TRIS10 ROBOTICS KickBall Solenoid

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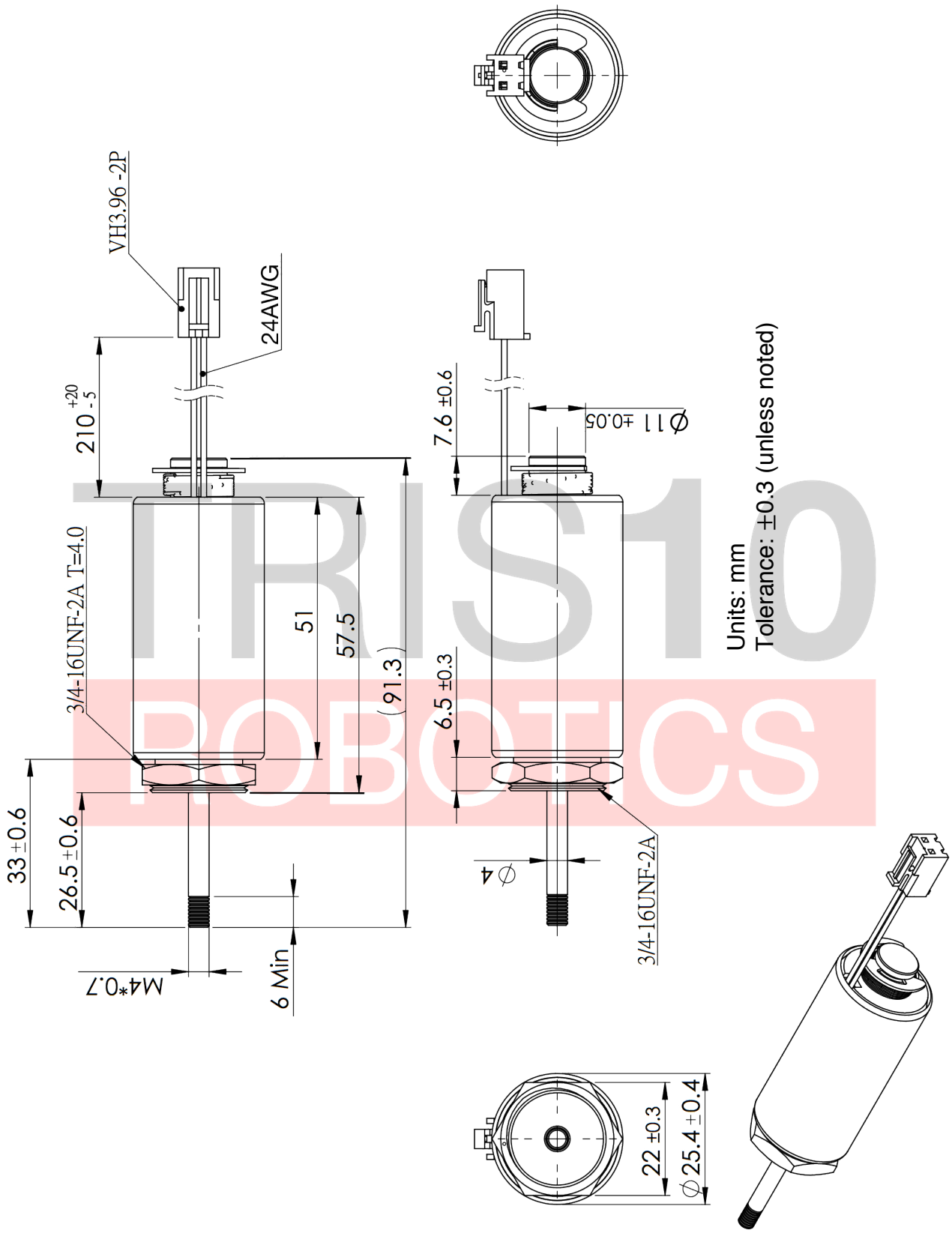
1.0 Characteristics

Characteristic	Value	Units
Resistance	0.64 ± 0.15	Ω
Rated Voltage for 100% Duty Cycle	6	V
Standard Duty Cycle for Kicking	<1	%
Connector	JST-VH-2P-F	
Lifetime	>5000	Kicks

2.0 Dimensions



3.0 Application Notes and Recommendations

3.1 Best Practices for Maintaining the Plunger

The shape and design of the plunger (or needle) is specifically matched to the solenoid it is supplied with. Deformation, including minor scratching, or warping, of the plunger, must be avoided and can result in absolute failure of the solenoid. As such, the following precautions should be taken.

3.1.1 Plunger storage

The solenoid and plunger is a matched pair. When not mounted for application, the plunger should be stored in the solenoid it was originally contained in and adhesive tape should be placed across the rear end of the solenoid to prevent accidental dislodgement. If packing for transport, special care should be taken to ensure the front of the plunger is protected from bending.

3.1.2 Gripping the plunger

Never use pliers, multi grips or other gripping devices on the plunger. All *KickBall Solenoids* are supplied with soft-grip material that allows the plunger to be held by hand when working on the plunger. Damage to the plunger surfaces will cause the solenoid to jam.

3.1.3 Avoiding damage to the ball

To prevent damage to the plunger when kicking, a protective head should be mounted on the front of the plunger. To avoid damage to the object being kicked, this is strongly recommended. All *KickBall Solenoids* are shipped with an M4 nut, a nylon-insert M4 nut and a rubber cap. **In accordance with 3.1.2 above**, the following is the recommended procedure for securely mounting the rubber cap to the plunger while the plunger is in the solenoid:

1. Screw the M4 nut on to the front of the plunger.
2. Screw the M4 nylon-insert nut on to the front of the plunger with the nylon edge facing the solenoid. Note, this is the reverse of the normal use of nylon-insert nuts but here it provides a larger flat surface area to support the rubber cap and also allows the nylon insert to fully engage the plunger thread and not work loose. Use the soft-grip material to hold the rear of the plunger and a small spanner to gently tighten the nylon-locking nut.
3. Push the rubber cap over both the nuts.

Do not apply glue of any type to the rubber cap or M4 nuts. Additional sets of parts are available on the TRIS10 ROBOTICS website as part of the *KickBall Spares Kit*.

3.1.4 Cleaning and oiling the plunger

If exposed to excessive dust, after some considerable use, the plunger may become immobile in the solenoid (jammed in the operated mode) and will require cleaning and lubricating. This process is simple and it is recommended to be performed after initial usage of 50 to 100 kicks, and when further required. In a relatively clean operating environment, the solenoid will operate for thousands of kicks without additional cleaning.

3.1.4.1 Cleaning Process

To clean the solenoid:

1. Remove the plunger from the solenoid
2. Wipe the plunger thoroughly using a soft cloth to remove any existing oil and debris.
3. Clean the barrel of the solenoid using a soft cloth.

3.1.4.2 Oiling Process

To oil, the solenoid:

1. Clean the solenoid in accordance with 3.1.4.2.
2. Using a small drop of fresh car engine oil, apply a very thin smear around only the angled edge of the plunger. The amount of oil applied should be so small that the surface appears to be almost dry.

Do not apply too much oil and do not apply oil to the rest of the plunger or the solenoid. A very small amount of oil on the angled edge will effectively cushion the plunger as it hits the front of the solenoid, however too much oil will allow dust and debris to adhere to the plunger, causing the solenoid to fail regularly.

3.2 Optimising the Kick

3.2.1 Electrical Considerations

To optimise the power of the kick, the maximum permissible DC voltage should be used. The power of the kick is proportional to the square of the voltage: $P = \frac{V^2}{R}$ $(R = 0.64\Omega)$. To avoid power supply issues, a pre-charged capacitor should be used. This is the basis of the *KickBall Controller*, which is designed specifically for the *KickBall Solenoid*.

3.2.2 Recommended Distance from Object

The force on the plunger increases as the plunger travels into the solenoid. To maximise the actuating force and achieve the optimal kick, the tip of the unpowered solenoid should be between 10mm and 16mm from the object (or surface) to kick. These values were determined empirically and may differ in some special applications.

3.2.3 Recommended Mounting of the Solenoid

The solenoid should be mounted in a rigid frame that supports both the front and rear sections of the solenoid but does not interfere with the plunger. The nut on the front of the solenoid provides a strong interface for mounting a support structure at the front. The rear support structure is not required to encapsulate the whole solenoid and can simply have the solenoid rest on it.

An example mount is available on the TRIS10 ROBOTICS website. This mount can be 3D printed and demonstrates the guidelines above.

3.2.4 Recommendations for Kicking

Although the solenoid, with rubber cap attached, can kick an object adequately, it is effectively a point source that may not be optimal in many applications such as robot soccer. A hinged flap is the least complex solution that increases the surface area that may be in contact with the object (the ball) and can decrease the accuracy required by the robot as a whole. The hinged flap should be perpendicular to the solenoid when not kicking, as non-perpendicular angles may cause the solenoid to bend and jam. To optimise the kick, the vertical distance between the hinges and the solenoid should be maximised.