

STANDARD PRACTICE FOR SHEAVE/PULLEY
BALANCING



MPTA STANDARD

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Abstract

This standard defines the balance tolerances to be used with all transmission sheaves/pulleys with or without grooves or teeth.

Foreword

This foreword is provided for informational purposes only and is not to be construed to be part of any technical specification.

When a body rotates, centrifugal forces act upon each particle in that body, tending to impel the particles away from the axis of rotation. If the mass of a rotating body is unevenly distributed about its axis of rotation, these centrifugal forces are unbalanced and there is a tendency for the entire body to rotate about its center of gravity. These unbalanced forces may cause vibration, noise, poor bearing life, and high fatiguing stresses. To minimize these forces, it is necessary to alter the mass distribution to make the center of mass concentric with the axis of rotation. That is known as balancing the product.

Suggestions for the improvement of, or comments on this publication are welcome. They should be mailed to: Mechanical Power Transmission Association, 6724 Lone Oak Blvd, Naples, FL 34109 on your company letterhead.

Table of Contents

SECTION	PAGE
1. Scope	4
2. Types of Balancing	4
2.1. One-Plane Balancing	
2.2. Two Plane or Dynamic Balancing	
3. Units of Unbalance	4
4. Static or One-Plane Balancing	4
5. Dynamic or Two-Plane Balancing	5
6. Table 1: MPTA BALANCING FORMULAE FOR STATIC (ONE-PLANE) BALANCING	6
7. Table 2: MPTA BALANCING FORMULAE FOR DYNAMIC (TWO-PLANE) BALANCING (Use when operating speed is unknown)	7
8. Table 3: MPTA BALANCING FORMULAE FOR DYNAMIC (TWO-PLANE) BALANCING (Use when operating speed is known)	8

1 Scope

1.1 This standard applies to sheaves/pulleys for rubber V-Belts covered under RMA/MPTA publications IP-20 (Classical), IP-21 (Double -V), IP-22 (Narrow), IP-23 (Light Duty), IP-24 (Synchronous Belts), IP-26 (V-Ribbed), and IP27 (Curvilinear Toothed Synchronous Belts).

2 Types of Balancing

2.1 One-Plane Balancing or Static Balancing: A one-plane balance is the recommended balance for all products.

2.2 Two Plane Balancing or Dynamic Balancing: A two-plane balance is recommended only in certain cases where the product face width is relatively large and the operational speed relatively fast, or where balance is considered very critical. A two-plane balance is an option which must be specified (see section 5.2).

3 Units of Unbalance

3.1 Unbalance may be measured in various ways and unbalance units may take several forms. This standard will list four:

	English Units	Metric Units
Mass at Rim O.D.	ounce	gram
Unbalance	ounce-inch	gram-millimeter
Eccentricity *	Inch	millimeter
Balance Quality (G)	inch/sec	millimeter/sec

* Eccentricity is the displacement from the center of mass to the center of rotation. This term should not be confused with vibration displacement measurements

4 Static or One-Plane Balancing (See Table 1)

4.1 The Balance Quality values are based on the allowable peripheral speed of cast iron (6,500 ft/min or 33m/sec).

4.2 Since it is impractical to attain a good balance level on sheaves/pulleys which are light in mass, the required lower limit of balance level is broken into two categories:

4.2.1 Standard or general purpose products (RMA/MPTA IP 20, 22 and 24) when the mass is under 11 pounds (5 kg).

4.2.2 Fractional Horsepower or Light Duty products such as RMA/MPTA Standard IP-23 (2L, 3L, 4L and 5L) are excepted when the mass is under 22 pounds (10 kg).

4.3 Refer to Table 1 for the balancing formulae.

5 Dynamic or Two-Plane Balancing

- 5.1 When considering dynamic balance, it is necessary to determine first when dynamic balancing is recommended and second the unbalance limits.
- 5.2 To determine whether dynamic balancing is recommended, perform the following calculation:

Formula # 1

$$\text{RPM} = \frac{15,500}{\sqrt{DF}}$$

Where: D is the Outside Diameter in inches
F is the Face Width in inches

OR

Formula # 2

$$\text{RPM} = \frac{25.4 \times 15,500}{\sqrt{DF}}$$

Where: D is the Outside Diameter in millimeters
F is the Face Width in millimeters

- 5.3 The resultant RPM is the maximum recommended operating RPM for a sheave or pulley with a single-plane balance. If the sheave or pulley is to be operated at a higher RPM, a two-plane balance is recommended.
- 5.4 When dynamic balancing is recommended, the formulae given in Table 2 or Table 3 should be applied.
- 5.4.1 When operating speed is not known, use Table 2.
- 5.4.2 When operating speed is known, refer to Section 5.6.
- 5.4.3 The Dynamic Balance Quality is based on a peripheral rim speed of 6,500 FPM or 33m/sec for cast iron and 10,000 FPM or 50.8 m/sec for ductile iron.

WARNING: When belt speeds exceed 6,500 feet per minute, special materials must be used. Consult your manufacturer for special design requirements.

- 5.5 Since it is impractical to maintain a constant Balance Quality of smaller products, cast iron products less than 57.6 pounds (26.2 kg) and ductile iron products less than 88.7 pounds (40.3 kg) are balanced to a lesser quality.

5.6 When products will knowingly be operated below their maximum speed limits, the formulae given in Table 3 may be used. These formulae will provide for a Balance Quality equal to those given in Table 2, but require less correction because of the lower operating speeds.

TABLE 1
MPTA BALANCING FORMULAE FOR STATIC (ONE-PLANE) BALANCING

English Units D = Product OD (inches) M = Product Mass (lb)	Light Duty Pulleys Under 22 lb	Standard Pulleys Under 11 lb	Light Duty 22 lb or More Standard Duty 11 lb or More
ounce @ rim	0.352	0.176	0.016 x M
ounce-inch	0.176 x D	0.088 x D	0.008 x M x D
e (inch)	$\frac{0.011 \times D}{M}$	$\frac{0.0055 \times D}{M}$	0.005 x D
G (inch/sec)	$\frac{28.6}{M}$	$\frac{14.3}{M}$	1.30
Metric Units D = Product OD (mm) M = Product Mass (kg)	Light Duty Pulleys Under 10 kg	Standard Pulleys Under 5 kg	Light Duty 10 kg or More Standard Duty 5 kg or More
g @ rim	10	5	M
g-mm	5.0 x D	2.5 x D	$\frac{(M \times D)}{2}$
e (mm)	$\frac{0.005 \times D}{M}$	$\frac{0.0025 \times D}{M}$	0.0005 x D
G (mm/sec)	$\frac{330}{M}$	$\frac{165}{M}$	33.0

TABLE 2**MPTA BALANCING FORMULAE FOR DYNAMIC (TWO-PLANE)
BALANCING WHEN OPERATING SPEED IS UNKNOWN**

English Units D = Product OD (inches) M = Product Mass (lb)	Cast Iron Products $V_{max} = 6,500$ FPM or 33 m/sec		Ductile Iron Products $V_{max} = 10,000$ FPM or 50.8 m/sec	
	All Products Less Than 57.6 lb	All Products 57.6 lb or More	All Products Less Than 88.7 lb	All Products 88.7 lb or More
ounce @ rim (1)	0.088	$0.0015 \times M$	0.088	$0.001 \times M$
ounce-inch (1)	$0.044 \times D$	$0.00075 \times D \times M$	$0.044 \times D$	$0.0005 \times D \times M$
e (inch) (2)	$\frac{0.0055 \times D}{M}$	$0.000095 \times D$	$\frac{0.0055 \times D}{M}$	$0.00062 \times D$
G (inch/sec) (2)	$\frac{14.3}{M}$	0.248	$\frac{22.0}{M}$	0.248
Metric Units D = Product OD (mm) M = Product Mass(kg)	All Products Less Than 26.2 kg	All Products 26.2 kg or More	All Products Less Than 40.3 kg	All Products 40.3 kg or More
g @ rim (1)	2.5	$0.095 \times M$	2.5	$0.062 \times M$
g-mm (1)	$1.25 \times D$	$0.0475 \times M \times D$	$1.25 \times D$	$0.031 \times M \times D$
e (mm) (2)	$\frac{0.0025 \times D}{M}$	$0.000095 \times D$	$\frac{0.0025 \times D}{M}$	$0.000062 \times D$
G (mm/sec) (2)	$\frac{165}{M}$	6.3	$\frac{254}{M}$	6.3

(1) Values given for each correction plane.

(2) Values for entire product

TABLE 3
MPTA BALANCING FORMULAE FOR DYNAMIC (TWO-PLANE)
BALANCING WHEN OPERATING SPEED IS KNOWN

English Units D = Product OD (inch) M = Product Mass (lb) (a) V = Rim Speed (FPM)	All Products Less Than 57.6 lb	All Products 57.6 lb or More
ounce @ rim (1)	0.088	$\frac{10 \times M}{V}$
ounce-inch (1)	$0.044 \times D$	$\frac{5 \times D \times M}{V}$
e (inch) (2)	$\frac{0.0055 \times D}{M}$	$\frac{0.62 \times D}{V}$
G (inch/sec) (2)	$\frac{0.0022 \times V}{M}$	0.248
Metric Units D = Product OD (mm) M = Product Mass (kg) (b) V = Rim Speed (m/sec)	All Products Less Than 26.2 kg	All Products 26.2 kg or More
g @ rim (1)	2.5	$\frac{3.15 \times M}{V}$
g-mm (1)	$1.25 \times D$	$\frac{1.575 \times D \times M}{V}$
e (mm) (2)	$\frac{0.0025 \times D}{M}$	$\frac{0.00315 \times D}{V}$
G (mm/sec) (2)	$\frac{5 \times V}{M}$	6.3

(a) Speed (FPM) = $0.262 \times D \times \text{RPM}$

(b) Speed (m/sec) = $0.000052 \times D \times \text{RPM}$

(1) Values given for each correction plane.

(2) Values given for entire product.

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