

Divider Module

**Instruction Manual
DIV280-000**

**CAROTRON**

Driven by Excellence

D.C. DRIVES, A.C. INVERTERS,
SOLID STATE STARTERS, SYSTEM INTERFACE
CIRCUITS AND ENGINEERED SYSTEMS

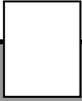


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General Description

A problem encountered in center driven takeup and letoff velocity mode applications is the nonlinear relationship between the diameter of a roll and the motor speed required to maintain constant surface speed of the roll during diameter increase or decrease. A plot of this relationship shows a hyperbolic curve.

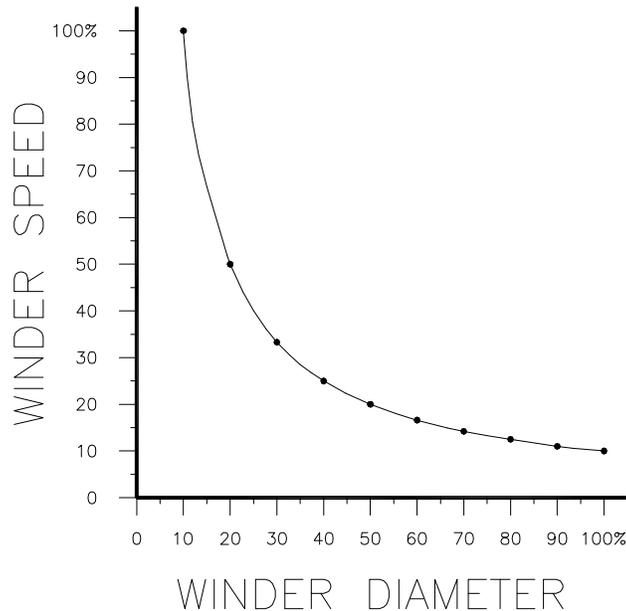


Figure 1: Winder Speed vs Winder Diameter (10:1 Build Ratio)

When the line speed and roll diameter values are known, the required roll speed can be calculated (i.e. Roll Speed = Line Speed/Roll Diameter). The material surface speed on a takeup or letoff would be held constant during roll diameter changes.

Furthermore, in torque applications, the torque required to maintain constant tension is proportional to roll diameter. When the line speed and roll rotational speed values are known, the required torque can be calculated (i.e. Roll Diameter = Line Speed/Roll Speed). The tension applied to the material on a takeup or letoff would be held constant during roll diameter changes.

Model DIV280-000 is designed for the above industrial applications where the division of DC voltage signals is required to produce the non-linear plot. The module has two voltage inputs (X & Y). Each voltage input has an associated Teach terminal that can be used to calibrate the minimum and maximum input levels. The output is based on the following formula:

$$Output = \frac{InputX}{InputY \times BuildRatio}$$

Multiturn GAIN, BIAS, BUILD RATIO, and Y TRIM RANGE potentiometers are used to calibrate the DIV280-000 module. An internal jumper allows selection of a voltage or current output. Onboard EEPROM is used to backup and retain the calibration values during a power loss.

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Specifications

2.1 Electrical

D.C. Power Input

- 24 VDC $\pm 10\%$, 60mA max, internally fused

+10VDC Reference Output

- 10mA max

X & Y Inputs

- Range: 0-10VDC
- Input Impedance: $10^{12} \Omega$

Potentiometers

- Turns: 15

Temperature Range

- 0-55° C

Signal Output

• Voltage Output

Selected by position V on J2. This circuit allows the output to source a voltage level of up to +10 VDC into a minimum resistance of 600 Ohms. If resistance is too low, output linearity may be affected.

• Current Output

Selected by position I on J2. This circuit allows the output to source a regulated current up to 20mA into a maximum resistance of 500 Ohms. Using the BIAS pot, the output can source a 4 to 20mA signal.

2.2 Physical

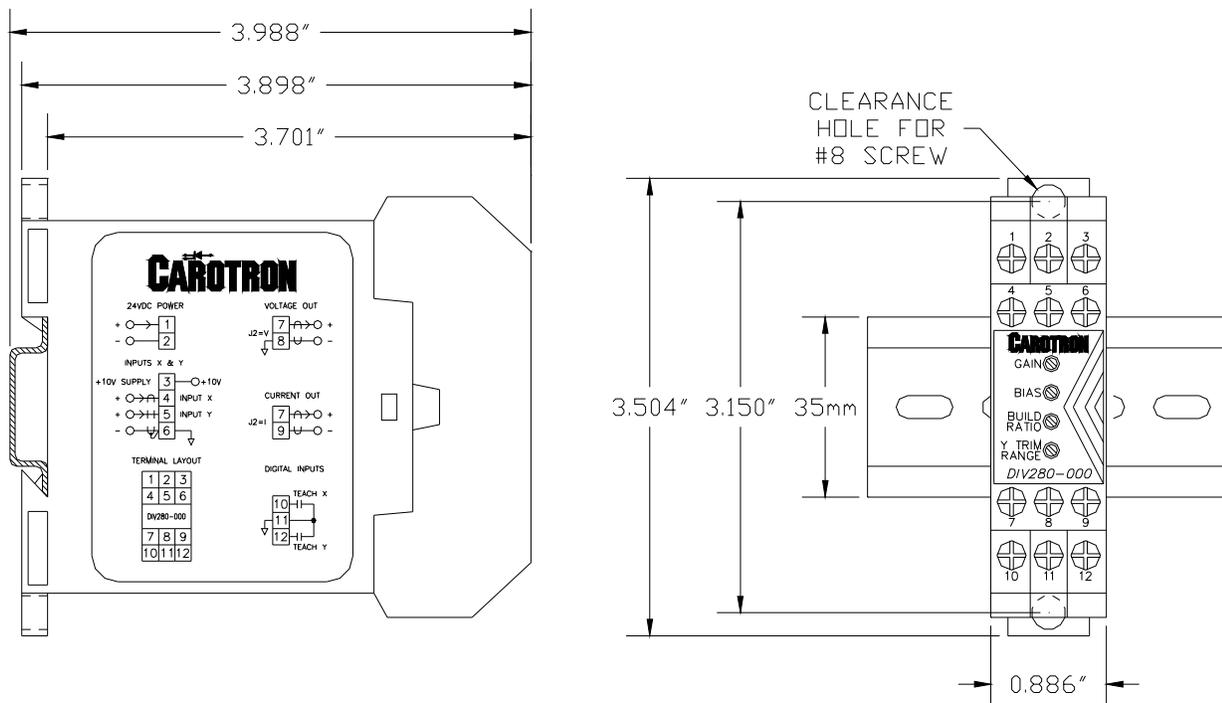


Figure 2: Physical Dimensions

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Installation

3.1 Wiring Guidelines

To prevent electrical interference and to minimize start-up problems, adhere to the following guidelines:

Use fully insulated and shielded cable for all signal wiring. The shield should be connected to circuit common at one end only. The other end of the shield should be clipped and insulated to prevent the possibility of accidental grounding.

Signal level wiring such as listed above should be routed separately from high level power wiring (such as the A.C. line, motor, operator control, and relay control wiring). When these two types of wire must cross, they should cross at right angles to each other.

Any relay, contactor, starter, solenoid or other electro-mechanical device located in close proximity to or on the same line supply as the DIV280-000 should have a transient suppression device such as an MOV or R-C snubber connected in parallel with its coil. The suppressor should have short leads and be connected as close to the coil as possible.

3.2 Signal Connections

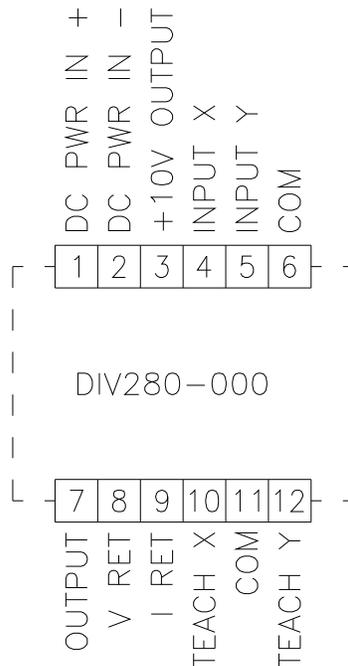


Figure 3: General Connections

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Description of Features & Adjustments

JUMPER J2

Selects the Output Mode between Voltage or Current. Position V on J2 selects the Voltage Mode and the output is sourced from terminals 7 & 8. Position I on J2 selects the Current Mode and the output is sourced on terminals 7 & 9.

BUILD RATIO Potentiometer

The BUILD RATIO is the ratio of maximum diameter to minimum diameter. The BUILD RATIO potentiometer has a range of 1 to 20. Clockwise rotation increases the ratio.

INPUT Y TRIM RANGE Potentiometer

In the velocity mode application (where Roll Speed is calculated by dividing Line Speed by Roll Diameter), a signal proportional to roll diameter (or radius) is required. When the minimum and maximum signal levels are taught (see the Teach function), the DIV280-000 module assumes the Zero Diameter and Max Diameter levels are used (points A and C). Note that point A is the 'zero' diameter level which would correspond to the center axis of the roll. With this type of signal, the normal operating range of signal would be between points B and C (since the diameter should never fall below core). During the teach process, the Zero Diameter point (center axis of roll) must be measured or simulated. Often, it is easier to calibrate the diameter signal by teaching the Core and Max Diameter levels. (points B to C). However, this introduces an error because the module assumes the Zero Diameter point has been taught. The Y TRIM RANGE potentiometer can be used to re-scale the signal so that the minimum input is treated as the Core level instead of the Zero level.

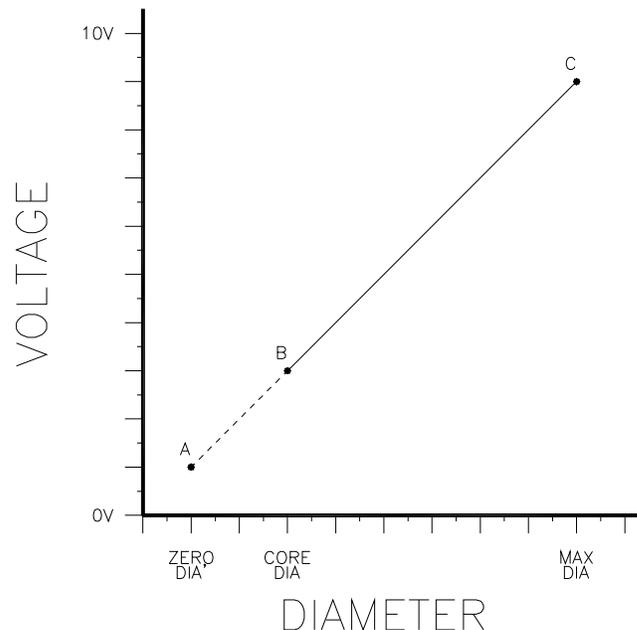


Figure 4: Diameter Signal Examples

GAIN Potentiometer

Sets the maximum output level at terminal 7.

BIAS Potentiometer

Sets the minimum output level at terminal 7.

TEACH INPUTS

The INPUT X and INPUT Y terminals can accept a nominal 0 to 10VDC input signal. Each input has an associated TEACH terminal that can be used to calibrate that input to the actual minimum and maximum signal levels. Thus, an input signal with a range less than 10V (1V to 9V for example) can be calibrated to reflect a 0 to 100% input. In addition, the order in which the voltage levels are taught can be used to invert the slope of the input. Thus the 1-9V input can reflect a 0-100% or a 100-0% signal.

Apply the signal level to the input terminal that corresponds to 0%. Teach this level by connecting the associated Teach input to circuit common (terminal 11). Next, apply to the input terminal the signal level that corresponds to 100%. Teach this level by disconnecting the Teach input from circuit common. If an error is made during the teach process, simply repeat the procedure.

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Adjustment Procedure



WARNING! DURING CALIBRATION, THE DIV280-000 MODULE WILL PRODUCE AN OUTPUT. PLEASE DISCONNECT ANY EQUIPMENT FROM THE MODULE THAT COULD BE DAMAGED OR CAUSE INJURY DURING THIS PROCESS.

Proceed to Section 5.1 for velocity mode takeups and to Section 5.2 for torque mode takeups or letoffs.

5.1 Velocity Mode Winder

The DIV280-000 can be used as a velocity mode winder control. In this application, the winder controls/sets the material speed. As the diameter increases, the center driven winder speed must be reduced in order to maintain a constant material speed. The DIV280-000 module calculates the winder speed signal by dividing the line speed by diameter. The diameter can be measured by using electronic sensors (such as a sonic or a laser, Figure 5) or by a simple rider arm and potentiometer (Figure 6).

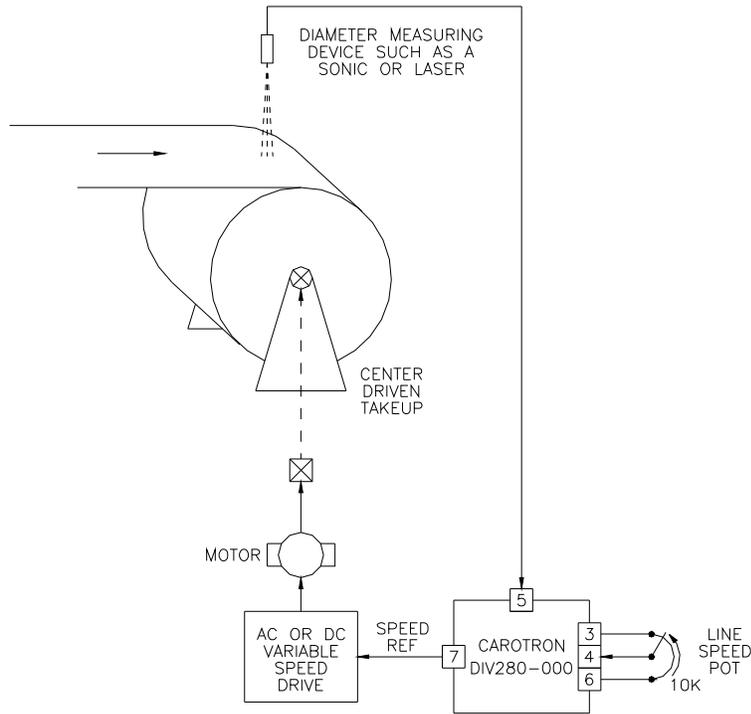


Figure 5: Velocity Mode Winder Example 1

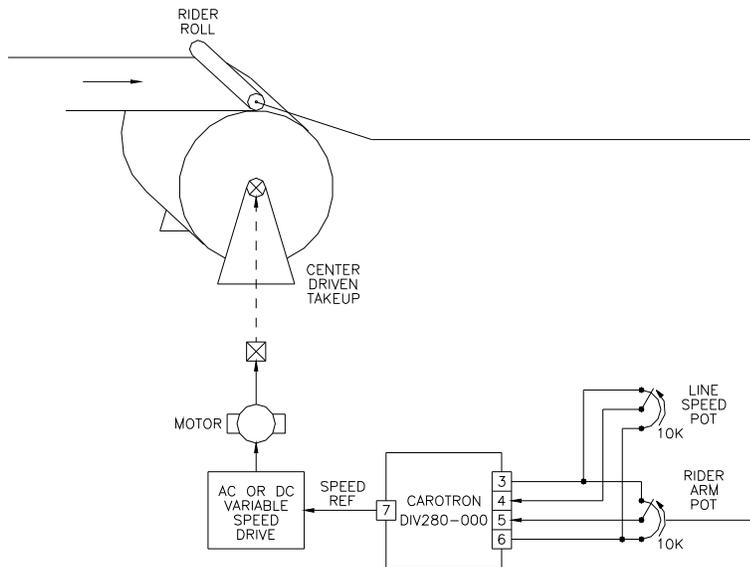


Figure 6: Velocity Mode Winder Example 2

Step 1: Select Output Type

1. Select the type of output desired using Jumper J2. If a Voltage output is desired, select V on J2 and use output terminals 7 (OUTPUT) and 8 (VOLTAGE RETURN). If a Current output is desired, select I on J2 and use output terminals 7 (OUTPUT) and 9 (CURRENT RETURN).

Step 2: Connections

1. Make connections per drawing C13815 on page 16. Initially, there should be no connection on the Teach inputs on terminals 10 & 12.

Step 3: Initial Settings

1. Initially set the potentiometers as follows:
 - GAIN..... fully counter-clockwise (CCW)
 - BIAS fully counter-clockwise (CCW)
 - BUILD RATIO fully counter-clockwise (CCW)
 - Y TRIM RANGE fully counter-clockwise (CCW)
2. Remove all material from the winder and load the smallest empty core that will be used.
3. Apply power to the module.

Step 4: Teach Inputs

1. Turn the Line Speed potentiometer fully counter-clockwise to apply the 0% Line Speed signal level to Input X on terminal 4. Connect the Teach X input (terminal 10) to circuit common (terminal 11). Turn the Line Speed potentiometer fully clockwise to apply the 100% Line Speed signal level to Input X. Disconnect the Teach X input from circuit common.
2. Apply either the Zero Diameter or Core Diameter signal level to Input Y on terminal 5. Connect the Teach Y input (terminal 12) to circuit common (terminal 11). Apply the Max Diameter signal level to Input Y. Disconnect the Teach Y input from circuit common.

Step 5: Set Minimum and Maximum Output

1. With GAIN fully CCW, adjust the BIAS potentiometer for minimum output on terminal 7. For a voltage output, the minimum output is typically 0V. For a current output, the minimum output is typically either 0mA or 4mA. (Note that the X & Y input levels have no affect on the output at this time since the GAIN is fully CCW.)
2. Load an empty core. Set external line speed potentiometer to maximum, and start the winder drive. With the BUILD RATIO fully CCW, adjust the GAIN potentiometer for the maximum desired output on terminal 7. Typical output levels are 10V or 20mA. A hand tachometer can be used to measure the surface speed of the winder (i.e. Ft/min[fpm], Ft/sec[fps], m/min[mpm], etc...). Adjust the GAIN potentiometer and/or the drive's speed scaling settings to obtain the maximum desired surface speed of the empty core. Note the surface speed as this level will be required later.
3. Ensure the external line speed potentiometer has control of the speed. Verify speeds with the external line speed potentiometer at minimum, mid-position, and maximum positions. Stop the drive when complete. If speeds are not correct, re-teach the Line Speed signal.

Step 6: Adjust Build Ratio

1. Determine the BUILD RATIO by dividing the maximum roll diameter by the minimum roll (empty core) diameter. If multiple sizes are used, calculate with the smallest core and the largest maximum diameter. For example, a maximum diameter of 32" and a core diameter of 4" will yield a Build Ratio of 8.
2. Determine the Max Diameter Core Speed by dividing the surface speed measured in 5.2 above by the BUILD RATIO. For example, with a maximum speed of 100fpm and a BUILD RATIO of 8, the Max Diameter Core Speed would be 12.5fpm ($100\text{fpm}/8=12.5\text{fpm}$)
3. Load a maximum diameter roll so that it can be rotated without feeding material. Rotate the BUILD RATIO potentiometer fully clockwise (approx 20 turns) and the external speed potentiometer to minimum. Start the winder drive and slowly rotate the external line speed potentiometer to maximum. Slowly adjust the BUILD RATIO potentiometer counter clockwise until the surface speed of the material matches the maximum surface speed measured in 5.2. Alternatively, if a portion of the core is not obstructed by the material, its surface speed should be equal the Max Diameter Core Speed value calculated in 6.2. Stop the machine once complete.

Step 7: Adjust Y TRIM RANGE

1. If the diameter signal on Input Y was calibrated using the Zero Diameter and Max Diameter levels, then no adjustment is required on the Y TRIM RANGE potentiometer (leave fully CCW). Calibration is now complete. Otherwise, continue below. (Note: The majority of users will need to continue with the following step.)
2. Load an empty core and set external line speed potentiometer to minimum. Rotate the Y TRIM RANGE potentiometer fully clockwise (approx 20 turns). Start the winder and slowly increase the external line speed potentiometer to maximum. Rotate the Y TRIM RANGE potentiometer counter-clockwise until the winder surface speed equals the maximum surface speed level measured in Step 5.2 above.

Step 8: Final Settings

1. The external Line Speed potentiometer can be used to set the desired material speed. As the diameter builds, the DIV280-000 will decrease the velocity signal to the winder to maintain a constant material speed.

5.2 Torque mode Takeup/Letoff

Another common application for the DIV280-000 module is the basic torque mode takeup (winder) or letoff (unwinder). The module takes a line speed signal and divides it by a roll speed signal to calculate a diameter (or torque) signal. The diameter signal can then be trimmed by an external Tension potentiometer to provide a torque reference for a motor or a brake. Note that this application provides only diameter compensating torque. Some applications may require additional torque compensation. Please contact Carotron for assistance in these advanced applications.

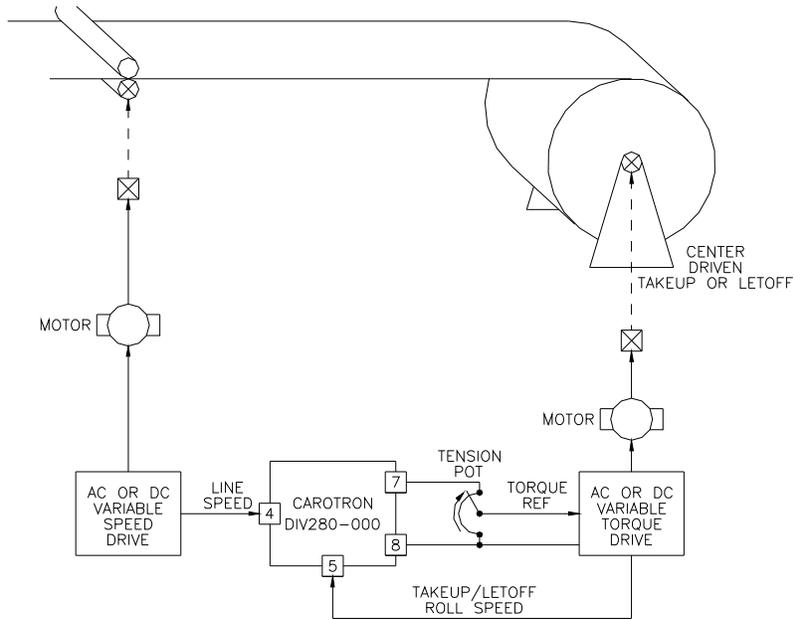


Figure 7: Torque Mode Drive Example

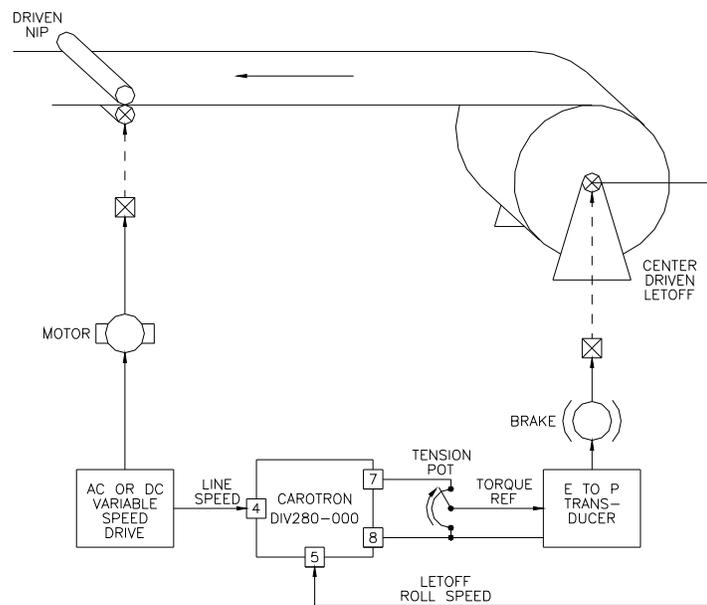


Figure 8: Torque Mode Brake Example

Step 1: Select Output Type

1. Select the type of output desired using Jumper J2. If a Voltage output is desired, select V on J2 and use output terminals 7 (OUTPUT) and 8 (VOLTAGE RETURN). If a Current output is desired, select I on J2 and use output terminals 7 (OUTPUT) and 9 (CURRENT RETURN).

Step 2: Connections

1. Make connections per drawing C13815 on page 16. Initially, there should be no connection on the Teach inputs on terminals 10 & 12.

Step 3: Initial Settings

1. Initially set the potentiometers as follows:
 - GAINfully counter-clockwise (CCW)
 - BIAS.....fully counter-clockwise (CCW)
 - BUILD RATIOfully counter-clockwise (CCW)
 - Y TRIM RANGEfully counter-clockwise (CCW)
2. Remove all material from the winder and load the smallest empty core that will be used.
3. Apply power to the module.

Step 4: Teach X Input

1. Apply the minimum Line Speed signal level to Input X on terminal 4. Connect the Teach X input (terminal 10) to circuit common (terminal 11). Apply the maximum Line Speed signal level to Input X. Disconnect the Teach X input from circuit common. Use a hand tachometer to measure the actual surface speed of the line (i.e. Ft/min[fpm], Ft/sec[fps], m/min [mpm], etc...). Note this level as it will be needed later.

Step 5: Teach Y Input

1. The minimum and maximum signal levels for Input Y are taught in a similar fashion to Input X. Follow the steps below based on the type of torque producing device being used:

Drive: In the normal operating mode, the drive will be in the torque mode. However, in order to calibrate the speed signals, the drive must be temporarily converted to a velocity (or speed) mode. With the takeup/letoff roll stopped, connect the Teach Y input (terminal 12) to circuit common (terminal 11). Run the empty core and increase its speed until it matches the surface speed measured on the line in Step 4.1 above. Disconnect the Teach Y input from circuit common.

Brake: Using a brake on a letoff complicates the process in that a brake cannot be used to rotate the unwind roll at a given speed needed for calibration. In most cases, a calculation will have to be performed to determine the roll speed signal level. A potentiometer can then be temporarily connected to Input Y (terminal 5) and adjusted to simulate the roll speed signal. Once calibration is completed, the potentiometer is disconnected and the actual roll speed signal is re-connected. If needed, please contact Carotron for assistance in performing this calculation. Rotate the potentiometer to minimum. Connect the Teach Y input (terminal 12) to circuit

common (terminal 11). Rotate the potentiometer until the calculated voltage level is obtained on Input Y (terminal 5). Disconnect the Teach Y input from circuit common.

Step 6: Set Minimum and Maximum Output

1. With GAIN fully CCW, adjust the BIAS potentiometer for minimum output on terminal 7. For a voltage output, the minimum output is typically 0V. For a current output, the minimum output is typically either 0mA or 4mA.
2. With the maximum levels applied to both inputs and BUILD RATIO fully CCW, adjust the GAIN potentiometer for the maximum desired output on terminal 7. Typical output levels would be 10V or 20mA.

Step 7: Adjust Build Ratio

1. Determine the BUILD RATIO by dividing the maximum roll diameter by the minimum roll (empty core) diameter. If multiple sizes are used, calculate with the smallest core and the largest maximum diameter. For example, a maximum diameter of 32" and a core diameter of 4" will yield a Build Ratio of 8.
2. Using the minimum and maximum output values set in Step 6 above, calculate the nominal output level for core diameter.

$$\text{CoreDiameterLevel} = \frac{(\text{MaxOutput} - \text{MinOutput})}{\text{BuildRatio}} + \text{MinOutput}$$

For example, a nominal 0 to 10V output with a Build Ratio of 8 would yield:

$$\text{CoreDiameterLevel} = \frac{(10V - 0V)}{8} + 0V = 1.25V$$

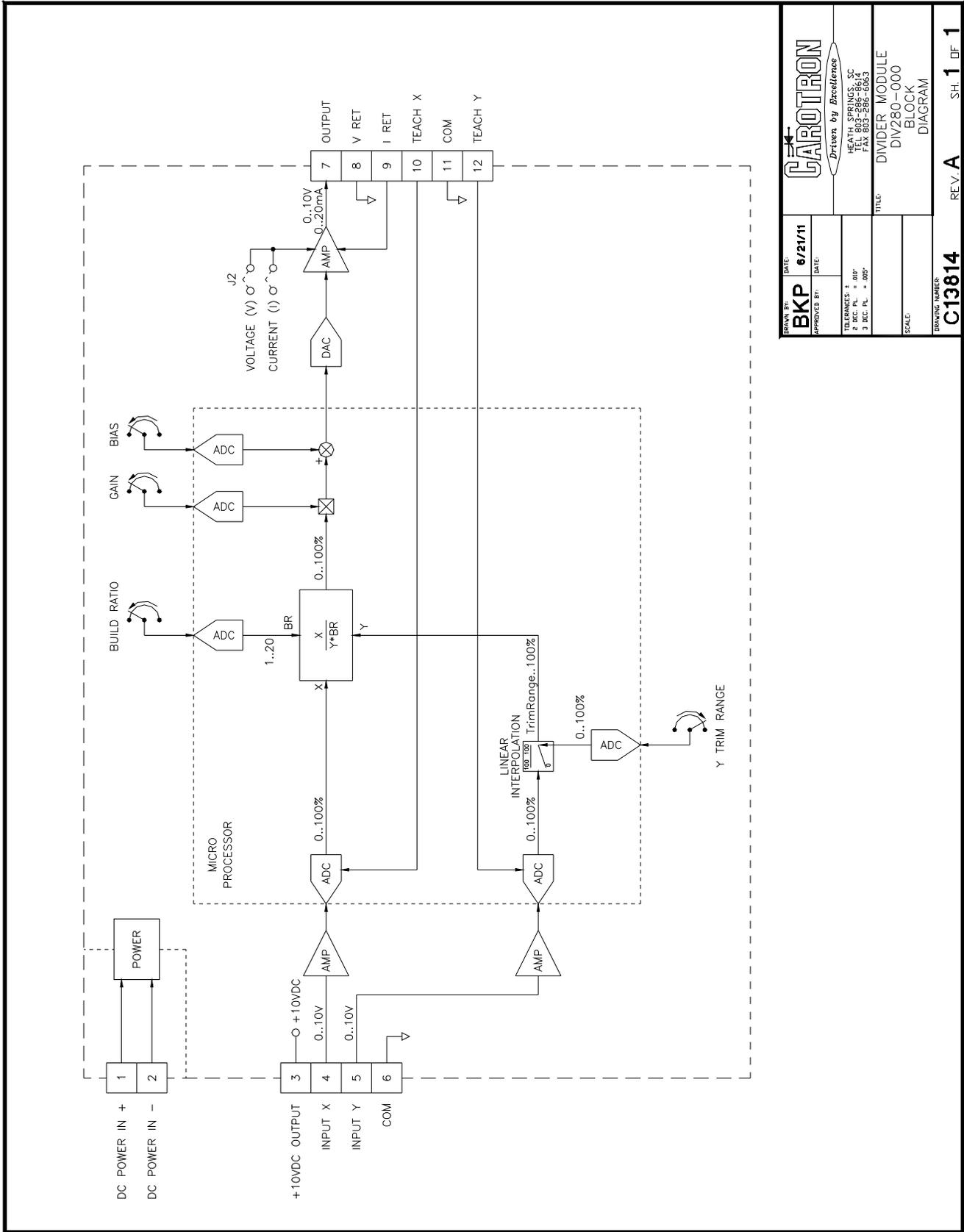
or a nominal 4 to 20mA output with a Build Ratio of 4 would yield:

$$\text{CoreDiameterLevel} = \frac{(20mA - 4mA)}{4} + 4mA = 8mA$$

3. With maximum signal applied to Inputs X and Y, adjust the BUILD RATIO potentiometer clockwise until the output on terminal 7 equals the value calculated above.

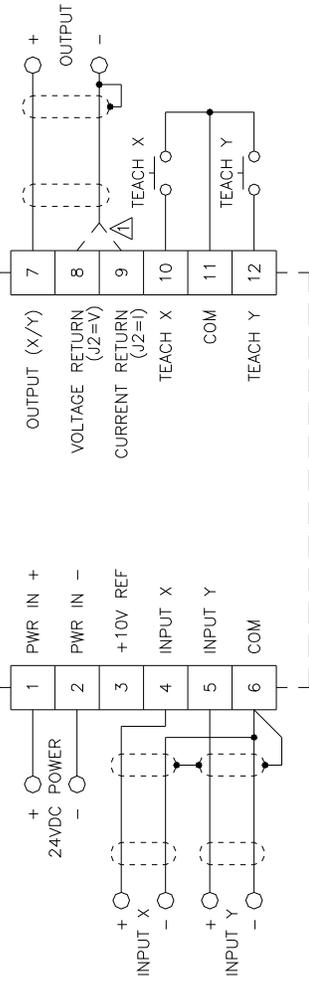
Step 8: Final Settings

1. Convert the velocity mode drive back to torque mode or disconnect the temporary roll speed potentiometer and re-connect the actual roll speed feedback signal.
2. If a minimum torque level is desired when stopped, a torque bias level must be set in the drive or the brake controller. The DIV280-000 will then add to this level once motion starts and the diameter/torque level calculation begins.
3. The external Tension potentiometer can be used to set the desired tension level.

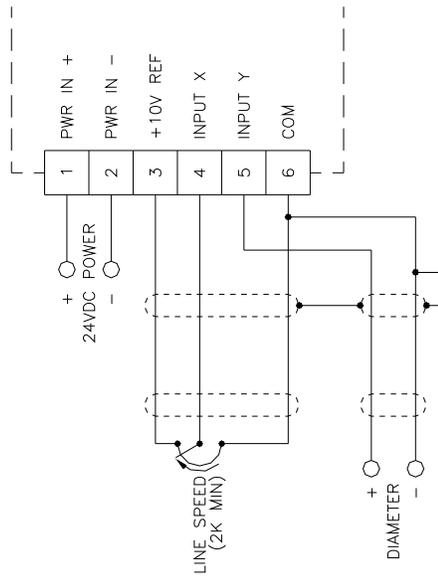


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APPROVED BY:		DATE:	
TOLERANCES: ±		± DEC PL = .00P	TITLE: DIVIDER MODULE BLOCK DIAGRAM
		± DEC PL = .00P	
SCALE:			DRAWING NUMBER: C13814
			REV. A SH. 1 OF 1

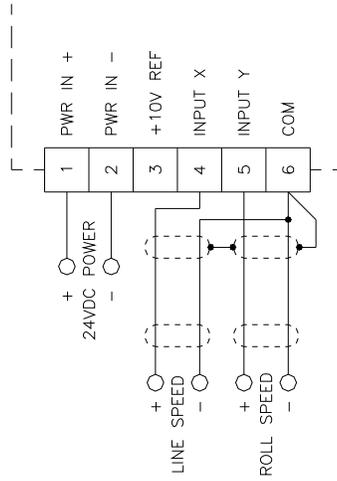
GENERAL CONNECTIONS



VELOCITY MODE TAKEUP



TORQUE MODE TAKEUP/LETOFF



NOTES:

- △ FOR A VOLTAGE OUTPUT, SET J2=V AND CONNECT THE NEGATIVE OUTPUT WIRE TO TERMINAL 8. FOR A CURRENT OUTPUT, SET J2=I AND CONNECT THE NEGATIVE OUTPUT WIRE TO TERMINAL 9.

DRAWN BY: BKP	DATE: 7/14/2011	 <i>Driven by Excellence</i>
APPROVED BY:	DATE:	
TEL: 803.286-6063 2 DEC. PL. = .000' 3 DEC. PL. = .005'		HEATH SPRINGS, SC FAX 803-286-6063
DRAWING NUMBER: C13815		TITLE: DIV280-000 GENERAL CONNECTIONS
REV. A		SH. 1 OF 1

Standard Terms & Conditions of Sale

1. General

The Standard Terms and Conditions of Sale of Carotron, Inc. (hereinafter called "Company") are set forth as follows in order to give the Company and the Purchaser a clear understanding thereof. No additional or different terms and conditions of sale by the Company shall be binding upon the Company unless they are expressly consented to by the Company in writing. The acceptance by the Company of any order of the Purchaser is expressly conditioned upon the Purchaser's agreement to said Standard Terms and Conditions. The acceptance or acknowledgement, written, oral, by conduct or otherwise, by the Company of the Purchaser's order shall not constitute written consent by the Company to addition to or change in said Standard Terms and Conditions.

2. Prices

Prices, discounts, allowances, services and commissions are subject to change without notice. Prices shown on any Company published price list and other published literature issued by the Company are not offers to sell and are subject to express confirmation by written quotation and acknowledgement. All orders of the Purchaser are subject to acceptance, which shall not be effective unless made in writing by an authorized Company representative at its office in Heath Springs, S.C. The Company may refuse to accept any order for any reason whatsoever without incurring any liability to the Purchaser. The Company reserves the right to correct clerical and stenographic errors at any time.

3. Shipping dates

Quotation of a shipping date by the Company is based on conditions at the date upon which the quotation is made. Any such shipping date is subject to change occasioned by agreements entered into previous to the Company's acceptance of the Purchaser's order, governmental priorities, strikes, riots, fires, the elements, explosion, war, embargoes, epidemics, quarantines, acts of God, labor troubles, delays of vendors or of transportation, inability to obtain raw materials, containers or transportation or manufacturing facilities or any other cause beyond the reasonable control of the Company. In no event shall the Company be liable for consequential damages for failure to meet any shipping date resulting from any of the above causes or any other cause.

In the event of any delay in the Purchaser's accepting shipment of products or parts in accordance with scheduled shipping dates, which delay has been requested by the Purchaser, or any such delay which has been caused by lack of shipping instructions, the Company shall store all products and parts involved at the Purchaser's risk and expense and shall invoice the Purchaser for the full contract price of such products and parts on the date scheduled for shipment or on the date on which the same is ready for delivery, whichever occurs later.

4. Warranty

The Company warrants to the Purchaser that products manufactured or parts repaired by the Company, will be free, under normal use and maintenance, from defects in material and workmanship for a period of one (1) year after the shipment date from the Company's factory to the Purchaser. The Company makes no warranty concerning products manufactured by other parties.

As the Purchaser's sole and exclusive remedy under said warranty in regard to such products and parts, including but not limited to remedy for consequential damages, the Company will at its option, repair or replace without charge any product manufactured or part repaired by it, which is found to the Company's satisfaction to be so defective; provided, however, that (a) the product or part involved is returned to the Company at the location designated by the Company, transportation charges prepaid by the Purchaser; or (b) at the Company's option the product or part will be repaired or replaced in the Purchaser's plant; and also provided that (c) the Company is notified of the defect within one (1) year after the shipment date from the Company's factory of the product or part so involved.

The Company warrants to the Purchaser that any system engineered by it and started up under the supervision of an authorized Company representative will, if properly installed, operated and maintained, perform in compliance with such system's written specifications for a period of one (1) year from the date of shipment of such system.

As the Purchaser's sole and exclusive remedy under said warrant in regard to such systems, including but not limited to remedy for consequential damages, the Company will, at its option, cause, without

charges any such system to so perform, which system is found to the Company's satisfaction to have failed to so perform, or refund to the Purchaser the purchase price paid by the Purchaser to the Company in regard thereto; provided, however, that (a) Company and its representatives are permitted to inspect and work upon the system involved during reasonable hours, and (b) the Company is notified of the failure within one (1) year after date of shipment of the system so involved.

The warranties hereunder of the Company specifically exclude and do not apply to the following:

- a. Products and parts damaged or abused in shipment without fault of the Company.
- b. Defects and failures due to operation, either intentional or otherwise, (1) above or beyond rated capacities, (2) in connection with equipment not recommended by the Company, or (3) in an otherwise improper manner.
- c. Defects and failures due to misapplication, abuse, improper installation or abnormal conditions of temperature, humidity, abrasives, dirt or corrosive matter.
- d. Products, parts and systems which have been in any way tampered with or altered by any party other than an authorized Company representative.
- e. Products, parts and systems designed by the Purchaser.
- f. Any party other than the Purchaser.

The Company makes no other warranties or representation, expressed or implied, of merchantability and of fitness for a particular purpose, in regard to products manufactured, parts repaired and systems engineered by it.

5. Terms of payment

Standard terms of payment are net thirty (30) days from date of the Company invoice. For invoice purposed, delivery shall be deemed to be complete at the time the products, parts and systems are shipped from the Company and shall not be conditioned upon the start up thereof. Amounts past due are subject to a service charge of 1.5% per month or fraction thereof.

6. Order cancellation

Any cancellation by the Purchaser of any order or contract between the Company and the Purchaser must be made in writing and receive written approval of an authorized Company representative at its office in Heath Springs, S.C. In the event of any cancellation of an order by either party, the Purchaser shall pay to the Company the reasonable costs, expenses, damages and loss of profit of the Company incurred there by, including but not limited to engineering expenses and expenses caused by commitments to the suppliers of the Company's subcontractors, as determined by the Company.

7. Changes

The Purchaser may, from time to time, but only with the written consent of an authorized Company representative, make a change in specifications to products, parts or systems covered by a purchase order accepted by the company. In the event of any such changes, the Company shall be entitled to revise its price and delivery schedule under such order.

8. Returned material

If the Purchaser desires to return any product or part, written authorization thereof must first be obtained from the Company which will advise the Purchaser of the credit to be allowed and restocking charges to be paid in regard to such return. No product or part shall be returned to the Company without a "RETURN TAG" attached thereon which has been issued by the Company.

9. Packing

Published prices and quotations include the Company's standard packing for domestic shipment. Additional expenses for special packing or overseas shipments shall be paid by the Purchaser. If the Purchaser does not specify packing or accepts parts unpacked, no allowance will be made to the Purchaser in lieu of packing.

10. Standard transportation policy

Unless expressly provided in writing to the contrary, products, parts and systems are sold f.o.b. first point of shipment. Partial shipments shall be permitted, and the Company may invoice each shipment separately. Claims for non-delivery of products, parts and systems, and for damages thereto must be filed with the carrier by the Purchaser. The Company's responsibility therefor shall cease when the carrier signs for and accepts the shipment.



CAROTRON

Driven by Excellence

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CIRCUITS AND ENGINEERED SYSTEMS

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