WOODWARD

Manual 82510
(Revision R)
Original Instructions

Magnetic Pickups and Proximity Switches for Electronic Controls

Reference Manual

IMPORTANT

DEFINITIONS

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

WARNING

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment. Practice all plant and safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage.

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, be sure to check the *publications page* on the Woodward website:
www.woodward.com/searchpublications.aspx
The current revision and distribution restriction of all publications are shown in manual *26311*.

The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

NOTICE

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Magnetic Pickups and Proximity Switches for Electronic Controls

⚠WARNING

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

Magnetic Speed Pickup

The magnetic speed pickup (MPU) is used to detect the speed of the prime mover. It is necessary when the prime mover drives something other than an alternator, and is often used where an alternator is driven directly by the prime mover and when a control signal is necessary before the alternator comes up to its proper output voltage. A speed sensor circuit, either a section on the governor amplifier chassis or a separate unit, is needed to convert the MPU's output signal to one usable by the governor amplifier.

The magnetic pickup produces a voltage output when any magnetic material moves through the magnetic field at the end of the pickup. Since most engines and turbines have flywheels or other large gears made of magnetic material (usually iron or steel), magnetic pickups can usually be installed without adding attachments to a gear or shaft. Nonmagnetic materials, such as aluminum, brass, and some stainless steels, will not excite the magnetic pickup.

The MPU makes use of a "stray magnetic field" and no provision for return magnetic circuits or paths is necessary. Any device which produces a dynamic discontinuity of magnetic material in the field of the pickup will produce an electrical voltage. Although gears are the normal devices measured by an MPU, other devices such as a vibrating surface, moving bar, crank, wheel spokes, or a steel screw head mounted on some moving surface will work equally well if surface speed and other factors are taken into account. The MPU may be excited by a keyway or slot in a wheel, but there is likely to be an unwanted background signal due to varying density or eccentricity of the material. It is better to excite the MPU from a protrusion on the surface. This places the pickup at a relatively great distance from the materials between excitation periods and it is less likely to pick up stray signals.

The output voltage of a magnetic pickup is affected by three factors.

- Voltage increases with increases of the surface speed of the monitored magnetic material.
- Voltage decreases as the air gap between the magnetic pickup and the surface of the gear tooth is increased.
- Voltage waveform is determined by the size and shape of the gear tooth in relation to the size and shape of the pole piece.

With any given speed and clearance conditions, a maximum power output will result when the field is filled with a relatively infinite mass of magnetic material at one instant and a complete absence of such material the next. A reasonable approach to these conditions exists when the cross-section of the exciting masses is equal to or greater than that of the pole piece, and the space between is equal to or greater than three times the diameter of the pole piece (see Figure 1).

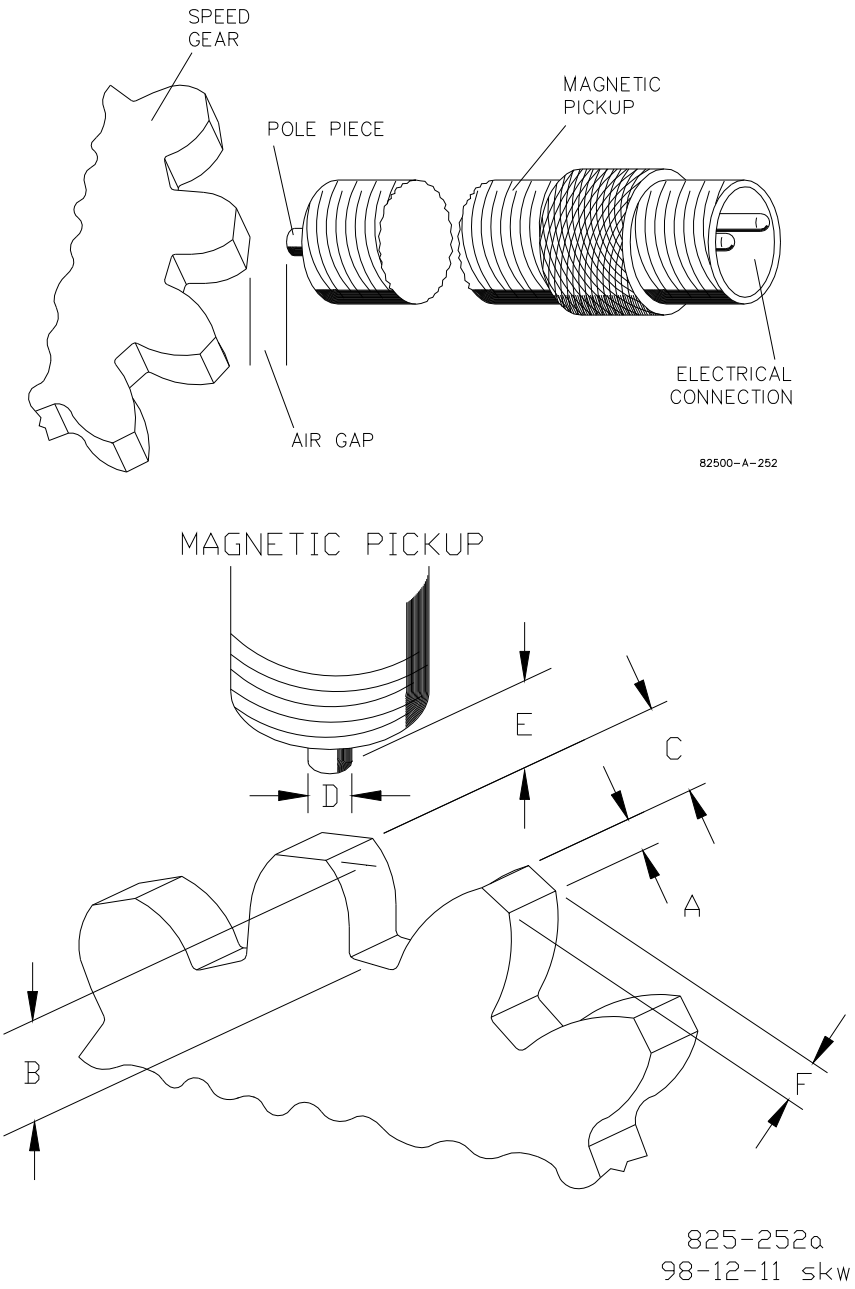

Figure 1. Magnetic Pickup Dimensions

In Figure 1, the optimum dimensions of A, B, C, and F are given as they relate to D, the diameter of the pole piece of the magnetic pickup. The optimum relationship for maximum output is as follows:

A equal to or greater than D
B equal to or greater than C
C equal to or greater than three times D
F equal to or greater than D

As the magnetic pickup-gear relationship begins to deviate from the specifications listed above, the MPU output waveform may deteriorate to an unacceptable shape. Because the speed sensor detects zero-crossings, the waveform should cross zero only twice for each tooth (once going positive and once going negative, see Figure 2).

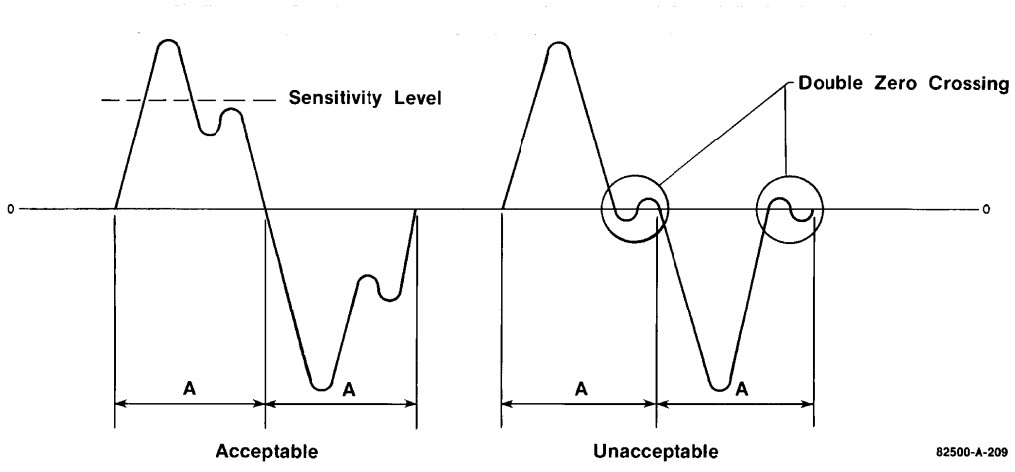

Figure 2. Magnetic Pickup Output Waveforms

MPU Installation

The magnetic pickup is available in short or long standard models, a standard metric model, hazardous duty models, and explosion-proof models, including CSA/ATEX approved models (see Figure 3 for dimensions and part numbers).

Mount the magnetic pickup radially to the outside diameter of the desired gear, either through a housing or on a rigid bracket. Make sure the gear is of magnetic material. The gap between the pickup and the outside diameter of the gear should be set normally between 0.25 mm and 1.02 mm (0.010” and 0.040") at the closest point [make sure the gear has less than 0.51 mm (0.020") diametric runout]. Since the signal strength is inversely proportional to gap distance, a weak signal may be generated with more than 1.02 mm (0.040") gap. A shield of non-magnetic material may be installed between the gear and the pickup if necessary for physical shielding. Since this material spaces the pickup face farther from the gear, and since an electromagnetic force may be generated by eddy currents in the shielding material, make sure the signal level is still high enough to operate the speed signal circuit.

Most electronic controls require a minimum output of 1.5 Vac (rms) from the magnetic speed pickup at the lowest controlling speed. Figures 4 and 5 show the maximum air gap allowed for each surface speed and diametral pitch or gear module to produce this minimum required voltage.

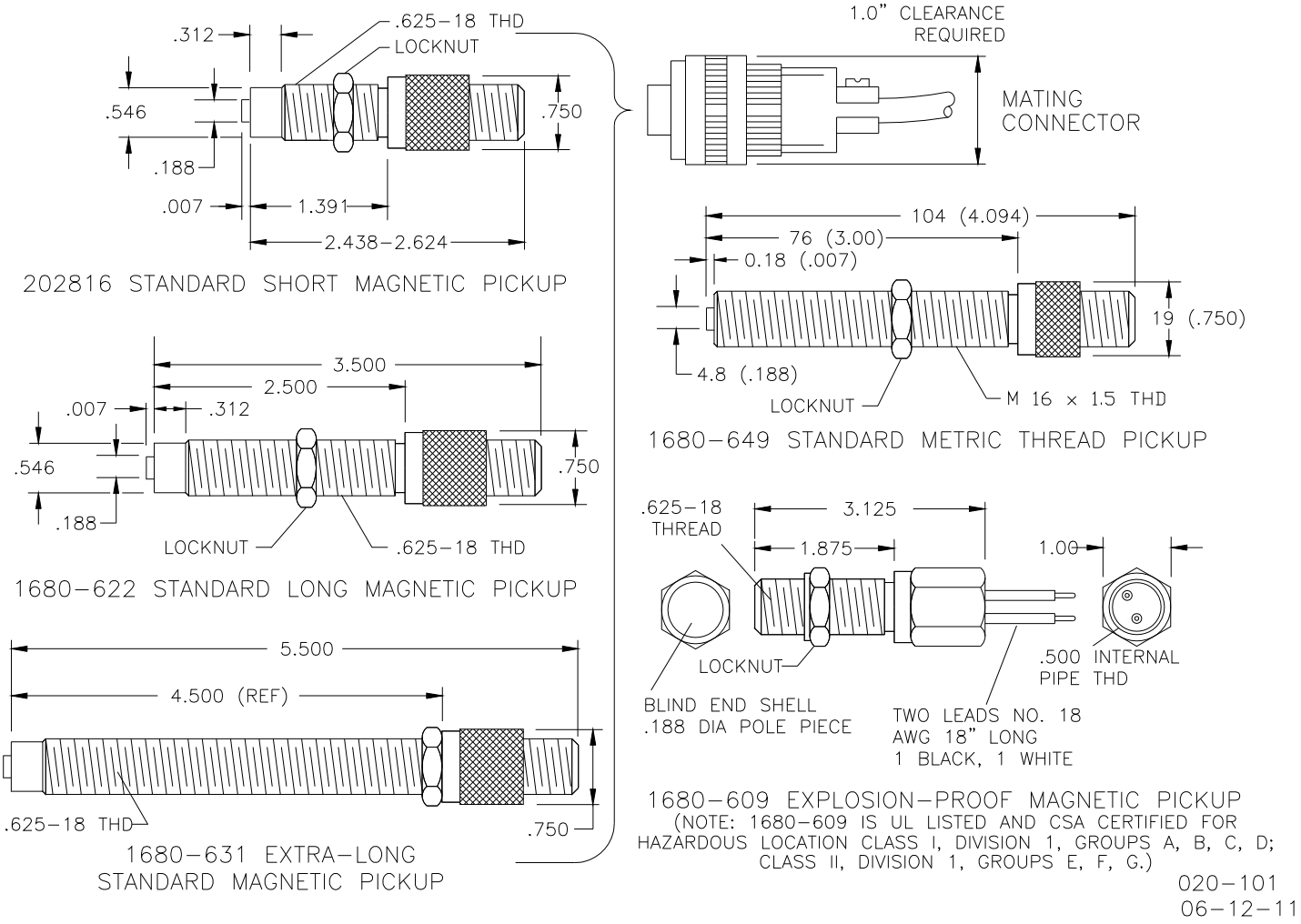

Figure 3a. MPU Models

The surface speed in meters per second (m/s) or inches per second (IPS) is related to revolutions per minute (rpm) by the following:

$$\text{Surface Speed} = \frac{\text{rpm} \times \pi \times \text{gear diameter}}{60}$$

The diametral pitch for the gear is obtained by the formula:

$$\text{Diametral Pitch} = \frac{\text{number of teeth} + 2}{\text{gear diameter (inches)}}$$

The gear module is obtained by the formula:

$$\text{Gear Module} = \frac{\text{gear diameter (mm)}}{\text{number of teeth} + 2}$$

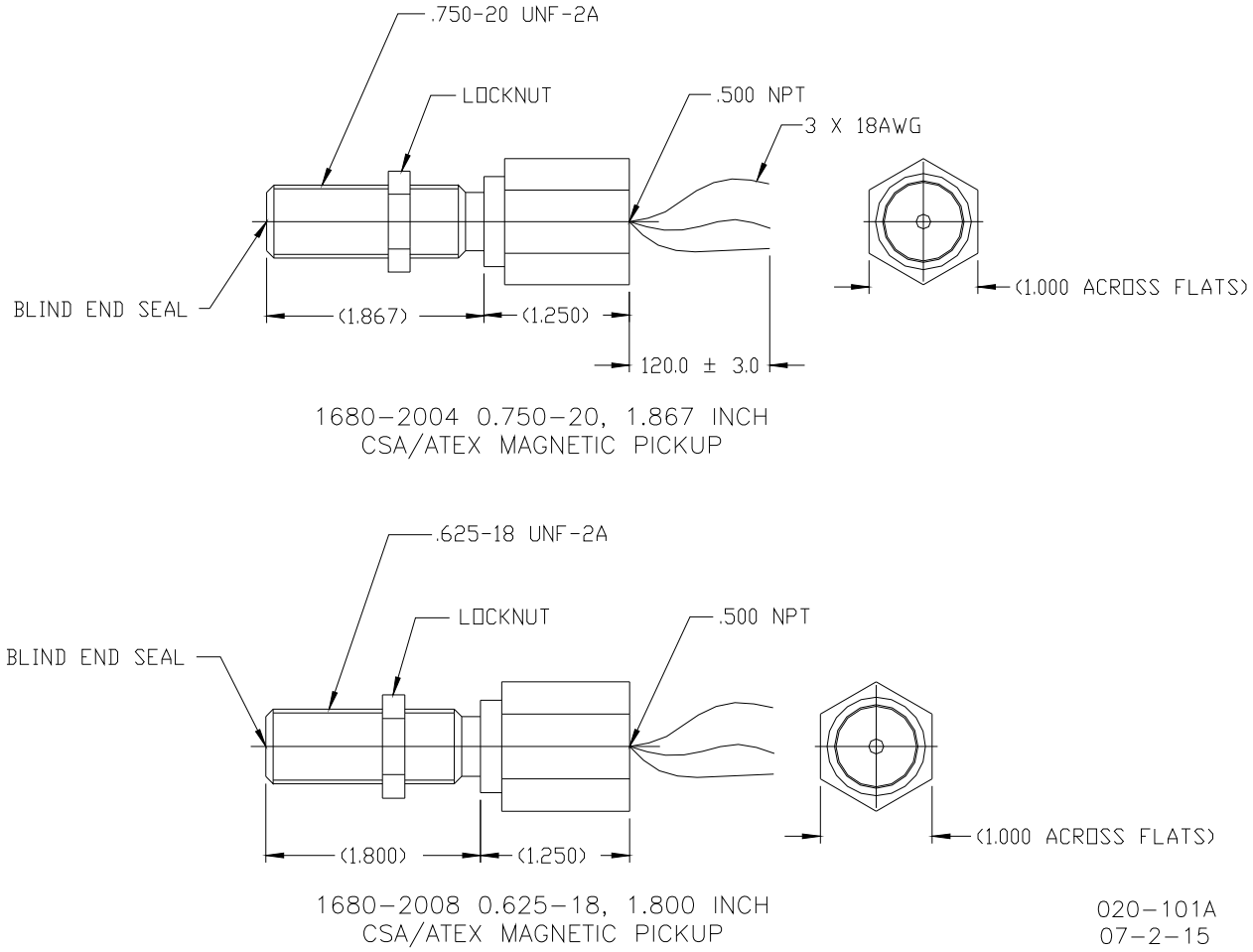

Figure 3b. CSA/ATEX Models

The standard magnetic pickup may be used with a gear with a diametral pitch coarser than 8 (gear module 3.2), but the output will not be increased. Gears with a finer diametral pitch than 8 (gear module 3.2) may be used with a corresponding decrease in output voltage. A diametral pitch of 20 (gear module 1.27) is the finest that may be used with this pickup without two teeth appearing over the pole piece at the same time. When adjusting the clearance between the pickup pole piece and the gear, adjust the pickup so the output voltage is a minimum of 1.5 Vac (rms) at the lowest speed.

If you cannot measure the gap directly, it can be determined in the following manner.

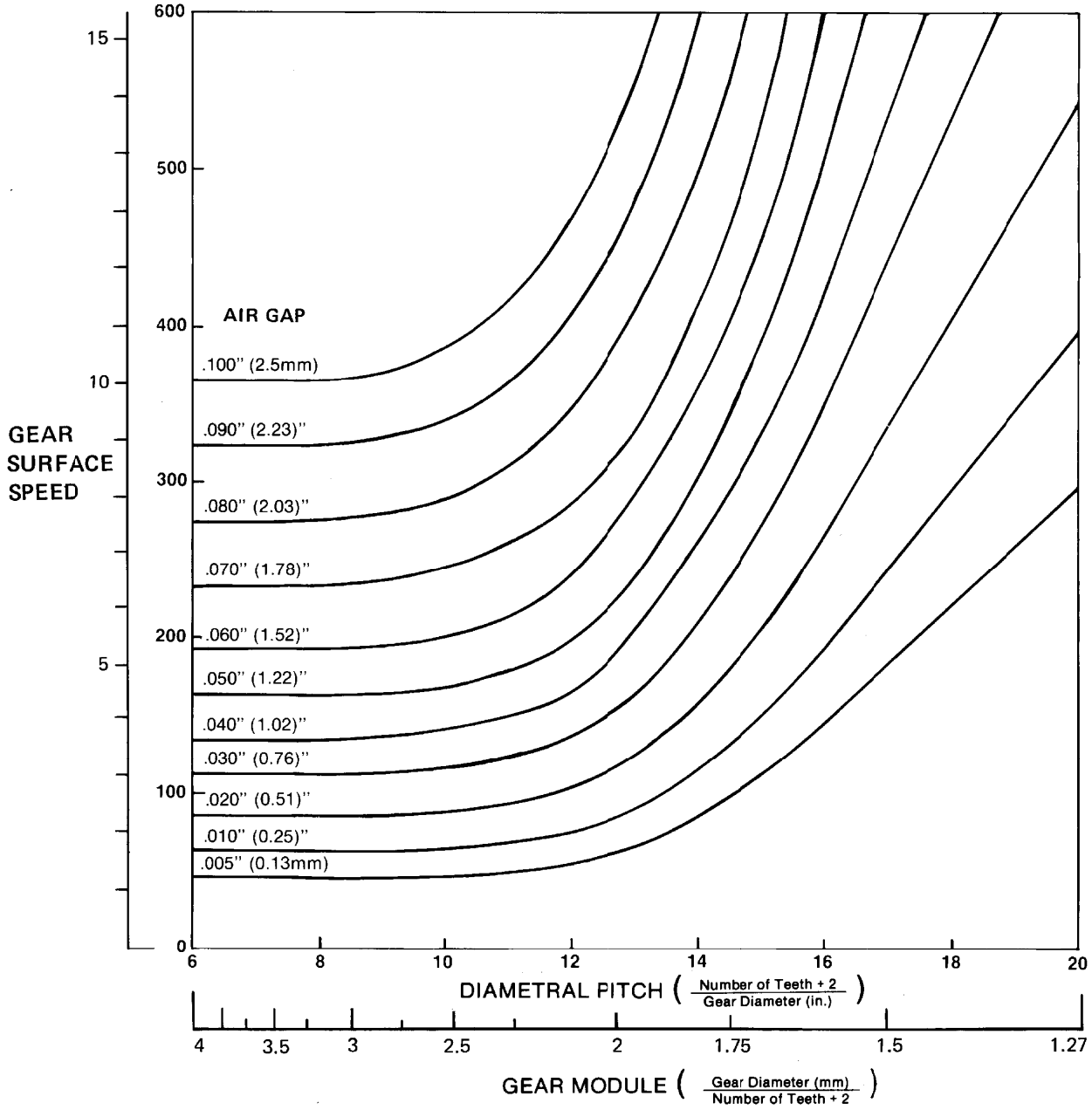

Figure 4. Maximum Air Gap Allowed to Provide Usable Signals for Most Electronic Controls

With the prime mover shut down, turn the pickup in until it just touches the outside diameter of the gear. If the pickup has a 5/8-18 thread, one 360° turn counterclockwise will move the pickup out 0.0555 inch (1.41 mm). The metric pickup will move 1.5 mm per turn. If the pickup has a 3/4-20 mounting thread, the pickup will move out 0.050 inch (1.27 mm) per turn. Screw out the amount required for the desired gap. If possible, run the gear slowly through 360° rotation to check the clearance of the pickup. When the gap is set, tighten the jam nut securely against the housing or bracket so the pickup cannot turn in or out.

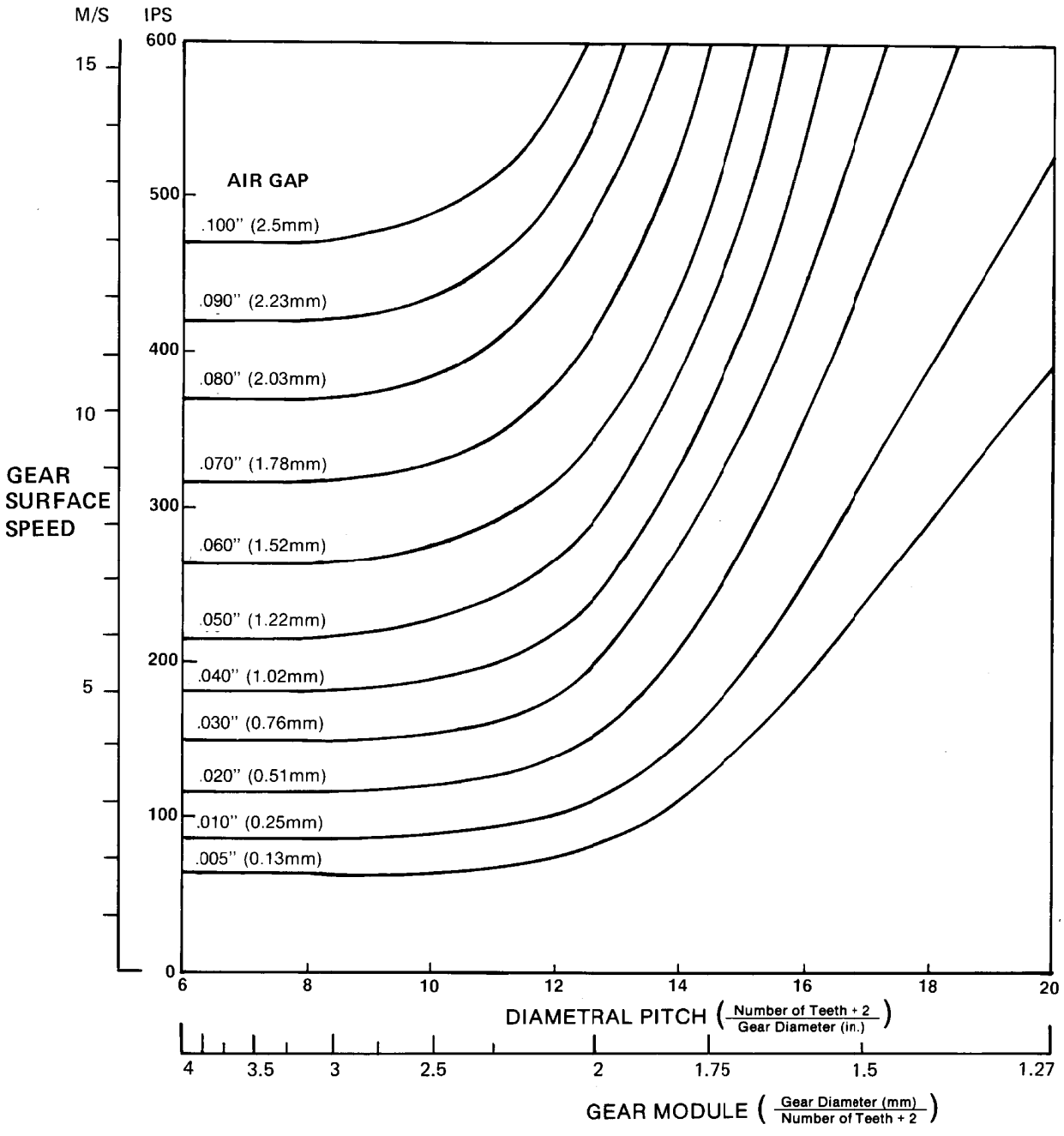

Figure 5. Maximum Air Gap Allowed to Provide 1.5 Vac (rms) on EGM Control

The standard models of pickups, including the metric model, require mating connector number MS-3106A-10SL-4S. These connectors are not furnished with the pickups, but may be ordered if desired. The hazardous duty and explosion-proof models have leads attached to the pickups, and the heads have 1/2" female pipe threads for installing conduit or pipe.

Troubleshooting Magnetic Pickups

Disconnect the pickup leads. Check between leads with an ohmmeter for resistance as listed below. Check between the pickup case and leads with an ohmmeter for near infinity resistance. Start the prime mover and control speed manually or block the throttle. Check pickup leads with a high-impedance ac voltmeter for 10 to 20 Vac (rms). Reconnect the pickup and check at the speed sensor input terminals for a minimum 1.5 Vac (rms) at the lowest controlling speed. Check the pickup and gear clearance if voltage is low.

MPU Resistance List

Long Standard Model	250 Ω max
Extra Long Standard Model	250 Ω max
Short Standard Model	220 Ω max
Standard Metric Model	250 Ω max
Conduit Model	114 to 140 Ω
Explosion Proof Model	165 to 225 Ω

Inspect for physical damage. Replace pickup if faulty.

Proximity Switches

Large engines usually have a larger air gap between the speed sensor probe and the monitored gear than smaller engines. This is necessary because of the relatively large runout of the monitored gear in a large engine. The monitored gears on large engines usually also have a slower surface speed. Because of either, or both, of these conditions, a magnetic pickup may not perform satisfactorily on a large engine. A proximity switch (zero velocity pickup) will, however, operate well on large engines because of its abilities to operate with a large air gap and at low surface speeds.

The output of these pickups depends solely on the position of the gear tooth (or similar ferrous discontinuity) and not the velocity at which the gear tooth passes the sensing end of the pickup.

When wired as a “sinking” type proximity switch, the output is normally zero. When a gear tooth is within the sensing range of the proximity switch, the output of the switch goes “high” (nearly equal to the supply voltage). After the tooth has passed, the output switches back to zero volts until another tooth comes into position. Typical wiring for a “sinking” type proximity switch is shown in Figure 7.

When wired as a “source” type proximity switch, the output is normally “high” (nearly equal to the supply voltage). When a gear tooth is within the sensing range of this proximity switch, the switch output goes to zero volts. After the tooth has passed, the output switches back to nearly the supply voltage until another tooth comes into position. Typical wiring for a “source” type proximity switch is shown in Figure 8.

The on-off nature of the output of a proximity switch produces a square wave which is compatible with nearly all Woodward speed sensors and will directly replace the signal from a magnetic pickup as a speed sensor input.

Proximity Switch Features

As long as the air gap between the sensor end of the proximity switch and the gear being monitored does not exceed the sensing range of a particular proximity switch, changing the air gap will not change the output voltage. The duty cycle of the signal from the proximity switch varies with the air gap, but this does not change the reference signals produced in the Woodward control.

For proper operation there cannot be more than one tooth in the sensing field of a proximity switch. (The distance between the teeth must be greater than the size of the sensing field.)

Types of Proximity Switches

Two different sizes of proximity switch are available from Woodward:

1. A proximity switch with a fairly narrow sensing field, suitable for medium size gears with a tooth size from diametral pitch 8 to 12 (gear module 3 to 2). This switch can be mounted flush with the mounting plate with an air gap up to 5.00 mm (0.197 inch).

2. A proximity switch with a wide sensing field is available for large gears where a wide air gap (maximum of 10 mm/0.4 inch) is necessary. This sensor requires larger gear sizes for proper operation and should be used for gears larger than diametral pitch 12 (gear module 2.1). There must be a 30 mm (1.1 inch) radius clearance of metal around the front of the sensor and mounting bracket.

NOTICE

Some Woodward controls have less than 300 Ω of dc impedance. In these cases the probe may be damaged by excess current when the engine is stopped. To prevent this possible damage, a 300 Ω, 2 W resistor should be installed in series with the probe.

Proximity Switch Power Supply

Proximity switches provided by Woodward require an external power supply of a single dc voltage, usually 24 volts. This may be from the same supply source as power for the control system. The maximum current rating for these proximity switches is 80 mA, but actual current is less and dependent on the external load.

NOTICE

The red plastic cap on top of the proximity switch is an integral part of the device, not a loose shipping cover. The proximity switch can be damaged beyond repair if an attempt is made to remove the cap.

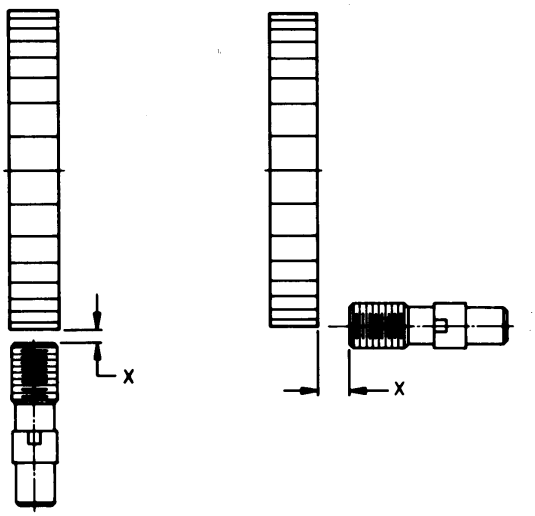

Figure 6. Air Gaps for Radial and Axial Sensing Proximity Switches

Checking Proximity Switch Operation

To check the operation of a proximity switch, a load resistance must be placed across the terminals from which the speed control speed sensor was removed. An oscilloscope may provide adequate load resistance.

Proximity Switch Wiring

The proximity switches supplied by Woodward are wired for a “sinking” type output. Figure 7 shows a typical wiring method. Other proximity switches, not supplied by Woodward, are wired dc “source”. Figure 8 shows a typical dc source wiring method. AC proximity switches are seldom used with Woodward controls.

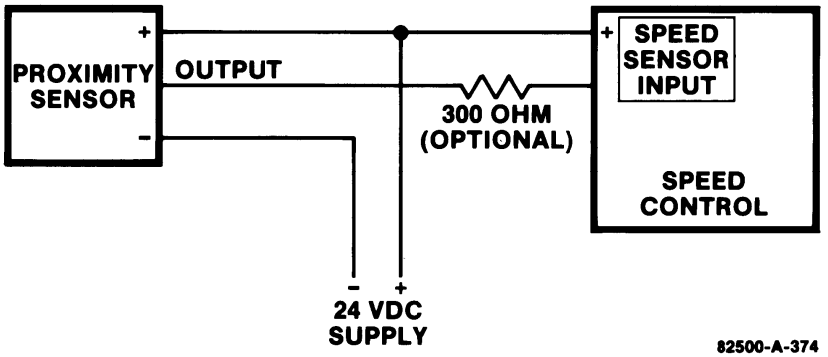

Figure 7. Suggested Wiring for a “Sinking” Type Proximity Switch

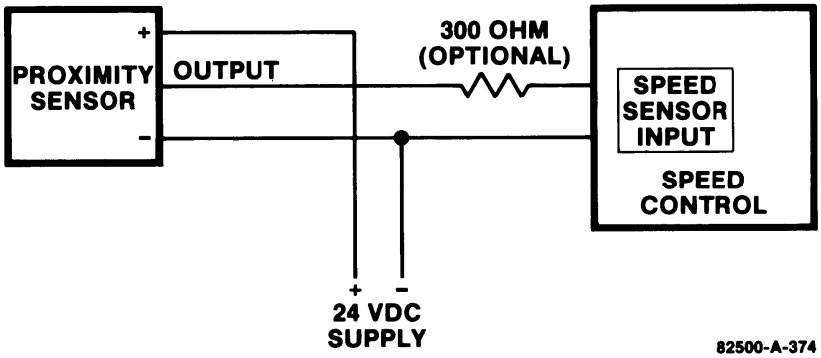

Figure 8. Suggested Wiring for a “Source” Type Proximity Switch

Using the Output of a Woodward MPU to Drive a Remote Tachometer or Other Device

Attach to Control Posts

Should a remote device be driven by a magnetic pickup, it is important that the connection be made on the governor posts which accept the input from the MPU. Polarity must be maintained as indicated on these posts or it is possible to short the system to ground and cause damage to the electronic circuits and render the governor inoperable. Woodward electronic controls are not directly grounded, but in many cases the negative (–) post or common is tied to ground through the battery powered supply. Should an additional device also be grounded or powered by the same grounded battery system, a short circuit is possible.

The MPU device provided by Woodward is not grounded, and polarity is not established until connections are made to the governor. Almost all remote devices will have a power source in addition to two leads for input. One of these input connections will be circuit common (–) and this should be determined prior to connection with the governor.

EPG and 2500 Governors

Since these units are indirectly tied to ground, care must be taken that polarity of the remote device and of the governor is not reversed.

2301 Governor

The 2301 governor is isolated from ground, and care should be taken that any device added to the system is also isolated from earth ground.

Shielding

Governor circuits have been carefully shielded, and circuits to remote devices must also be shielded from interference, since this could prevent adequate governor control. Inadequate shielding could cause unstable control.

Minimum Signal

Most Woodward controls require a minimum speed-signal strength of 1.5 Vac from the magnetic pickup during cranking. The addition of remote devices to the output of the magnetic pickup could prevent the reception of an adequate signal to allow engine start-up.

⚠WARNING

Make sure all polarity has been established and the system is not shorted to ground before trying to start the engine after adding an auxiliary device to the MPU output. Attempting to start the system with reversed polarity between the auxiliary device and the control could destroy either or both devices. Should the control be damaged due to the reversed polarity, dangerous overspeed is possible, damaging equipment, causing personal injury or even death.

IMPORTANT

Woodward advises dedicating the entire output of a governor magnetic pickup to the exclusive use of driving the control system.

This information is provided for those installations where the output of the magnetic pickup is also used to drive other devices.

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 82510R.

B82510:R

PO Box 1519, Fort Collins CO 80522-1519, USA
1000 East Drake Road, Fort Collins CO 80525, USA
Phone +1 (970) 482-5811 • Fax +1 (970) 498-3058

Email and Website—www.woodward.com

**Woodward has company-owned plants, subsidiaries, and branches,
as well as authorized distributors and other authorized service and sales facilities throughout the world.**

Complete address / phone / fax / email information for all locations is available on our website.

2011/12/Colorado