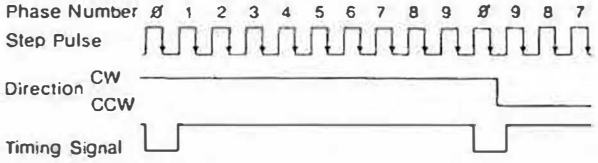
CAUTION:

Securely attach all wiring to the correct terminals prior to putting power to the driver. Failure to do so may damage the driver unit.

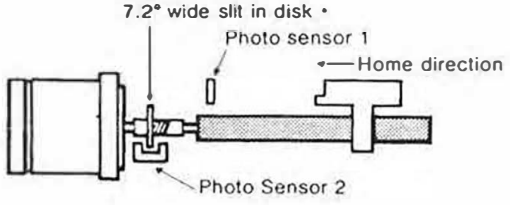
When power is applied, potentially hazardous voltages will be in the AC line and wires leading to the motor. Care should be taken to electrically insulate any exposed metal parts of the connector, wires or terminal strip to prevent accidental contact.

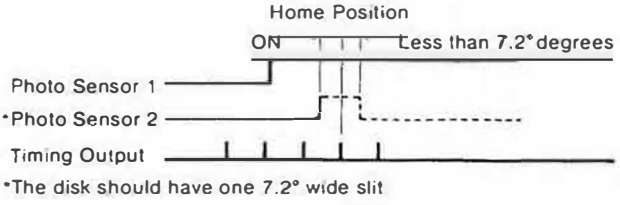
The terminal marked FG (frame ground) on the UPD driver must be properly grounded to reduce the chance of electrical shock.

DRIVER'S INPUT/OUTPUT SIGNAL CIRCUIT CHARACTERISTICS

SIGNAL NAME	INTERNAL DRIVER CIRCUIT	INPUT SIGNAL TERMINALS:
STEP PULSE INPUT (in 1 pulse mode) (CW step input in 2 pulse mode)		**"PULSE" (STEP) Terminal** **1 PULSE MODE:** Motor moves one step for each pulse detected. (Motor moves on trailing edge of pulse.) **2 PULSE MODE:** Motor moves one step clockwise for each pulse detected.(Motor moves on the trailing edge of the pulse.)
DIRECTION SIGNAL (in 1 pulse mode) (CCW step input in 2 pulse mode)		**"CW/CCW" (DIRECTION) Terminal** **1 PULSE MODE:** A "HIGH" signal causes the motor to rotate counter-clockwise for each pulse received at the "PULSE" terminal. A "LOW" signal causes the motor to rotate clockwise. **2 PULSE MODE:** Motor moves one step counter-clockwise for each pulse detected. (Motor moves on the trailing edge of the pulse.)
A. W. OFF input (All Windings Off) *Hook-up not required for operation		**A.W. OFF:** ALL WINDINGS OFF. A signal applied at this terminal turns the current to the motor off. This can be used for positioning the motor manually, or to reduce heat.
		OUTPUT SIGNAL TERMINALS:
*Hook-up not required for operation Timing Signal Output O.Heat Signal Output (Overheat Signal)		**TIMING OUTPUT STEP Ø MONITOR OUTPUT TERMINAL:** The polarity of the motor windings is repeated every ten steps in the full step mode, and every twenty steps in the half step mode. This phase sequence is numbered STEP Ø to 9 for full step and STEP Ø to 19 for half step. Each time the phases are energized in the STEP Ø condition, the TIMING LED indicator lights and the opto-isolated output of the monitor terminal is activated. When the driver is first turned on, the motor phases are energized in the STEP Ø position.  **O.HEAT OUTPUT-OVERHEAT OUTPUT:** When the driver's temperature reaches 80° C, power to the motor is removed. In applications where the removal of motor current poses a problem, the A.H.O. switch can be used to disable this function. The overheat indicator will light and the signal will be sent to the O.HEAT terminal if the temperature exceeds 80° even with the automatic power off function disabled.

USING THE TIMING OUTPUT TO FIND HOME POSITION: By using a logic "AND" circuit, with inputs from the TIMING output, and a HOME switch, the external controller can find the home position to the exact step. The driver powers-up with the phases in the step Ø position. It is desirable to put the machine in the home position using this method before turning it off, to prevent the motor from moving when power is turned back on.





*The disk should have one 7.2° wide slit

INTERFACING TO IC LOGIC FAMILIES

The UPD driver can be easily interfaced to various IC logic families. The recommended hook up for TTL and CMOS are shown in **Figure 6, A.B.**

Figure 6 A **TTL INTERFACE**

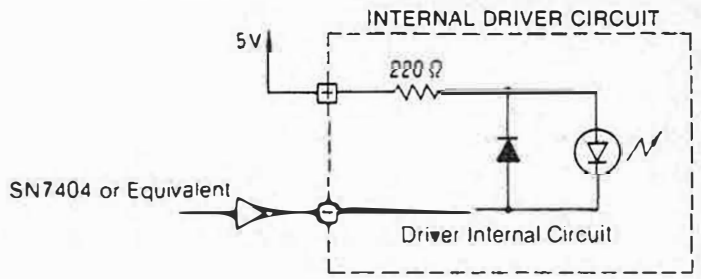
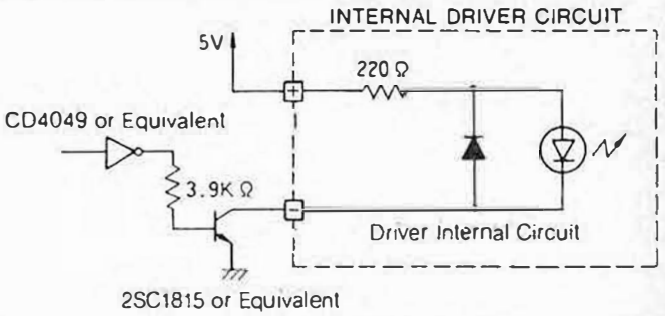


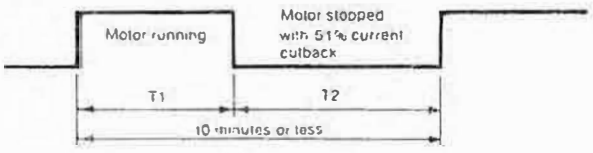
Figure 6 B **CMOS INTERFACE**



DUTY CYCLE AND RECOMMENDED APPLICATIONS

The UPD motor/driver is designed primarily for use as a high performance positioning device. It is recommended for applications that have a duty cycle made up of a combination of running and stopped periods. The stopped periods allow the motor and driver to cool down because of the automatic current cutback at standstill.

The recommended conservative duty cycle for the UPD motor/driver package is 50%. This means the motor is running 50% of the time, and stopped with the current automatically cutback for the remainder of the time.



$$\text{Duty Cycle} = \frac{T1}{T1 + T2} \times 100\,(\%) \leqq 50\%$$

Actual duty cycle limit will depend on the load, heat sinking, actual time stopped verses running, air flow around the driver and motor, and ambient temperature. The duty cycle limit can easily be determined by temperature measurement. The motor can be run continuously as long as the driver temperature is below 80° C (176° F), and the motor winding temperature is below 130° C (266° F).

The motor is designed using class "B" insulation materials and is capable of withstanding temperatures at the motor coil of 130° C (266° F) with no reduction in motor life. It is recommended the motor be mounted to a heat conductive metal bracket to reduce motor temperature and insure long life.

CALCULATION OF REQUIRED TORQUE

An explanation of the methods and formulas needed to calculate the required torque for a particular application is covered in chapter 4 and 5 of our "TECHNICAL INFORMATION ON STEP MOTORS" manual. This manual is available from your local Oriental Motor representative.

THE FOLLOWING PRECAUTIONS SHOULD BE OBSERVED TO ENSURE TROUBLE-FREE OPERATION

- The signal wiring must be kept physically separated from the motor wiring and from the AC line cord. This will reduce the chances of introducing electrical noise from the high voltage lines into the signal lines.
- Route the wires carefully so the mechanisms in motion do not snag or interfere with the wires. Also, be sure to route the motor lead wires away from any electromagnetically sensitive devices.
- Both the driver and the pulse generator used to control the driver should be grounded so that they have the same ground potential.
- Current is flowing to the motor even when it is not moving. This results in the motor becoming hot. Even though the motor insulation is designed using "B" class insulation materials which withstand up to 130° C., (266° F.), it is strongly recommended that the motor be mounted to a metal frame which will work as a heat sink.
- Avoid installation in areas where the ambient temperature falls outside the range 0-40° C, or where the relative humidity exceeds 85%.
- Do not block the air holes in the driver enclosure. Additionally, keep the driver at least an inch away from any panels or other vertical obstructions. When multiple drivers are installed, be sure to separate them by at least an inch so as not to block air for cooling.
- Where possible, the drivers should be attached or mounted on a metal base to work as an additional heat sink.
- When mounting the unit, do not use screws that protrude into the driver more than 5/32".
- Do not mount the driver in an area where it will be subjected to strong vibration or physical shocks.
- Do not use the driver or motors in corrosive or explosive atmospheres.
- The stepping motor included in this package uses shielded, precision ball bearings which must be protected from contaminants (i.e. dust, liquids). They are permanently lubricated and maintenance free.

SAFETY CONSIDERATIONS

The UPD driver is a high performance, high power piece of equipment. As with all concentrated forms of energy, the UPD driver does pose a safety hazard if installed or used incorrectly. The following warnings highlight some of the potential hazards the user should avoid.

In high duty cycle applications, it is normal for the motor and driver to become very hot. It is possible for the driver case temperature to reach 75-85° C. (170-185° F.) and the motor case temperature to reach 100° C (212° F). Steps should be taken to make sure users cannot accidentally touch the motor or driver.

The UPD driver works directly from the AC power lines without an isolation transformer. It is therefore important that the FG terminal (frame ground) be properly grounded to reduce the possibility of a shock hazard.

On the UPD driver, the Automatic Thermal cutoff is self-resetting. If dip switch A.H.O. is "ON" (Automatic Thermal cutoff) the driver will shut down if the internal driver heat sink temperature exceeds 80°C. Once the driver has cooled sufficiently, it may restart abruptly if input signal source is still active. Precautions should be taken to reset the system and protect persons and property against unexpected motor activity.

The UPD driver is **NOT** U.L. Listed. The UPD motor/driver should be used only in applications where Underwriters Laboratories listing is not required.

W-A-R-N-I-N-G

HAZARDOUS VOLTAGES CAPABLE OF CAUSING DEATH MAY BE PRESENT IN THE DRIVER AND IN THE WIRES LEADING TO THE MOTOR. ALWAYS DISCONNECT THE DRIVER FROM THE AC POWER LINE PRIOR TO CHANGING ANY OF THE WIRING OR INTERNAL ADJUSTMENTS. USE PROPER INSTALLATION TECHNIQUES TO PREVENT ACCIDENTAL CONTACT BY USERS. MAKE SURE THE WIRING IS SECURELY CONNECTED AND THE FG TERMINAL IS PROPERLY GROUNDED TO REDUCE THE POSSIBILITY OF A SHOCK HAZARD.

The user's application should incorporate safety measures to protect persons who may come in contact with potentially hazardous parts of the equipment. It is the user's sole responsibility to install, maintain and operate this equipment in such a manner as to eliminate potential hazards from the high voltages present in the driver and motor, and from any mechanical devices attached to the motor.

Failure to comply with these precautions or with warnings elsewhere in this manual or on the equipment violates safety standards of design, manufacture and intended use of this product. Oriental Motor assumes no liability for the customer's failure to comply with these and general safety requirements and practices.

CUSTOMIZING THE UPD DRIVER

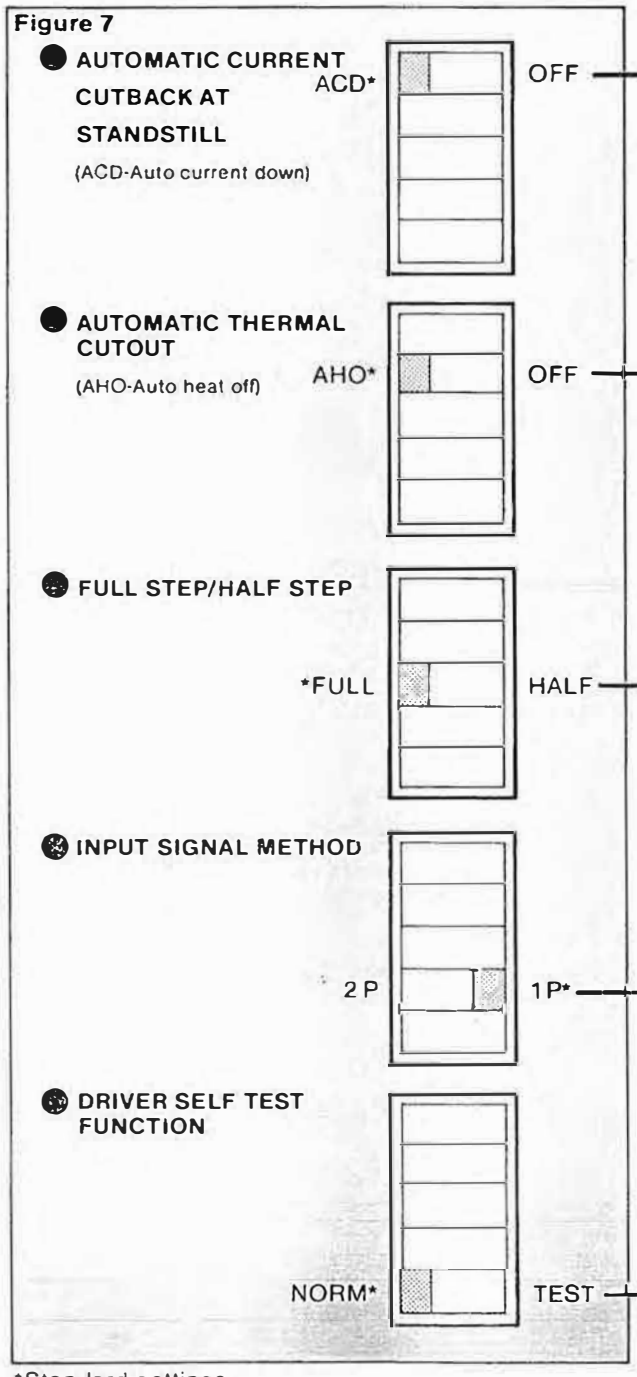
UPD DRIVER SWITCH SETTINGS

The UPD driver has been designed to be easily readjusted to meet a wide variety of application requirements.

SWITCH SELECTABLE FUNCTIONS:

The UPD driver can be set up to match a wide range of system requirements by using the dip switches as shown in **figure 7**. The functions controlled by the dip switches are:

Figure 7



*Standard settings

AUTOMATIC CURRENT CUTBACK AT STANDSTILL

After the motor has been stopped for approximately 100 milliseconds, the motor current is automatically reduced to between 13% to 100% of the selected running current. This reduces driver and motor power consumption during stopped periods in applications where holding torque is not required.

AUTOMATIC THERMAL CUTOUT

When the driver's internal temperature reaches 80° C. power to the motor is automatically removed. In applications where the sudden removal of drive current could pose a safety problem (e.g. motor is moving a weight against the force of a spring or gravity), the A.H.O. switch can be used to disable this automatic power off function. The overheat warning indicator will light and the signal will be sent to the 0.HEAT terminal if the temperature exceeds 80° even with the automatic power off function disabled.

FULL STEP/HALF STEP OPERATION

This switch selects either the four-phase-on full step, or the four-five phase on half step mode. In the full step position, a 500 step per revolution motor will move 0.72 degrees for each pulse received, and will move 0.36 degrees for each signal if the half step mode is selected.

INPUT SIGNAL METHOD

The two input signals that control step motor direction and movement are switch selectable in two configurations:

1 PULSE-STEP AND DIRECTION
The direction input signal being held high or low causes the motor to rotate CW or CCW when pulses are received at the step terminal. Care must be taken so step signal is inactive when the direction signal is changed, or missed steps may result.

2 PULSE-UP-CLOCK DOWN-CLOCK
The motor will rotate one step in one direction when pulses are sent to the first terminal, and will rotate one step in the other direction when a signal is received at the second terminals. Again, care must be taken that both inputs are not active at the same time, or missed steps will result.

DRIVER SELF TEST FUNCTION

When the switch is in the "TEST" position, the driver's internal pulse generator is activated and the motor will move at 3pps. This is used to checking the driver and the motor wiring connections.

CUSTOMIZING THE UPD DRIVER

ADJUSTING THE OUTPUT CURRENT LEVEL

The UPD Driver comes with the current already adjusted to match the motor included in the package; adjustment by the customer is not necessary. If the pre-set current needs to be changed, please refer to the procedure described below. Please note that incorrect motor current setting may result in poor performance, or cause motor overheating.

The UPD driver has potentiometers for adjusting the current when the motor is either running or at standstill. The RUN and STOP potentiometers on the front of the driver are for these adjustments. The adjustments are best done using a small screwdriver.

ADJUSTING THE RUNNING CURRENT

By referring to **figure 8b**, the Running Current can be set to the appropriate level by adjusting the RUN potentiometer to the correct setting as indicated in the RUN SCALE TABLE. Setting to "0" equals the minimum current/phase while setting to "F" equals the maximum current/phase.

ADJUSTING THE STOP CURRENT

By referring to **figure 8c**, the automatic current cutback level can be set to 13% to 100% of the selected running current as indicated in the STOP SCALE table. The STOP current level should be set to the minimum value that will just hold the load in place without slipping.

For the most efficient and coolest overall system operation, the STOP potentiometer should be set just above the minimum value which will hold your load in place without slipping.

It is recommended that the automatic current cutback at standstill switch (A.C.D.) be turned ON to protect the motor and driver.

Figure 8a

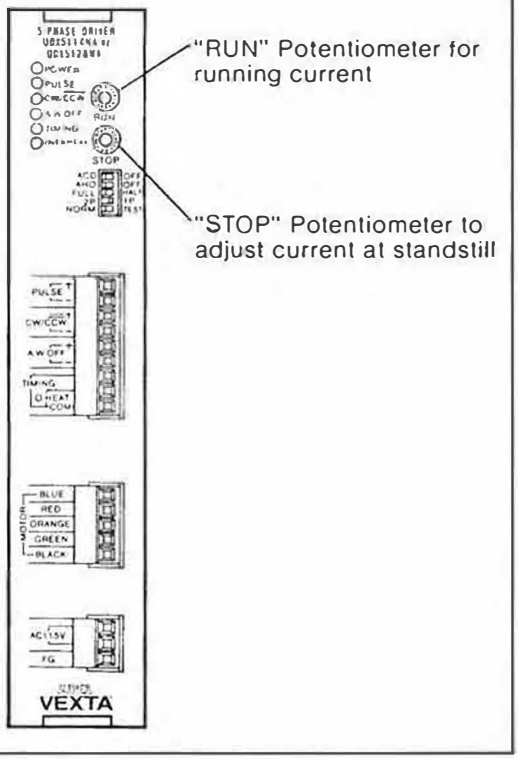


Figure 8b

RUN SCALE	RUN CURRENT (A/φ)	
	UDX5114NA	UDX5128NA
0	0.40	0.70
1	0.40	0.84
2	0.47	0.98
3	0.54	1.12
4	0.61	1.26
5	0.68	1.40
6	0.75	1.54
7	0.82	1.68
8	0.90	1.82
9	0.97	1.96
A	1.04	2.10
B	1.11	2.24
C	1.18	2.38
D	1.25	2.52
E	1.32	2.66
F	1.40	2.80

Figure 8c

STOP SCALE	CURRENT REDUCTION RATE (%)	
	UDX5114NA	UDX5128NA
0	20	13
1	25	13
2	30	13
3	36	16
4	41	23
5	46	30
6	52	37
7	57	44
8	63	51
9	69	58
A	74	65
B	79	73
C	85	80
D	90	87
E	95	93
F	100	100

TROUBLESHOOTING THE UPD MOTOR DRIVER PACKAGE

If problems develop in the operation of the UPD motor/driver package, please refer to the following list of symptoms and causes.

MOTOR FAILS TO TURN

Power Indicator is On:

- No signal coming to driver. Check to see if input signal pulses are present and meet the required timing characteristics. (5V, <25ma, length > 5 microsecond, pulse rise/fall time < 2 microsecond).
- Polarity of input signal pulse is wrong. If the signal is present and has the correct characteristics, the plus/minus wires may be switched.
- The load may be jammed.
- Driver overheated. Check to see if the overheat indicator light is on. If this is the case, the driver has shut down because of overheating.
- Motor current turned off by a signal being applied to the A.W. OFF terminal. (ALL WINDINGS OFF.) Remove signal at A.W. OFF terminal.
- Run self test function to check for miswiring.
- Driver in wrong input mode.

Power Indicator is Off:

- AC power not connected. Check the AC power wiring.
- Blown fuse. There are two fuses located under the cover. Contact your local Oriental Motor dealer for repair.

DRIVER OR MOTOR OVERHEATS

- The UPD motor/driver is a high performance device. The motor and driver normally run warm. Maximum internal temperature for the driver is 80° C., and for the motor is 130° C.
- Ambient Temperature too high. Move motor to a cooler location.
- Motor/Driver is not sufficiently heat sinked. Mount motor and drive to a metal surface to work as a heat sink.
- Motor current level set too high. Check setting according to the instructions on page 12.
- Current Cutback at Standstill Overriden. Turn current cutback switch (A.C.D.) on.
- Duty cycle too high or running time too long. Either reduce the amount of running time compared to stopped time, or improve cooling. Cooling can be improved by either mounting the driver and motor to heat conductive metal mounting surfaces, or by applying forced air cooling. If this is not possible in your application, it is recommended that the next size larger motor be used, and the motor should be run at less than rated running current. See explanation on page 9.

MOTOR TURNS ERRATICALLY OR TURNS WRONG DIRECTION

- Motor is mis-wired, or has loose connections.
- Strong electrical noise is being picked up by input signal lines. Use twisted pair wires, move input wires away from electrical noise source, or use shielded cable.
- Direction signal is being changed at the same time a step pulse is being received. Change signal timing.
- Run self test function.

MOTOR STOPS OR LOSES STEPS DURING ACCELERATION:

- Load requires a greater torque than the motor can produce.
- Too steep an acceleration ramp.
- Extreme mis-match of load inertia and motor rotor inertia.

For all three of the previous problems, a larger motor, or a slower acceleration ramp may be needed. (Some experimentation is often required in designing acceleration ramps for step motors.) Proper motor load matching is covered in chapter 4 and 5 of our "TECHNICAL INFORMATION ON STEP MOTORS" manual.

- User-supplied pulse generator frequency is not stable. If the pulses are being generated directly from a computer, especially an interrupt driven computer, the pulse frequency may vary over a wide range causing the motor to loose steps.
- A stepping motor can only lose steps in groups of ten. If the number of lost steps is not evenly divisible by ten, then it is a controller or programming problem – not a motor/driver problem.
- In certain unstable, high performance applications, the addition of a magnet damper may be needed to reduce the chance of losing steps.

MOTOR IS NOISY

- Motor/driver combination is too powerful for the load being driven. Change to half stepping (remembering to double the number of steps for each move). Reduce the running current of the motor down to match the torque actually required by the load. Add a magnet damper. Change the ratio of the transmission between motor and load.

UPD DRIVER SPECIFICATIONS (UDX5114NA AND UDX5128NA)

INPUT POWER: UDX5114NA UDX5128NA	115V NOMINAL (104V to 126V), 50/60 Hz, 3.5 AMPS OR LESS 115V NOMINAL (104V to 126V), 50/60 Hz, 7.3 AMPS OR LESS
MOTOR VOLTAGE	162VDC NOMINAL, 180VDC MAXIMUM, PULSE WIDTH MODULATED
INPUT SIGNAL CIRCUIT	220 OHM, 25mA, OPTICALLY ISOLATED, 10 MICROSECOND PULSE WIDTH MINIMUM
INPUT SIGNAL OPTIONS	DIRECTION AND STEP CLOCK (STANDARD), UP/DOWN CLOCK
POWER SAVING FEATURE	OUTPUT CURRENT AUTOMATICALLY DROPS TO ABOUT 50% OF RUNNING CURRENT AFTER 100 MILLISECONDS AT STANDSTILL. (ADJUSTABLE PERCENTAGE)
AMBIENT TEMPERATURE	0° TO 40° C. (32° TO 104° F.)
DIELECTRIC STRENGTH	UNDER NORMAL AMBIENT TEMPERATURE AND HUMIDITY, SUFFICIENT TO WITH-STAND 1 KVAC APPLIED BETWEEN CASE AND INPUT TERMINALS FOR ONE MINUTE.
INSULATION RESISTANCE	GREATER THAN 100M OHMS WITH 500VDC POTENTIAL APPLIED BETWEEN CASE AND TERMINALS.
OVERHEAT PROTECTION	OUTPUT CURRENT IS SHUT OFF AND OVERHEAT INDICATOR LIGHTS WHEN INTERNAL HEAT SINK TEMPERATURE EXCEEDS 80° C. (SWITCH SELECTABLE CURRENT SHUT OFF OVERRIDE)
DIMENSIONS: UDX5114NA UDX5128NA	1.6"(W) x 4.2"(D) x 9.5"(H) (40.6mm x 106.7mm x 241.3mm) 1.8"(W) x 5.4"(D) x 9.5"(H) (45.7mm x 137.2mm x 241.3mm)
WEIGHT: UDX5114NA UDX5128NA	35.2 oz. (1 Kg) 45.8 oz. (1.3 Kg)

UPD MOTOR SPECIFICATIONS (2.36"φ AND 3.39"φ DIAMETER MODELS)

MAX. MOTOR WIND. CURRENT 2.36"φ 3.39"φ	1.4 AMPS/PHASE 2.8 AMPS/PHASE
STEP ANGLE ACCURACY	±5 MIN.
DIELECTRIC STRENGTH	UNDER NORMAL AMBIENT TEMPERATURE AND HUMIDITY, SUFFICIENT TO WITH-STAND 1 KVAC APPLIED BETWEEN CASE AND INPUT TERMINALS FOR ONE MINUTE.
INSULATION RESISTANCE	GREATER THAN 100M OHMS WITH 500VDC POTENTIAL APPLIED BETWEEN CASE AND LEADS.
INSULATION CLASS	CLASS B (130° C.)
MAX. TEMPERATURE RISE	WITH 5 PHASES "ON", (80° C.)
TEMPERATURE RANGE	0° C. TO +50° C., (+32° F. TO +122° F.)
WEIGHT: 2.36"φ 3.39"φ	PH564-NAA(BA) = 17.6 oz. (0.5 Kg), PH566-NAA(BA) = 26.4 oz. (0.75 Kg), PH569-NAA(BA) = 45.8 oz. (1.3 Kg) PH596H-NAA(BA) = 52.9 oz. (1.5 Kg), PH599H-NAA(BA) = 88.2 oz. (2.5 Kg) PH5913H-NAA(BA) = 123.5 oz. (3.5 Kg)

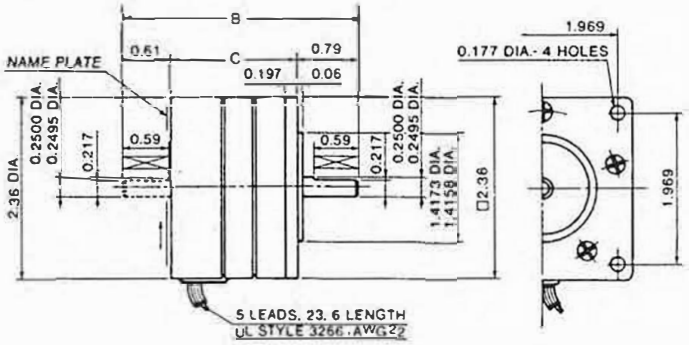
UPD MOTOR/DRIVER PACKAGES 2.36"φ VERSION

UPD PACKAGE MODEL NUMBER	STEP MOTOR MODEL NUMBER	SHAFT TYPE	LEAD WIRES	DRIVER TYPE	DRIVER MODEL NUMBER
UPD564-NAA	PH564-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5114NA
UPD564-NBA	PH564-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5114NA
UPD566-NAA	PH566-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5114NA
UPD566-NBA	PH566-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5114NA
UPD569-NAA	PH569-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5114NA
UPD569-NBA	PH569-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5114NA

DIMENSIONS

MOTOR:

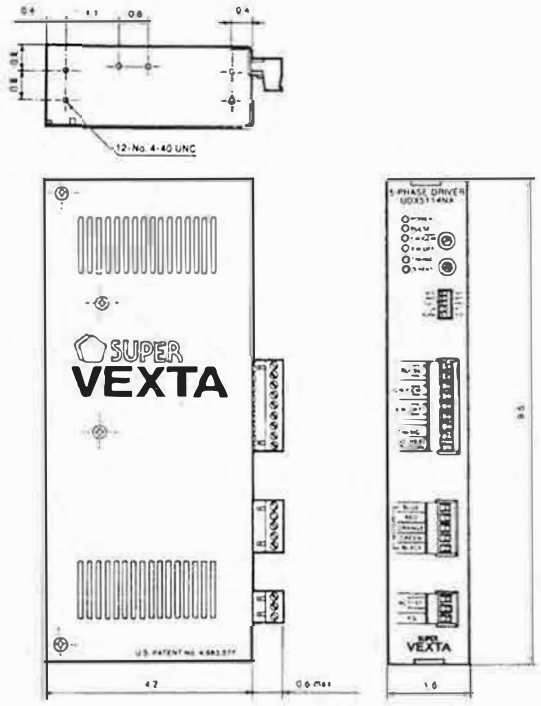
PH56□-N□A



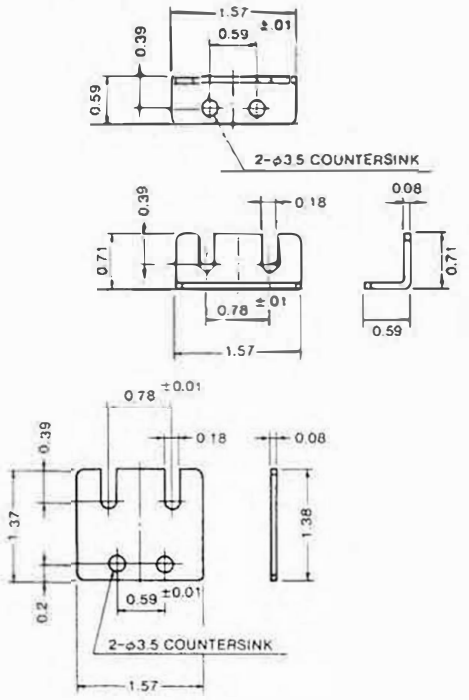
MODEL	C	B
PH564-N□A	1.65	3.05
PH566-N□A	2.32	3.72
PH569-N□A	3.72	5.12

unit = inch

DRIVER: UDX5114NA



MOUNTING HARDWARE:

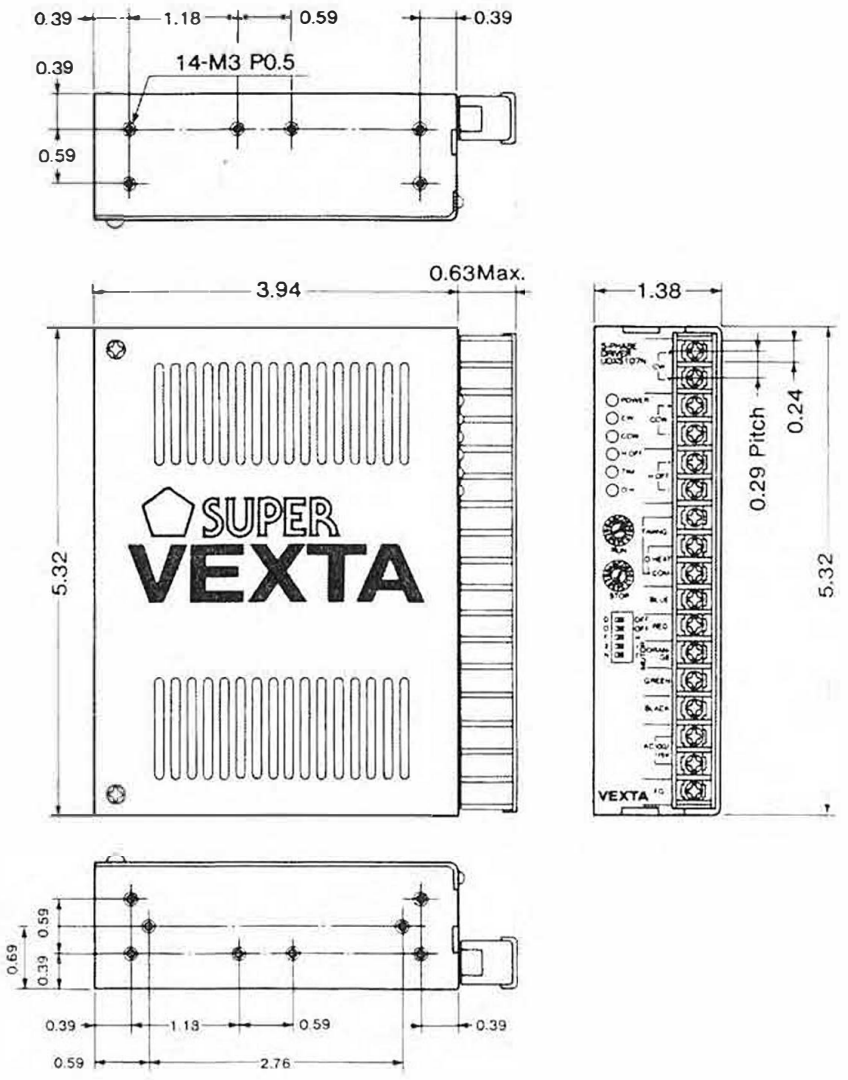


UPD MINI MOTOR/DRIVER PACKAGES

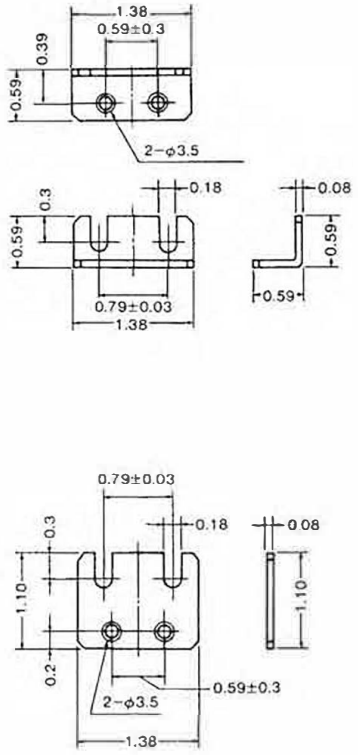
UPD PACKAGE MODEL NUMBER	STEP MOTOR MODEL NUMBER	SHAFT TYPE	LEAD WIRES	DRIVER TYPE	DRIVER MODEL NUMBER
UPD533-NAA	PH533-NA	SINGLE	5	5φ NEW PENTAGON	UDX5107N
UPD533-NBA	PH533-NB	DOUBLE	5	5φ NEW PENTAGON	UDX5107N
UPD544-NAA	PH544-NA	SINGLE	5	5φ NEW PENTAGON	UDX5107N
UPD544-NBA	PH544-NB	DOUBLE	5	5φ NEW PENTAGON	UDX5107N
UPD554-NAA	PH554-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5107N
UPD554-NBA	PH554-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5107N

DIMENSIONS

DRIVER: UDX5107N (Unit = in.)



MOUNTING HARDWARE:
(Unit = in.)



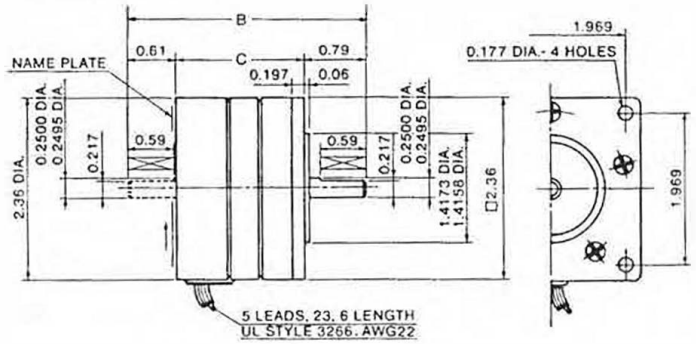
UPD MOTOR/DRIVER PACKAGES 2.36"φ VERSION

UPD PACKAGE MODEL NUMBER	STEP MOTOR MODEL NUMBER	SHAFT TYPE	LEAD WIRES	DRIVER TYPE	DRIVER MODEL NUMBER
UPD564-NAA	PH564-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5114NA
UPD564-NBA	PH564-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5114NA
UPD566-NAA	PH566-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5114NA
UPD566-NBA	PH566-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5114NA
UPD569-NAA	PH569-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5114NA
UPD569-NBA	PH569-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5114NA

DIMENSIONS

MOTOR:

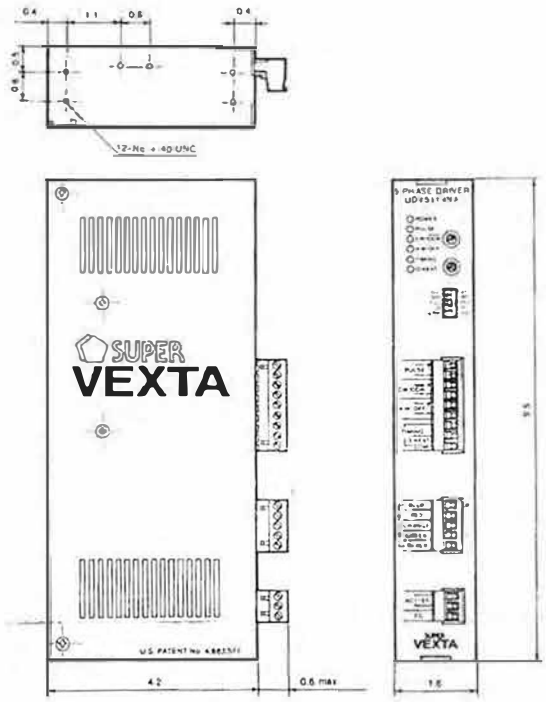
PH56□-N□A



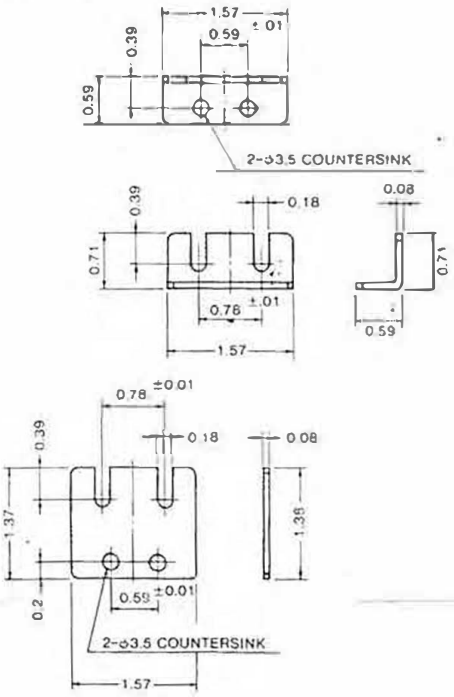
MODEL	C	B
PH564-N□A	1.65	3.05
PH566-N□A	2.32	3.72
PH569-N□A	3.72	5.12

unit = inch

DRIVER: UDX5114NA

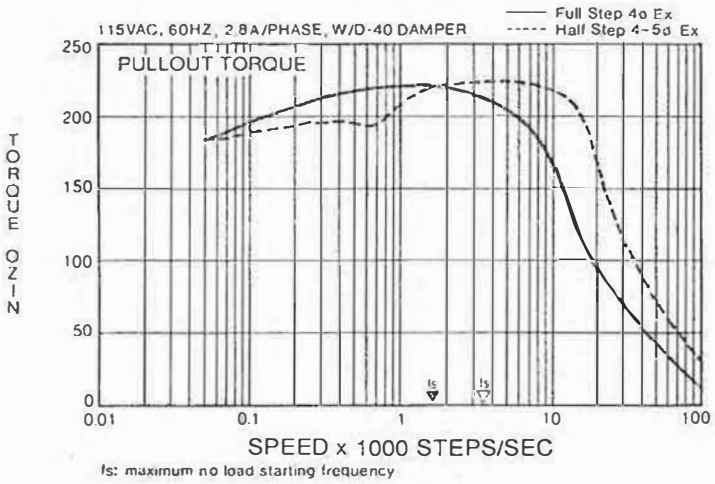


MOUNTING HARDWARE:



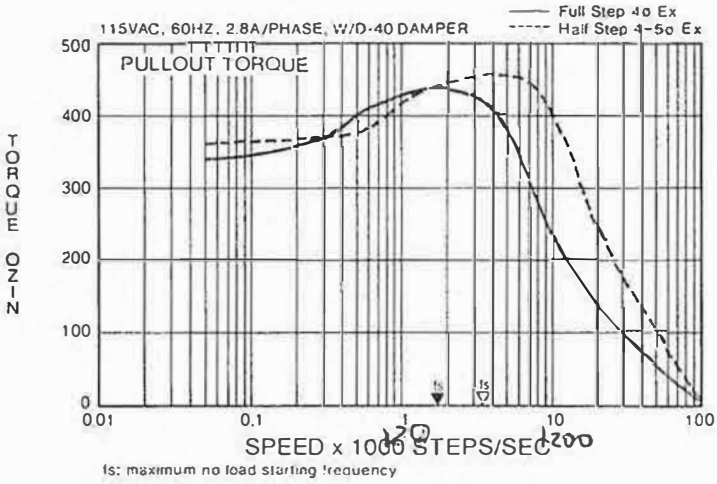
SPEED VS. TORQUE CHARACTERISTICS 3.39"ϕ VERSION

UPD596H-NAA
UPD596H-NBA



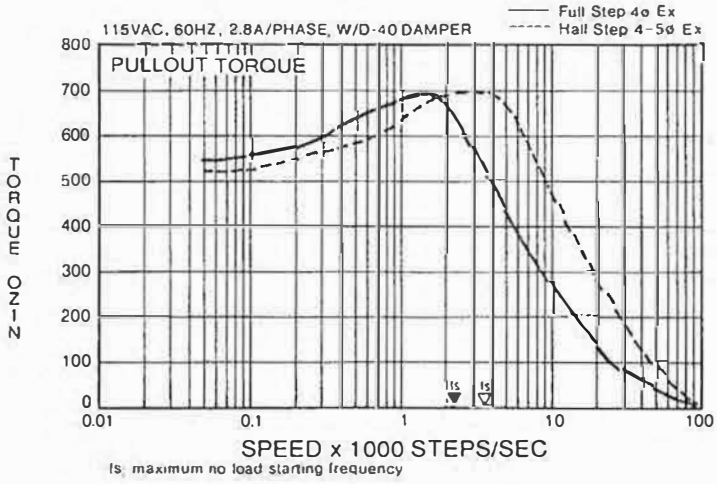
fs: maximum no load starting frequency

UPD599H-NAA
UPD599H-NBA



fs: maximum no load starting frequency

UPD5913H-NAA
UPD5913H-NBA



fs: maximum no load starting frequency

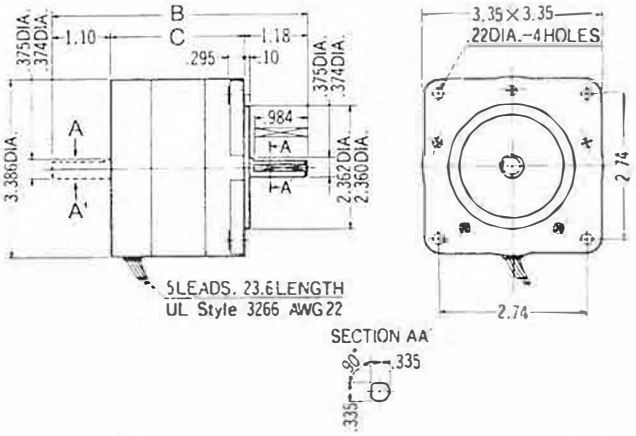
UPD MOTOR/DRIVER PACKAGES 3.39"φ VERSION

UPD PACKAGE MODEL NUMBER	STEP MOTOR MODEL NUMBER	SHAFT TYPE	LEAD WIRES	DRIVER TYPE	DRIVER MODEL NUMBER
UPD596H-NAA	PH596H-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5128NA
UPD596H-NBA	PH596H-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5128NA
UPD599H-NAA	PH599H-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5128NA
UPD599H-NBA	PH599H-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5128NA
UPD5913H-NAA	PH5913H-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5128NA
UPD5913H-NBA	PH5913H-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5128NA

DIMENSIONS

MOTOR:

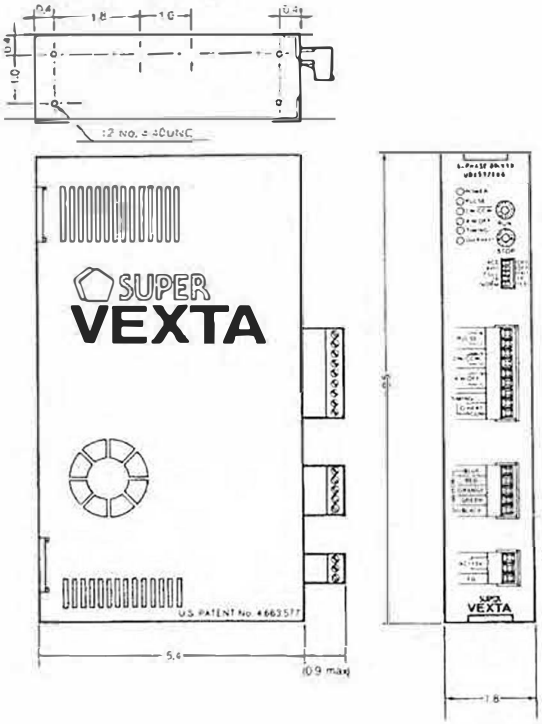
PH59□H-N□A



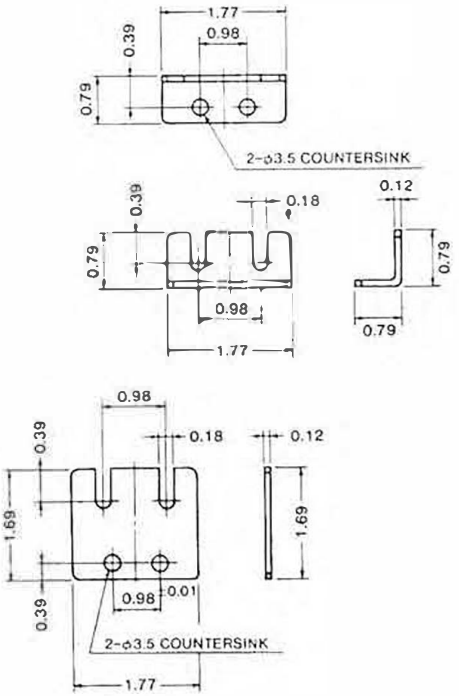
MODEL	C	B
PH596H-N□A	2.52	4.8
PH599H-N□A	3.82	6.1
PH5913H-N□A	5.12	7.4

unit = inch

DRIVER: UDX5128NA

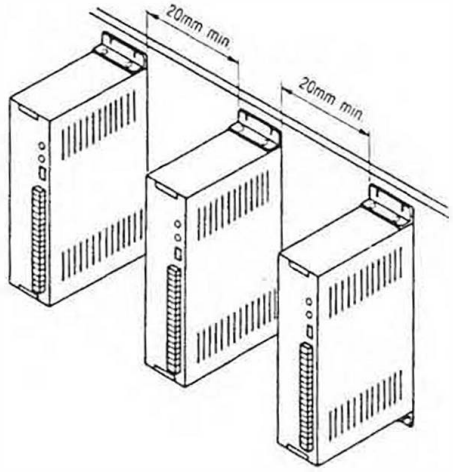


MOUNTING HARDWARE:



2. When Installing more than Two Drivers

When installing more than two drivers, any rise in the temperature of the driver will rise the ambient temperature. Drivers should be installed so that a space of at least 20mm is maintains between drivers.
Forced cooling by a cooling fan is recommended when the ambient temperature exceed 40 C.



3. Recommended Place for Driver Installation

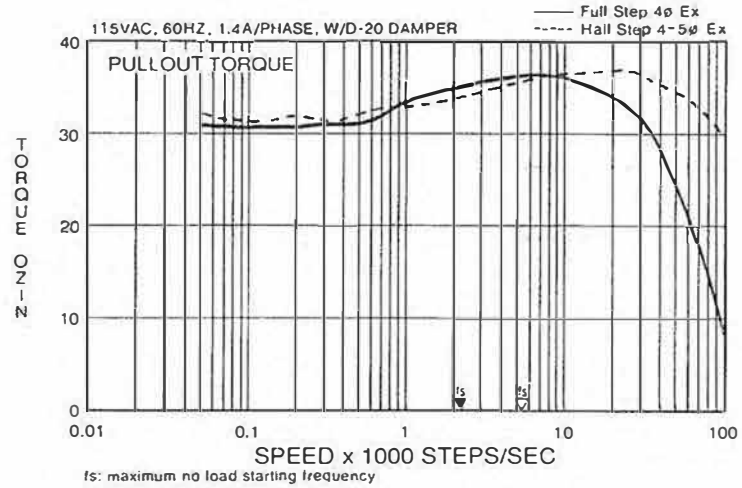
Install drivers in place that meet the following conditions.

- Indoors
- Ambient temperature is 0°C to +40°C (non-freezing)
- Ambient humidity is less than 85% (non-condensing)
- Free from dust or corrosive gas
- Free from water or oil

Note: * When attaching the driver in a close space such as control box, or somewhere close to a heat-radiating object, vent hole should be make to prevent overheating of the drivers.
* If the drivers are installed near a source of vibration, protect the drive from vibration with a shock absorber.
* In the case that the drivers are located close to a large noise source such as high frequency weldering machine or large electromagnetic switch, etc., take steps to prevent noise interference, either by inserting noise filters or connecting the driver to a separate circuit.
* Take care that pieces of conductive material (filings, pins, pieces of wirings, etc.) not to enter the driver.

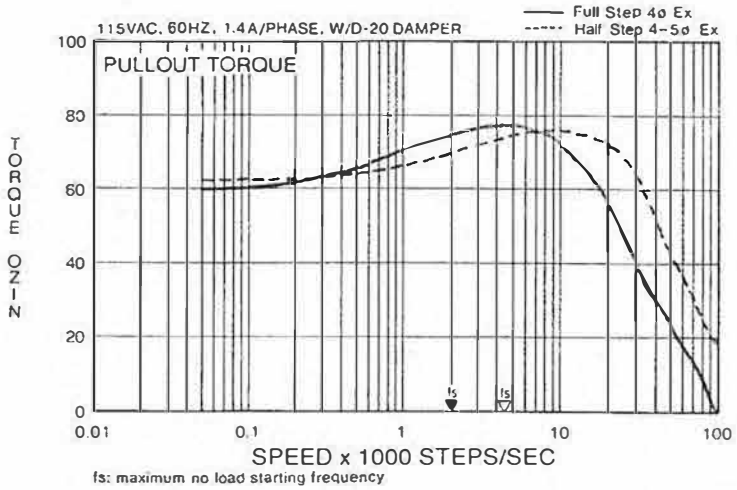
SPEED VS. TORQUE CHARACTERISTICS 2.36"ϕ VERSION

UPD564-NAA
UPD564-NBA



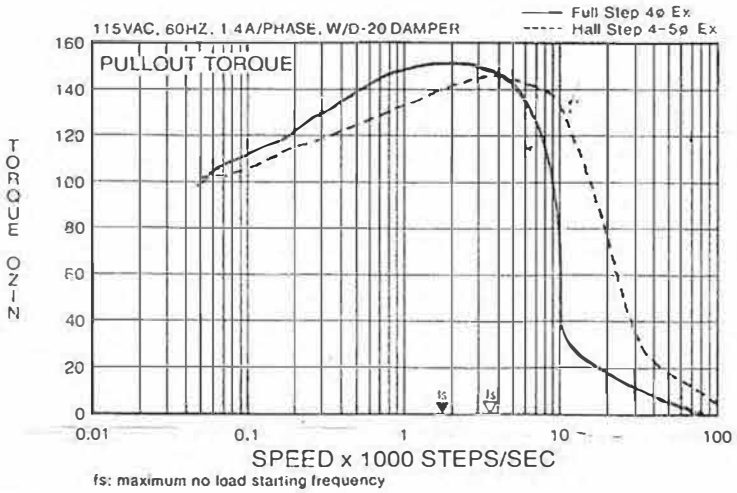
fs: maximum no load starting frequency

UPD566-NAA
UPD566-NBA



fs: maximum no load starting frequency

UPD569-NAA
UPD569-NBA



fs: maximum no load starting frequency

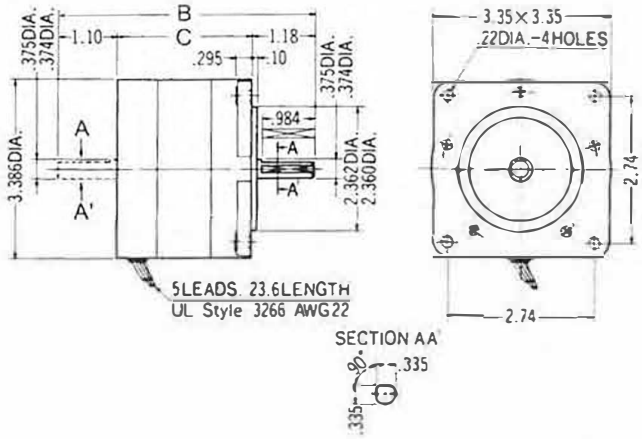
UPD MOTOR/DRIVER PACKAGES 3.39"φ VERSION

UPD PACKAGE MODEL NUMBER	STEP MOTOR MODEL NUMBER	SHAFT TYPE	LEAD WIRES	DRIVER TYPE	DRIVER MODEL NUMBER
UPD596H-NAA	PH596H-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5128NA
UPD596H-NBA	PH596H-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5128NA
UPD599H-NAA	PH599H-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5128NA
UPD599H-NBA	PH599H-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5128NA
UPD5913H-NAA	PH5913H-NAA	SINGLE	5	5φ NEW PENTAGON	UDX5128NA
UPD5913H-NBA	PH5913H-NBA	DOUBLE	5	5φ NEW PENTAGON	UDX5128NA

DIMENSIONS

MOTOR:

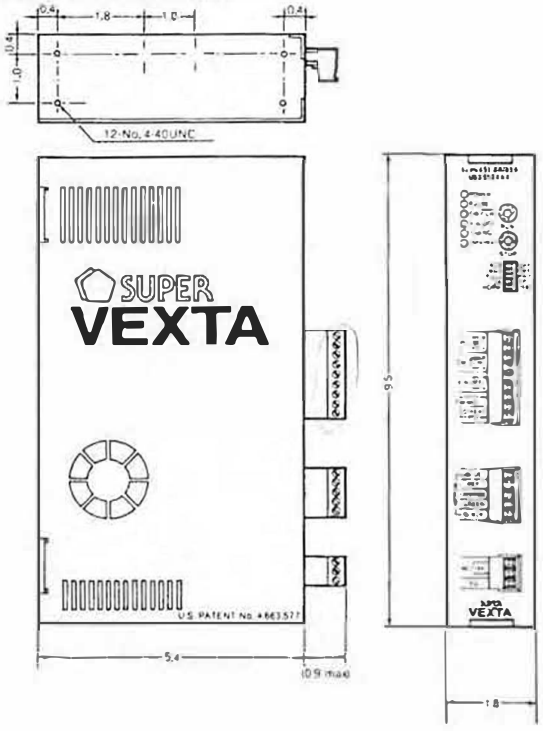
PH59□H-N□A



MODEL	C	B
PH596H-N□A	2.52	4.8
PH599H-N□A	3.82	6.1
PH5913H-N□A	5.12	7.4

unit = inch

DRIVER: UDX5128NA



MOUNTING HARDWARE: