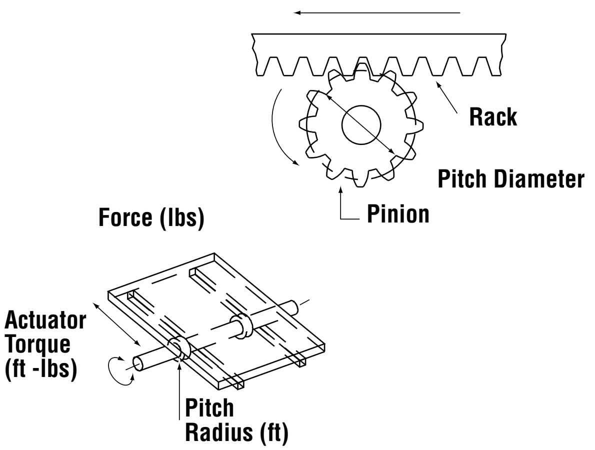
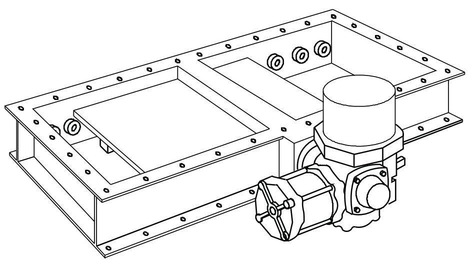
GENERAL APPLICATIONS

RACK AND PINION GATES





Formulas

$$\text{Pitch dia.} = \frac{\text{No. of teeth on pinion}}{\text{Diametral pitch}} = \_\_\_\_\_\_\text{in}$$

$$\text{Pitch Radius} = \frac{\text{Pitch dia.(in)}}{2} = \_\_\_\_\_\_\text{in}$$

$$\text{Pitch Radius} = \frac{\text{Pitch Radius (in)}}{12\ \text{(in/ft)}} = \_\_\_\_\_\_\text{ft}$$

$$\text{Actuator RPM} = \frac{\text{Velocity (in/sec)} \times 60\ \text{(sec/min)}}{\text{pitch dia. (in)} \times 3.14} = \_\_\_\_\_\_\text{RPM}$$

$$\text{VEL.} = \frac{\text{Act. RPM}}{60\ \text{(sec/min)}} \times \text{Pitch dia. (in)} \times 3.14 = \_\_\_\_\_\_\text{in/sec}$$

$$\text{No. of Output Revolutions} = \frac{\text{Total Travel (in)}}{\text{Pitch dia. (in)} \times 3.14} = \_\_\_\_\_\_\text{revs}$$

$$\text{Actuator Torque} = \text{Force (lbs)} \times \left[\frac{\text{Pitch radius (ft)}}{0.9}\right] = \_\_\_\_\_\_\text{ft-lbs}$$

(Assumed efficiency between Rack and Pinion Gears)

Example

A 18 inch x 18 inch slide gate is found to require 1600 lbs. of breakaway force. Find the actuator torque and RPM required to obtain a minimum linear velocity of 2.5 ins/sec using a 2 inch pitch dia. pinion.

$$\text{Pitch Radius} = \frac{2\ \text{(in) pitch dia.}}{2} = 1\ \text{inch}$$

$$\text{Pitch Radius} = \frac{1\ \text{(in) pitch radius}}{12\ \text{(in/ft)}} = 0.083\ \text{ft}$$

$$\text{Actuator Torque} = 1600\ \text{lbs} \times \left[\frac{0.083\ \text{ft}}{0.9\ \text{efficiency}}\right] = 148\ \text{ft/lbs}$$

$$\text{Actuator RPM} = \frac{2.5\ \text{(in/sec)} \times 60\ \text{(sec/min)}}{2\ \text{(in) pitch dia.} \times 3.14} = 24\ \text{RPM}$$

APPLICATION NOTES

For each rack and pinion slide gates find:

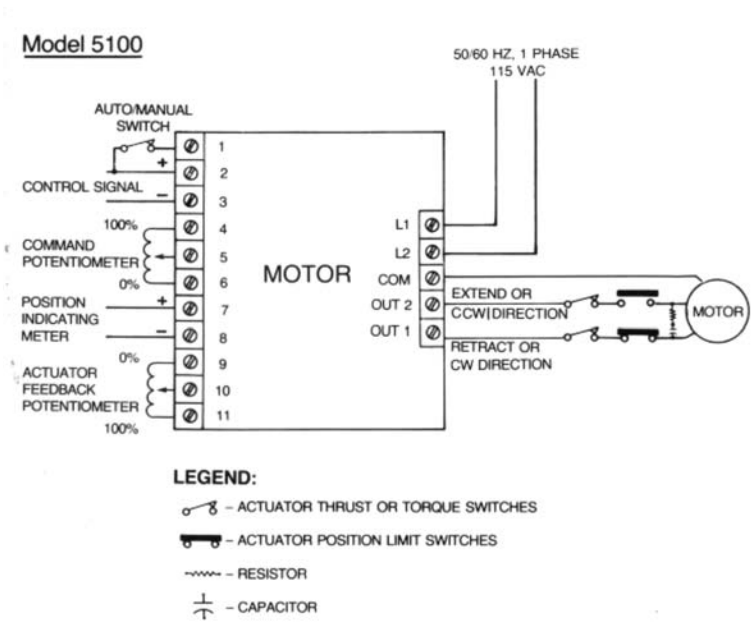
1. Force required to operate the gate
2. Pinion pitch diameter

Reference Tables on Page 45.

CONTROLS

POSITION/PROCESS CONTROL REMOTE MODEL 5100

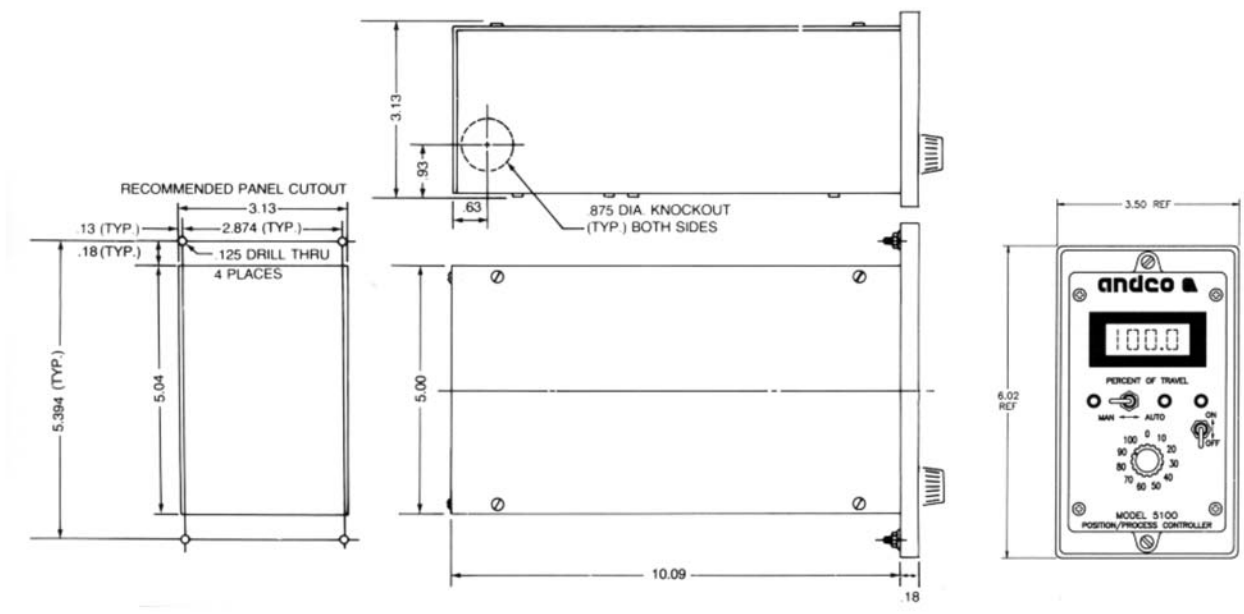
CONNECTION DIAGRAM



TECHNICAL NOTES

Power, single phase	115 VAC 50/60 Hz
Manual Mode Input (command potentiometer)	0-1000 Ohms
Auto Mode Input (control signal)	4-20 mAdc 10-50 mAdc or 1-5 VDC
Feedback Input (actuator potentiometer)	0-1000 Ohms
Active Filter, 60Hz Rejection	-24 dB
Temperature Range	0° to 65°C (150°F)
Position Indicating Meter Range	0-100 percent of full travel
Output (two triacs)	10 Amp inductive load

OUTLINE DRAWING



ENGINEERING TABLES

TABLE 1

Guide Type	Coefficient of Friction Between Steel Plate and Various Type Guides			
	Dry		Lubricated	
	Starting ($\mu 1$)	Running ($\mu 3$)	Starting ($\mu 1$)	Running ($\mu 3$)
Ball Bearings	–	–	0.08	0.05
Steel Rollers	–	–	0.15	0.10
Bronze	0.45	0.20	0.2	0.15
Steel	0.4-0.8	0.2-0.4	0.2-0.4	0.15-0.2

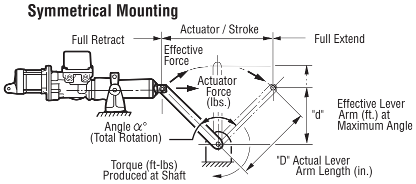
TABLE 2

Material	Coefficient of Friction Between Steel Plate and Various Materials		Specific Weights "W1" (lbs/ft3)	Column Height Factor "h"
	Starting ($\mu 2$)	Running ($\mu 4$)		
Ash (fly)	0.6-0.7	0.3	40-45	3.0
Ash (wet) (coal refuse)	0.75-0.95	0.5	45-50	2.0
Cement (portland)	0.6-0.65	0.3	95-100	3.0
Cement (clinker)	0.55-0.6	0.3	80-95	4.0
Coal (anthracite)	0.50-0.55	0.25	55-60	4.5
Coal (bituminous)	0.55-0.6	0.3	45-55	3.0
Coke	0.55-0.6	0.3	25-35	3.5
Grain	0.32-0.40	0.2	40-50	4.75
Iron Ore	0.55-0.65	0.3	125-180	3.5
Limestone (crushed)	0.55-0.65	0.3	80-90	3.5
Rock (crushed)	0.65-0.7	0.3	125-140	4.0
Sand (dry)	0.5-0.55	0.3	90-110	4.0
Sand (damp)	0.6-0.65	0.4	110-125	2.5
Slag (blast furnace)	0.4-0.45	0.2	80-90	5.5
Steel	See Table 1	See Table 1	490	–
Taconite	0.35-0.4	0.2	120-130	8.25
Wood chips	0.75-0.8	0.4	10-30	2.5

TABLE 3

Velocity (in/sec.)	0.1 to 3.5	3.6 to 6.4	6.4 to 12.2	12.3 to 25.0
Acceleration Factor (a)	1.2	1.3	1.4	1.5

Symmetrical Mounting



Non-Symmetrical Mounting

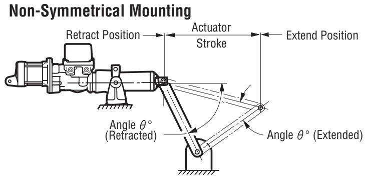


TABLE 4

Angle a	6" Stroke d'	6" Stroke D"	12" Stroke d'	12" Stroke D"	18" Stroke d'	18" Stroke D"	24" Stroke d'	24" Stroke D"
30°	.93	11.6	1.87	23.2	2.80	34.8	3.73	46.4
45°	.60	7.8	1.21	15.7	1.81	23.5	2.41	31.4
60°	.43	6.0	.87	12.0	1.30	18.0	1.73	24.0
90°	.25	4.2	.50	8.5	.75	12.7	1.00	17.0

Angle a	30" Stroke d'	30" Stroke D"	36" Stroke d'	36" Stroke D"	48" Stroke d'	48" Stroke D"	60" Stroke d'	60" Stroke D"
30°	4.67	58.0	5.60	69.5	7.46	92.7	9.33	115.9
45°	3.02	39.2	3.62	47.0	4.83	62.7	6.04	78.4
60°	2.17	30.0	2.60	36.0	3.46	48.0	4.33	60.0
90°	1.25	21.2	1.50	25.5	2.00	33.9	2.50	42.4

Angle Ø°	5°	15°	30°	45°	60°	75°	90°
Force Factor	0.09	0.26	0.50	0.71	0.87	0.97	1.00

Effective force (lbs) = Actuator force (lbs) x force factor
Effective lever arm (ft) = Actual length arm (ft) x force factor

NOTES

1. For non-symmetrical mounting the angle Ø° will change as the actuator moves through its travel. The angle Ø° is formed between the actuator drive rod centerline and the lever arm axis.

Torque (ft/lbs) = Effective lever arm (ft) x actuator force (lbs)
Force Required (lbs) = Torque (ft/lbs) ÷ Effective lever arm (ft)