Bulletin No. MP-H
Drawing No. LP0020
Revised 8/00

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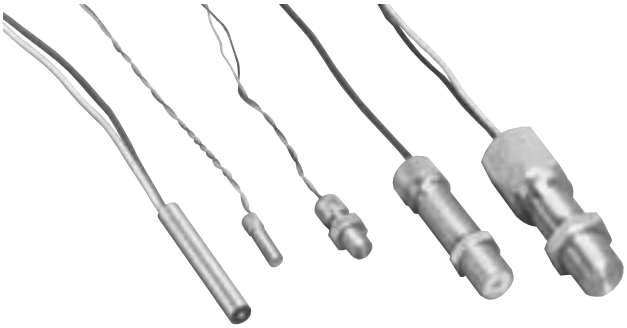
MAGNETIC PICKUPS & IN-LINE PREAMPLIFIER

SIMPLE, RELIABLE & ECONOMICAL PULSE GENERATORS FOR:



SPEED SWITCHES
DIGITAL TACHOMETERS
FREQUENCY TO D.C. CONVERTERS

FEATURES INCLUDE

- *SELF-GENERATING, NO EXT. POWER NEEDED*
- *WIDE OPERATING TEMPERATURE RANGE*
- *EPOXY ENCAPSULATED, MECHANICALLY RUGGED*
- *IMPERVIOUS TO DIRT, OIL & WATER*
- *NO MAINTENANCE REQUIRED*
- *LOW COST*

DESCRIPTION OF OPERATION

A Magnetic Pickup consists of a permanent magnet, a pole-piece, and a sensing coil all encapsulated in a cylindrical case. An object *(target)* of iron, steel, or other magnetic material, passing closely by its pole-piece causes distortion of the magnetic flux field passing through the sensing coil and pole-piece, which in turn generates a signal voltage. The magnitude of the signal voltage depends on the relative size of the magnetic target, its speed of approach, and how close it approaches. The polarity of the signal depends on whether the target is moving toward or away from the pole-piece.

Magnetic Pickups are most frequently used to sense passing teeth on a gear, sprocket, or timing belt wheel, to bolt-heads, key-ways, or other moving machine mounted targets. Typical targets and resulting signal wave forms are shown below in Fig. 1.

SELECTING A MAGNETIC PICKUP

Selecting a magnetic pickup is a matter of matching a pickup to a gear *(or other target)*, to provide enough input signal to a tachometer, speed-switch, or other device for operation at the required minimum speed. The open-circuit output from a magnetic pickup is directly proportional to speed, and once the minimum operating speed conditions have been met, excess signal will always be available at higher speeds.

The *"1-Volt Threshold Speed"* column in the Application and Ordering Table *(next pg.)* provides a convenient guide for estimating minimum operating speeds. This value is the linear surface-speed of a reference gear required to generate a 1-Volt peak, open-circuit output at an air-gap of 0.005". The reference gear listed for each pickup is near the optimum size for that pickup, as defined by the criteria in Fig. 1B. The RPM listed is for a reference gear with 60 teeth running at that surface-speed. Gears with larger teeth will provide about the same or somewhat more output at the same surface-speed, while gears with smaller teeth will yield lower outputs. The *"Minimum Gear Size"* column lists the Diametral Pitch size at which the output drops to 40-60% of the output when the reference gear is used. Gears with very small teeth in relation to the pole-piece diameter, deliver greatly reduced outputs, as shown in Fig. 1A. Threshold outputs when using targets other than gear teeth can be estimated by their relative size with respect to the reference gear teeth. For more information on gears, definitions and relationships, see Sensing Gears.

The 1-Volt Threshold Speeds are based on a 0.005" air-gap. In applications where this air-gap cannot be maintained or where the air-gap can vary due to eccentricity of the sensing gear, a correction factor can be applied from the curve in Fig 2. The effect of electrical loading is usually minimal at low speeds and low output frequencies, however, output voltage drop due to loading at high frequency or with low impedance inputs can be estimated based on the Output Impedance data.

Note: Magnetic Pickups are used primarily for tachometer and other speed related functions. They are not normally used for counting since loss of counts will occur at low speeds. Therefore, counters are not designed to accept outputs directly from conventional magnetic pickups. In special applications where counting occurs only at running speed or where low-speed count loss is acceptable, a Model LMPC or ASTC can be used.

TYPICAL APPLICATION EXAMPLE

A Digital Tachometer, with an input sensitivity of 0.25 V is to be used with a Magnetic Pickup and gear to indicate speed down to 75 RPM. What are the alternative choices?

Since the input voltage required by the tachometer is only 0.25 V, the surface speeds and reference gear RPM's required would only be 2 of the 1-Volt Threshold Speeds listed. The MP-25TA with a 60-tooth, 24 D.P. reference gear would obviously fall short since this combination will not develop 0.25 V until the reference gear speed reaches 250 RPM.

The MP-37CA with the 60-tooth, 20 C.P. reference gear would both prove suitable since they would deliver the required 0.25 V at 50 and 45 RPM respectively. They would also provide some additional margin for air-gap variation. The curve of Fig. 2 shows a typical output drop of about 25% when the air-gap is increased from 0.005" to 0.0075". Since the minimum operating speed in this application is 75 RPM, the additional sensitivity can be traded for a wider air-gap allowance.

The MP-62TA and MP-75TX with their respective reference gears would allow operation at even lower speeds. With both of these pickups it would be possible to drop to a smaller gear pitch for this application.

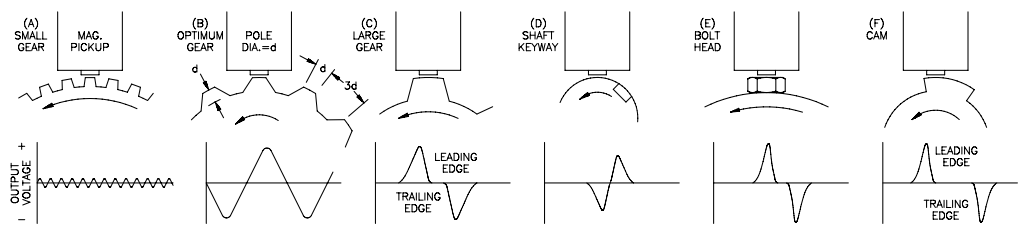


FIG. 1 OUTPUT WAVEFORMS WITH VARIOUS TARGET SHAPES & SIZES

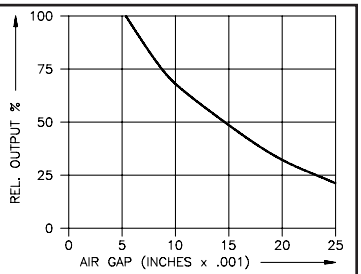
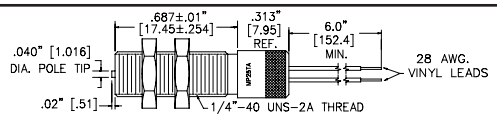
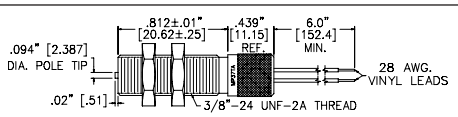
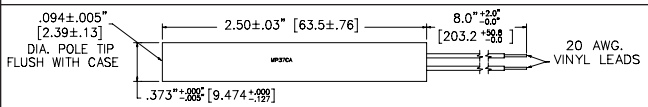
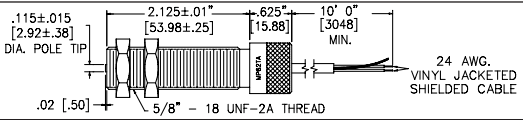
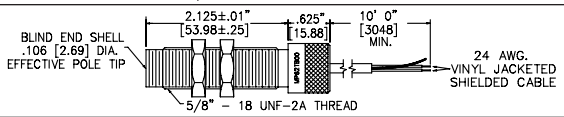
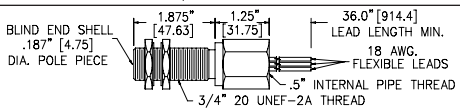


FIG. 2 TYPICAL OUTPUT/AIR-GAP

MAGNETIC PICKUP APPLICATION & ORDERING INFORMATION

MODEL NO.	DIMENSIONS	1-VOLT THRESHOLD SPEED (1)	MINIMUM GEAR PITCH (2)	TEMP. RANGE °C	OUTPUT IMPENDANCE	PART NO.
MP-25TA		135 in/sec 1000 RPM 60T 24 D.P. Ref. Gear	48 D.P.	-40 to +107	130 Ω ±20% 15 mH	MP25TA00
MP-37TA		33 in/sec 200 RPM 60T 20 D.P. Ref. Gear	32 D.P.	-40 to +107	340 Ω ±20% 44 mH	MP37TA00
MP-37CA		30 in/sec 180 RPM 60T 20 D.P. Ref. Gear	32 D.P.	-40 to +107	300 Ω ±30% 65 mH	MP37CA00
MP-62TA		10 in/sec 50 RPM 60T 16 D.P. Ref. Gear	24 D.P.	-40 to +107	1200 Ω ±20% 400 mH	MP62TA00
MP-62TB		20 in/sec 100 RPM 60T 16 D.P. Ref. Gear	24 D.P.	-40 to +107	1200 Ω ±20% 400 mH	MP62TB00
MP-75TX Explosion Proof (3)		30 in/sec 100 RPM 60T 10 D.P. Ref. Gear	12 D.P.	-73 to +93	230 Ω ±20% 100 mH	MP75TX00

NOTES:

1) Surface speed of listed reference gear to produce 0.8 volt peak min., open-circuit output @ 0.005" air-gap.
2) Gear pitch where output will drop to 40-60% of that generated by the reference gear size, at the same surface speed.
3) UL Listed CSA Certified, Class I Group A, B, C and D; Class II Group E, F and G. (VDO Control Systems, Inc.) PN#AIRPAX/70085-1010-005, UL File #E40545 (N), CSA File #042648.
4) Polarity, all pickups: white output lead goes positive with respect to black when target approaches pole.
5) 2-Wire shielded cable is recommended for all magnetic pickup outputs. Connect the shield to the *"COMMOM"* or *"GROUND"* terminal of the instrument being used and leave the shield un-connected at the pickup. Magnetic Pickup signal leads should never be run in conduit, troughs, or bundles with other power or control voltage lines.
6) Lead length of magnetic pickup should not be extended. An in-line pre-amplifier (ASTC) can be placed on the end of the provided length which would allow longer length after the in-line pre-amplifier.

MODEL ASTC IN-LINE PREAMPLIFIER & PULSE SHAPER FOR MAGNETIC PICKUPS

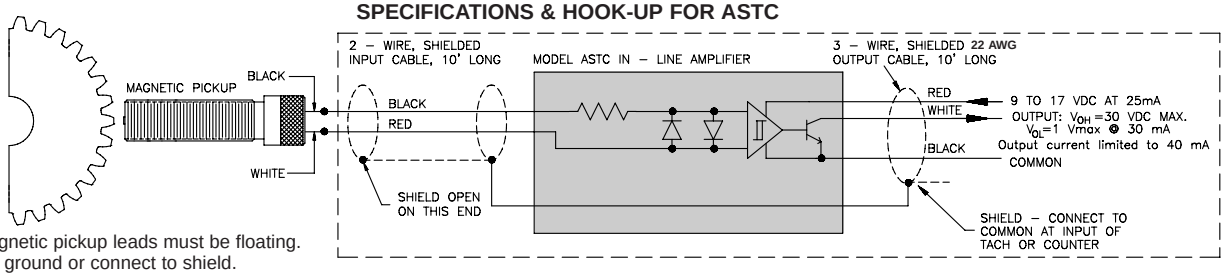
- *CURRENT SINKING OUTPUT*
- *PROVIDES ULTRA-LOW THRESHOLD SPEEDS*
- *ALLOWS LARGER AIR-GAPS*
- *PROVIDES HIGH NOISE IMMUNITY*

The ASTC boosts magnetic pickup signals by a factor of more than 100, and provides and NPN Open-Collector pulse output which is compatible with practically all Red Lion Controls' Tachometers, Motion Monitors and Counters. Low speed input sensitivity is 20 millivolts which permits operation at 1/50th of the 1-Volt Threshold Speeds listed in the Magnetic Pickup Specifications and Ordering Table. The ASTC can be used at pulse rates to 10 KHZ. The NPN O.C. output is current limited to 40 mA. The unit is epoxy-encapsulated in a 3/4" Dia. stainless steel shell, with overall dimensions of 0.9" D X 4.5" L including Neoprene strain-reliefs on each end. In installations where long signal runs are to be made it is advisable to keep the ASTC close to the pickup and let its output cable make the long run. Input and output cables should not be run in conduit, cable troughs, or bundles with power or control voltage lines. Operating temperature is -18° to +60° C.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
ASTC	In-Line Amplifier	ASTC0000

SPECIFICATIONS & HOOK-UP FOR ASTC



Note: Both magnetic pickup leads must be floating. Do NOT ground or connect to shield.

Bulletin No. GRS-G
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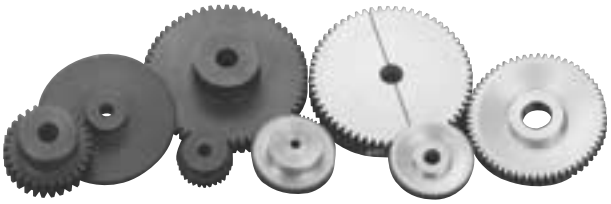
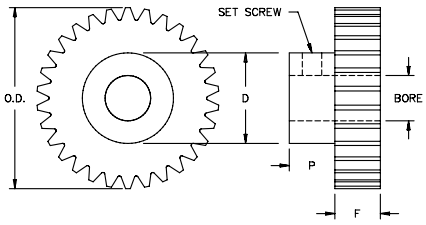
MACHINED STEEL SENSING GEARS FOR EXCITING SENSORS



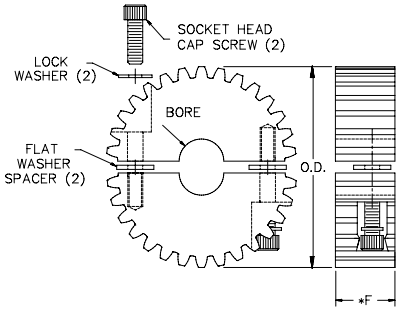
Sensing Gears are available in a variety of sizes to cover most applications where a sensor is to be used, but a suitable existing machine gear is not available. Split-type gears are convenient for use on machine drive shafts where a shaft-end is not available to mount a standard gear. Hubless gears are ideal for mounting in tight locations or when only a short shaft stub is available. Hub-type, Split, and Hubless gears can be supplied with special bores (See notes below Ordering Information & Dimensions table).

*Caution: RLC's machined steel sensing gears are **NOT** to be used as driving or driven gears in a power transmission system.*

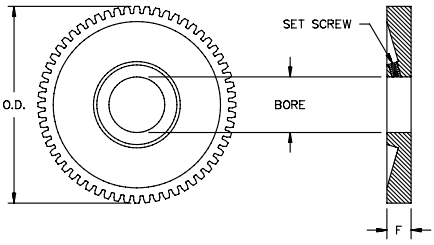
HUB TYPE GEARS



SPLIT GEARS



HUBLESS GEARS



ORDERING INFORMATION & DIMENSIONS

TYPE	NO. OF TEETH & DIAMETRAL PITCH	STOCK BORE +0.003" -0.000"	MAX. SPL. BORE +0.003" -0.000"	O.D. ±0.003"	HUB		FACE "F" ±0.010"	RECOMMENDED TORQUE FOR SET & CAP SCREWS	RECOMMENDED MAXIMUM GEAR SPEEDS	PART NUMBER
					DIA "D" ±0.010"	PROJ "P" ±0.020"				
HUB TYPE	30 T. 16 D.P.	0.500"	1.375"	2.000"	1.625"	0.500"	0.500"	25 in. lbs.	5000 RPM	0950500
	30 T. 10 D.P.	0.750"	1.875"	3.200"	2.125"	0.875"	1.000"	55 in. lbs.	5000 RPM	0900750
	60 T. 20 D.P.	0.375"	1.750"	3.100"	2.000"	0.500"	0.375"	25 in. lbs.	5000 RPM	0970375
	60 T. 10 D.P.	0.875"	2.250"	6.200"	2.500"	0.875"	1.000"	55 in. lbs.	5000 RPM	0910875
	120 T. 24 D.P.	0.500"	1.250"	5.090"	1.500"	0.500"	0.250"	25 in. lbs.	5000 RPM	0980500
SPLIT GEAR	30 T. 10 D.P.	0.750"	1.875"	3.200"			*1.000"	182 in. lbs.	3000 RPM	0920750
	60 T. 10 D.P.	0.875"	4.250"	6.200"			*1.000"	182 in. lbs.	1500 RPM	0930875
HUBLESS	60 T. 20 D.P.	0.625"	0.870"	3.100"			0.375"	25 in. lbs.	5000 RPM	0960625
	60 T. 20 D.P.	0.875"	0.875"	3.100"			0.375"	25 in. lbs.	5000 RPM	0960875
	60 T. 12 D.P.	1.125"	1.370"	5.160"			0.656"	40 in. lbs.	5000 RPM	0941125
	60 T. 12 D.P.	1.375"	1.620"	5.160"			0.656"	40 in. lbs.	5000 RPM	0941375
	60 T. 12 D.P.	1.625"	1.625"	5.160"			0.656"	40 in. lbs.	5000 RPM	0941625

* A portion of the teeth near the cap screws are milled away. However, at least ¼" of the teeth face width is available, allowing sensing of all teeth.

SPECIAL BORES: Hub-Type, Split, and Hubless gears can be supplied with special bore sizes between the Stock Bore and Max. Special Bore sizes listed above. To order Special Bores, substitute 9999 for the last 4 digits of the part number and specify special bore size required.

ASSEMBLY NOTE FOR SPLIT GEARS: When tightening the split gear halves on a shaft, it is recommended that the flat washer spacers be used to help keep the gap between halves equal.

Run-out should be checked after installation is complete. Always use the supplied lock washers when tightening the socket head cap screws. Torque these screws to 182 in. lbs.

STANDARD SPUR GEAR DEFINITIONS, RELATIONSHIPS & FORMULA

Gear parameters are fundamentally related to their use as power transmission elements. Although these parameters are not the most convenient when using gears to excite magnetic pickups, they can be easily converted to more useful form, once the basic definitions are understood.

PITCH DIAMETER (P.D.) - The diameter of the circle described by the tooth-to-tooth contact point when running in mesh with the teeth of another gear. This point is roughly half way between the root (bottom) and the tip of the gear tooth. The Pitch Diameter is slightly smaller than the outside diameter of the gear.

DIAMETRAL PITCH (D.P.) - The number of teeth/inch of Pitch Diameter. Thus a 20 D.P. gear has 20 teeth for each inch of Pitch Diameter. A 60-tooth, 20 D.P. gear would have a pitch diameter of 3", a 60T, 10 D.P. gear has a Pitch Diameter of 6".

PRESSURE ANGLE - Pressure angle relates to tooth shape and strength. It has no significant effect on the operation of the gear for exciting magnetic pickups, and pickups can be used with gears of any pressure angle.

OUTSIDE DIAMETER (O.D.) - The outside diameter is the overall diameter of the gear to the tops of the teeth, and is used for calculating surface speed when the gear is used to excite a magnetic sensor. The O.D. can be determined from the following formula:

$$\text{O.D.} = \frac{\text{Nt(No. of teeth)} + 2}{\text{D.P. (Diametral Pitch)}}$$

Example: A 60T, 16 D.P. Gear has an O.D. of:

$$\text{O.D.} = \frac{60 + 2}{16} = 3.875 \text{ inches}$$

SURFACE SPEED - The output of a magnetic pickup depends on the linear surface speed of the tops of the passing gear teeth. Surface speed is normally expressed in inches/sec. and can be calculated for a given gear as follows:

$$\text{Surface Speed in inches /sec.} = \frac{\text{RPM x O.D. x } \pi}{60}$$

$$\textbf{or};\quad \text{RPM} = \frac{\text{Surface Speed x 60}}{\text{O.D. x } \pi}$$

Example: What is the surface speed of the 60T, 20 D.P. Gear when running at 50 RPM? At what RPM will the 1-Volt Threshold Speed (10 inches/sec.) for the MP-62TA be realized?

$$\text{Gear O.D.} = \frac{60 + 2}{20} = 3.1\text{" (From O.D. formula above)}$$

$$\text{Surface Speed} = \frac{50 \text{ x } 3.1 \text{ x } \pi}{60} = 8.115 \text{ inches /sec.}$$

$$\text{1-Volt Threshold RPM (@ 10 in/sec.)} = \frac{10 \text{ x } 60}{3.1 \text{ x } \pi} = 61.61 \text{ RPM}$$

OUTPUT SIGNAL FREQUENCY - The frequency generated by passing gear teeth is related to gear RPM and the number of gear teeth (Nt) by the following:

$$\text{Output frequency (Hz or teeth/sec.)} = \frac{\text{RPM x Nt}}{60}$$

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