BUSHING INTEGRATION

SUPERWIND 350 and 353 Turbines

(Version 2.2019)

BUSHING INTEGRATION

1. Bushing Basics

1.1 Introduction:

A bushing is the piece of equipment that anchors the Superwind yaw shaft to the mast, allowing it to freely rotate 360º on its vertical axis.
The bushing slides over the yaw shaft of the turbine, where it is then fastened in place utilizing three screws. Once attached to the yaw shaft, the bushing is then inserted into the mast tube and screwed in place for support, stability and safety (Fig. No. 1).

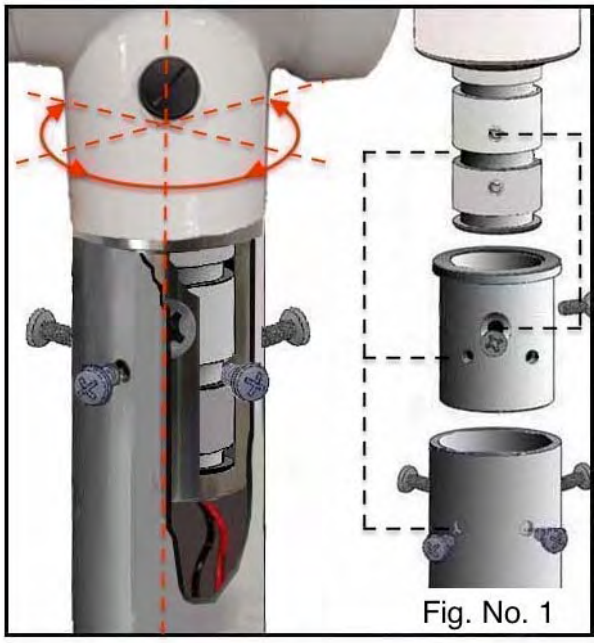
Fig. No. 1

The original bushing used with the Superwind 350 turbine was designed to help with noise reduction when installed aboard sailing yachts. The concept and design of these bushings has evolved considerably since then.

1.2 Types of Bushings:

There are currently five types of bushings available for use with the SW350 and SW353 turbines, allowing installations that can accommodate a wide variety of mast sizes and configurations.

American Delrin® *(White)* Section 2.1	***European Delrin®*** *(with or without bands)* Section 2.2	***European Stainless Steel*** *(with or without bands)* Section 2.3	***American Stainless Steel*** Section 2.4	***American Delrin®*** *(Black)* Section 2.5

Bushing selection depends on the type of location the turbine will be deployed in. American and European Delrin® bushings are used for integration on ships and other salt water applications. American and European Stainless Steel bushing are used on tall towers and in locations subject to higher wind speeds, as well as Mobile platforms (such as trailers).

American Delrin® White (Fig. No.2), European Delrin® White (Fig. No. 3) and American Delrin® Black (Fig. No. 6) bushings come with predrilled holes to facilitate attachment to the yaw shaft and to the mast (Fig No. 7) with their respective hardware as follows:

- Three (3) M6 x 8 Socket cap screws (with TUFLOK coated threads and rubber rings) are included and are used to attach the bushing to the yaw shaft.
- Two (2) M6 x 6 hexagon socket button head screws (also included) are used to attach the bushing to the mast. These screws will extend into the groove of the yaw shaft, but will not touch it. Optional M6 x 12 screws are also included and may need to be used, depending on installation requirements.

Both the European (Fig. No. 4) and American (Fig. No. 5) stainless steel bushings come with pre-drilled holes for attachment to the yaw shaft and to the mast as follows:

- Three (3) M6 x 14 flathead, hex drive screws are used to attach the bushing to the yaw shaft.
- For the American Stainless Steel Bushing, four (4) ¼" x 20 pan head, Philips drive screws (or alternatives) are used to attach the bushing to the mast.
- For the European Stainless Steel Bushing, six (6) ¼" x 20 screws (or alternatives) are used to attach the bushing to the mast.

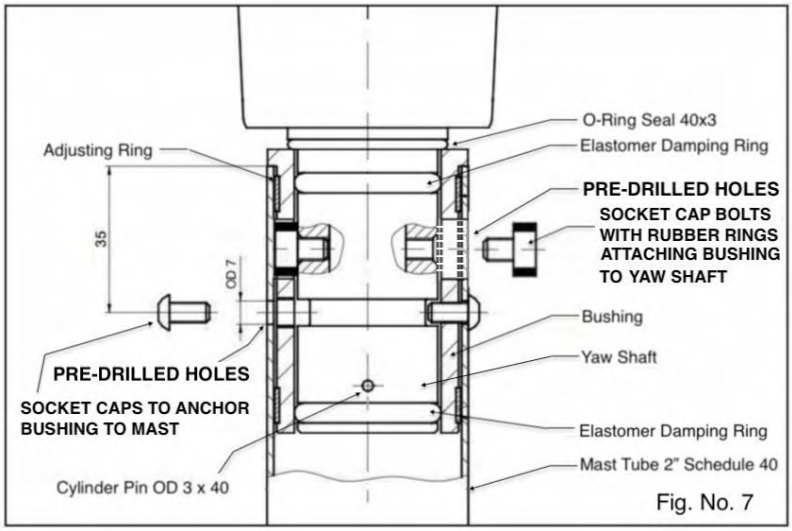

Fig. No. 7

1.3 Mast Tube Specifications

The proper size for mast selection is 2" schedule 40 stainless steel or aluminum piping. Stainless steel tubing can be used as well, provided the size is 2 ¼", 316L, 16 gauge.
In general, any type of high quality, commercial grade metal can be used, provided it is 2" schedule 40.

Common American Masts			
Mast Type	**Inner Diameter***	**Outer Diameter****	**Wall Thickness****
Stainless Steel Pipe (2" Schedule 40)	52.46 mm *2.065 in*	60.3 mm *2.37 in*	3.92 mm *0.15 inch*
Stainless Steel Tube (2 ¼", 316L, 16 Gauge)	53 mm *2.09 in*	57.15 mm *2.25 in*	2.54 mm *0.01 inch*
Aluminum Pipe (2" schedule 40)	52.50 mm *2.066 in*	60.325 mm *2.375 in*	3.912 mm *0.15 inch*
**Inches are rounded to nearest thousandth*			
***Inches are rounded to nearest hundredth*			

2. Detailed Bushing Descriptions

2.1 American Delrin® (White) Bushing Assembly

Use with SW350 only (Fig. No. 8).

There are two (2) black elastodamphner rings that may be installed on the SW350 yaw shaft upon receipt of the turbine. When using the American Delrin® (White) bushing, both of the black elastodamphner rings installed on the SW350 **must stay** on the yaw shaft during installation. Coating the elastodamphner rings and inside of the bushing with Vaseline® (supplied) prior to installation will lessen resistance when inserting the yaw shaft into the bushing. Delrin® will swell slightly in salt water applications. This can be useful in helping to reduce any non-circular dimensions of the mast. When installed correctly, the bushing provides both sound and vibration dampening.

Fig. No. 8

2.1.1 Dimensions

The inner diameter of the American Delrin® (White) bushing is 44.2 mm (1.74 inches). The maximum outer diameter of the bushing is 52.9 mm (2.08 inches). When required, the outer diameter of the bushing can be reduced slightly by sanding to help accommodate installation inside the mast.

2.1.2 Hardware

The American Delrin® (White) bushing comes with predrilled holes for attachment. Hardware is provided for attaching the bushing to the SW350's yaw shaft and to the mast. Three (3) M6 x 8 Socket cap screws with TUFLOK coated threads and rubber rings (Fig No. 8) are used to attach the bushing to the yaw shaft. Two (2) M6 x 6 hexagon socket button head screws are used to attach the bushing to the mast. (Optional M6 x 12 hexagon socket button head screws are also included). These screws will extend into the groove of the yaw shaft, but should not touch it.

2.2 European Delrin® (White) Bushing Assembly

Use with SW350 only (Fig. No. 9).

There are two (2) black elastodamphner rings that may be installed on the SW350 yaw shaft upon receipt of the turbine. When using the European Delrin® (White) bushing, both of the black dampener rings installed on the SW350 **must stay** on the yaw shaft during installation. Coating the elastodamphner rings and the inside of the bushing with Vaseline® (supplied) prior to installation will lessen resistance when inserting the yaw shaft into the bushing. Delrin® will swell slightly in saltwater applications. This can be useful in helping to reduce any non-circular dimensions of the mast. When installed correctly, the bushing provides both sound and vibration dampening. The European Delrin® (White) bushing comes with removable expansion bands on the outside of the bushing. These can be used to alter the exterior dimension of the bushing, based on the dimension required for the mast.

Fig. No. 9

2.2.1 Dimensions

The inner diameter of an European Delrin® (White) bushing is 44.2 mm (1.74 inches). This dimension will not change, regardless of the band configurations. When bands are installed, the outer diameter is 56 mm (2.20 inches). When the bands are not installed, the outer diameter is 54.6 mm (2.15 inches).

2.2.2 Hardware

The European Delrin® (White) bushing comes with predrilled holes for attachment. Hardware is provided to attach the bushing to the SW350 and to the mast. Three (3) M6 x 8 socket cap screws (with TUFLOK applied to the threads and rubber rings) are used to attach the bushing to the yaw shaft. Two (2) M6 x 6 or M6 x 12 hexagon socket button head screws are used to attach the bushing to the mast. These screws extend into the groove of the yaw shaft, but should not touch it (see Fig. No. 7).

2.3. European Stainless Steel Bushing Assembly

Use with SW350 & SW353 - (Fig. No. 10)

There are two (2) black elastodamphner rings that may be installed on the SW350 yaw shaft upon receipt of the turbine. When using the European Stainless Steel bushing, the black dampener rings installed on the SW350 **must be removed** from the yaw shaft prior to bushing installation.

The European Stainless Steel bushing comes with removable expansion bands on the outside of the bushing. These can be used to alter the exterior dimension of the bushing, based on the dimension required for the mast. The European Stainless Steel bushing is approved for use with SW353 turbines due to the increased survivability it provides in high crosswind areas.

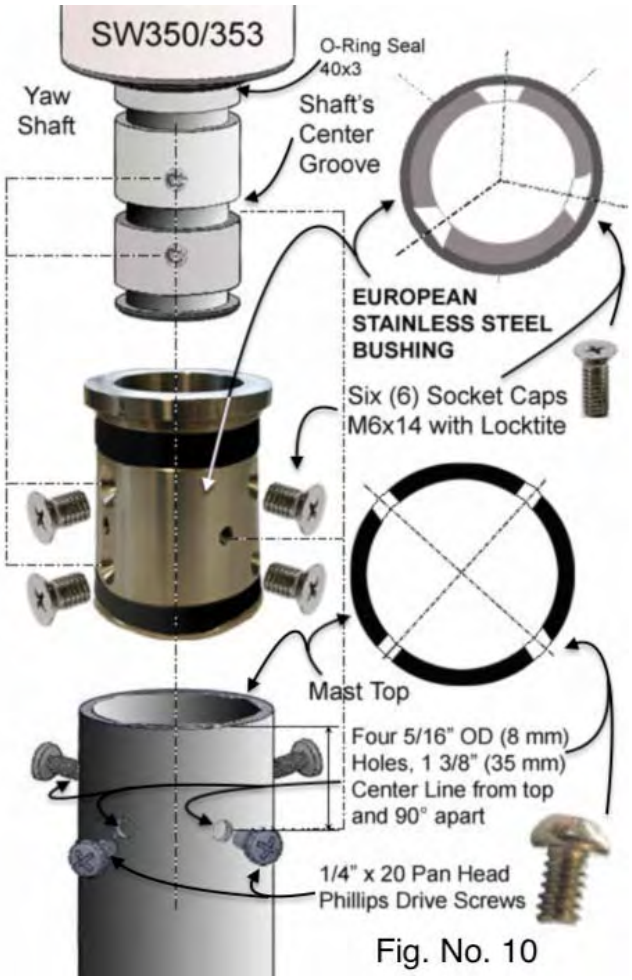

Fig. No. 10

2.3.1 Dimensions

The inner diameter of the EU Stainless Steel bushing is 42.2 mm (1.66 inches). This dimension will not change regardless of the band configurations. With the bands installed, the outer diameter is 56 mm (2.20 inches). When the bands are <u>not</u> installed, the outer diameter will be 54.6 mm (2.15 inches).

2.3.2 Hardware

The EU Stainless Steel bushing comes with predrilled holes for attachment. Six (6) M6x14 type screws are provided to attach the bushing to the yaw shaft. Four (4) ¼" x 20 pan head screws are provided to attach the bushing to the mast, however as pipe wall thickness can vary, alternative screws for correct installation of the bushing may need to be provided by the installer. The screws must be long enough to travel through the mast, the stainless-steel bushing and touch the yaw shaft within the center groove, after which they must be backed out a quarter turn (so they are not touching the yaw shaft once the installation is complete).

2.4 American Stainless Steel Bushing Assembly

Use with SW350 & SW353 - (Fig. No. 11)

The American Stainless Steel bushing is standard equipment for the SW353 and optional equipment for the SW350. This bushing is designed for use on high towers or in areas that experience higher than average wind speeds or extreme cross winds. The American Stainless Steel bushing is not recommended for use aboard vessels. There are two (2) black elastodamphner rings that may be installed on the SW350 yaw shaft upon receipt of the turbine. When using the American Stainless Steel bushing, the black elastodamphner rings installed on the SW350 **must be removed** from the yaw shaft prior to bushing installation.

Fig. No. 11

2.4.1 Dimensions

The American Stainless Steel bushing is designed to fit inside a standard 2" schedule 40 pipe. The inner diameter of an American Stainless Steel bushing is 42.2 mm (1.66 inches). The outer diameter of an American Stainless Steel bushing is 52.1 mm (2.05 inches).

2.4.2 Hardware

The American Stainless Steel bushing comes with predrilled holes for attachment. Hardware is provided for attaching the bushing to the yaw shaft of the SW350 or SW353 and to the mast. Three (3) M6 x 14 flathead, hex drive screws are used to attach the bushing to the yaw shaft. Four (4) ¼" 20 pan head screws are provided to attach the bushing to the mast, however as pipe wall thickness can vary, alternative screws for correct installation of the bushing may need to be provided by the installer. The screws must be long enough to travel through the mast, the stainless steel bushing and touch the yaw shaft within the center groove, after which they must be backed out a quarter turn (so they are not touching the yaw shaft once the installation is complete).

2.5 American Delrin® (Black) Bushing Assembly

Use with SW350 only - (Fig. No. 12)

There are two (2) black elastodamphner rings that may be installed on the SW350 yaw shaft upon receipt of the turbine. When using the American Delrin® (Black) bushing, the black dampener rings installed on the SW350 **must be removed** from the yaw shaft prior to installation. Delrin® will swell slightly in saltwater applications. This can be useful in helping to reduce any non-circular dimensions of the mast.

Fig No. 12

2.5.1 Dimensions

The inner diameter of an American Delrin® Black bushing is 42.2 mm (1.66 inches). The outer diameter of an American Delrin® (Black) bushing is 52.1 mm (2.05 inches).

2.5.2 Hardware

The American Delrin® (Black) bushing comes with predrilled holes for attachment. The following hardware is provided for attaching the bushing to the SW350 and to the mast:

- Three (3) M6 x 8 Socket cap screws (with TUFLOK applied to the threads and rubber rings) are used to attach the bushing to the yaw shaft.

- Two (2) M6 x 6 or M6 x 12 hexagon socket button head screws (with TUFLOK applied to the threads) are used to attach the bushing to the mast. These screws extend into the groove of the yaw shaft, but will not touch it (see Fig. No. 7).

3. Bushing Quick Reference Guide

BUSHING QUICK GUIDE			
Type of Bushing	**Dampener Rings On/Off**	**Inner Hardware**	**Outer Hardware**
A Delrin® White Fig. No. 2	**ON**	(3) – Socket Cap Screw with rubber rings (M6 x 8)	(2) – Hexagon socket button head screw (M6 x 6 or M6 x 12)
EU Delrin® White Fig. No. 3	**ON**	(3) – Socket Cap Screw with rubber rings (M6 x 8)	(2) – Hexagon socket button head screw (M6 x 6 or M6 x 12)
EU Stainless Steel Fig. No. 4	**OFF**	(6) – M6 x 14	(4) – Pan head ¼" 20 screw (*or alternative*) with Tuflok
A Stainless Steel Fig. No. 5	**OFF**	(3) – M6 x 14	(4) – Pan head ¼" 20 screw (*or alternative*) with Tuflok
A Delrin® (Black) Fig. No. 6	**OFF**	(3) – Socket Cap Screw with rubber rings (M6 x 8)	(2) – Hexagon socket button head screw (M6 x 6 or M6 x 12)

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