# 1205R/1209R/1221R MODELS

| CURTIS PMC MODEL | NOMINAL VOLTAGE | DRIVE CURRENT | UNDER VOLTAGE POINT | OVER VOLTAGE POINT | CHARGE VOLTAGE ADJ. RANGE | CHARGE VOLTAGE SETPOINT | MOSFET ON RES. @ 25° C |
|---|---|---|---|---|---|---|---|
| 1205R-11XX | 36 V | 350 A | 21 V | 87 V | 40-45 V | 43 V | 2.3 mΩ |
| 1205R-11XX | 48 V | 350 A | 21 V | 87 V | 53-60 V | 58 V | 2.3 mΩ |
| | | | | | | | |
| 1209R-11XX | 36 V | 450 A | 21 V | 87 V | 40-45 V | 43 V | 2.2 mΩ |
| 1209R-11XX | 48 V | 450 A | 21 V | 87 V | 53-60 V | 58 V | 2.2 mΩ |
| 1209R-11XX | 60 V | 450 A | 29 V | 87 V | 66-75 V | 72 V | 2.2 mΩ |
| 1209R-11XX | 72 V | 450 A | 45 V | 103 V | 80-90 V | 86 V | 1.8 mΩ |
| 1209R-11XX | 78 V | 450 A | 45 V | 103 V | 86-98 V | 94 V | 1.8 mΩ |
| 1209R-11XX | 84 V | 275 A | 45 V | 159 V | 92-105 V | 101 V | 5.6 mΩ |
| 1209R-11XX | 96 V | 275 A | 45 V | 159 V | 106-120 V | 115 V | 5.6 mΩ |
| 1209R-11XX | 108 V | 275 A | 45 V | 159 V | 119-135 V | 130 V | 5.6 mΩ |
| 1209R-11XX | 120 V | 275 A | 45 V | 159 V | 132-150 V | 144 V | 5.6 mΩ |
| | | | | | | | |
| 1221R-11XX | 36 V | 550 A | 21 V | 87 V | 40-45 V | 43 V | 1.6 mΩ |
| 1221R-11XX | 48 V | 550 A | 21 V | 87 V | 53-60 V | 58 V | 1.6 mΩ |
| 1221R-11XX | 60 V | 550 A | 29 V | 87 V | 66-75 V | 72 V | 1.6 mΩ |
| 1221R-11XX | 72 V | 550 A | 45 V | 103 V | 80-90 V | 86 V | 1.3 mΩ |
| 1221R-11XX | 84 V | 400 A | 45 V | 159 V | 92-105 V | 101 V | 4.0 mΩ |
| 1221R-11XX | 96 V | 400 A | 45 V | 159 V | 106-120 V | 115 V | 4.0 mΩ |
| 1221R-11XX | 108 V | 400 A | 45 V | 159 V | 119-135 V | 130 V | 4.0 mΩ |
| 1221R-11XX | 120 V | 400 A | 45 V | 159 V | 132-150 V | 144 V | 4.0 mΩ |

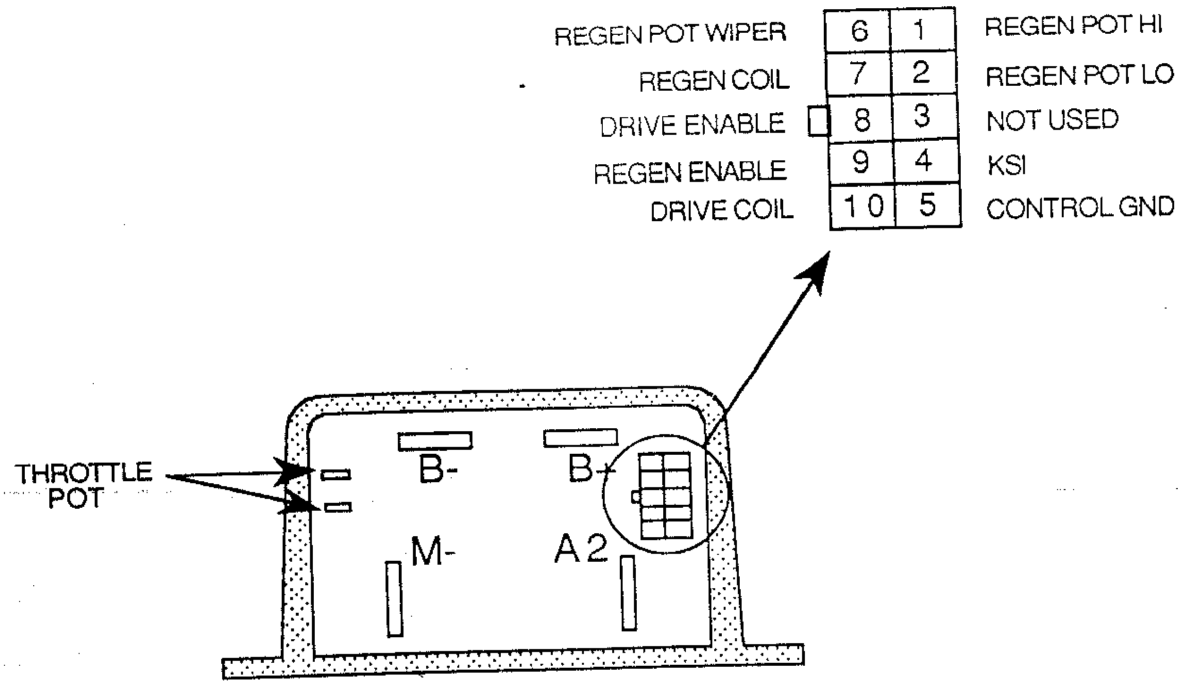
## CONTROL CONNECTORS

With the exception of the throttle pot, which connects to 1/4 inch push-on terminals, all control connections to the controller are made by a 10 pin Molex connector near the A2 bus bar. Figure 1 shows the location of these connections. The connector is of the Molex "Mini-Fit, Jr." family. The mating receptacle is Molex part number 39-01-2100. The Molex part number for the female contact (wire size AWG 18-24) is 39-00-0039. The manufacturer's address is:

Molex, Inc.
2222 Wellington Ct.
Lisle, IL 60532
Phone: 708-969-4550

European Headquarters: Munich, Germany
Tel: 49-89-413092-0

## CONNECTIONS




CONNECTOR PIN OUTS

Figure 1

## CONTROL CONNECTION DESCRIPTIONS

<u>Regen Pot High (pin 1)</u>
<u>Regen Pot Low (pin 2)</u>
<u>Regen Pot Wiper (pin 6)</u>
These are the connections to the regen braking current control pot. If no pot is used (fixed regen current), a 4.7 kΩ resistor must be connected between pins 1 and 2, otherwise, the controller will interpret the lack of a pot as a fault. If a pot is used, its resistance should be in the range of 2kΩ to 5kΩ. A three wire connection is used so pots with a high wiper contact resistance (e.g. linear slide types), which would be unsuitable for use as a two wire rheostat, may be used here.

<u>Key Switch Input (pin 4)</u>
This input has the same function as in other Curtis PMC controllers. In <u>Isolated</u> control systems, the KSI is turned on by connection to the positive isolated supply (+12 Volts). In <u>Non-isolated</u> systems, full traction battery voltage is used. In either case, it is recommended that the control circuitry feed to the keyswitch be fused to prevent wiring damage in the event of accidental short circuits. If it is desired to provide protection against damage due to reversed polarity of either the control or traction batteries, this can be done with a diode in series with the keyswitch line, as shown on the drawings. This diode must, of course, be rated to carry the full current of all the contactors that may be operated at once (power dissipation in the diode may need to be considered) and withstand the control circuit voltage in the reverse direction.



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<u>Control Wiring Return (pin 5)</u>
In <u>Isolated</u> control systems, this is the negative terminal of the isolated supply. In order to maintain the integrity of the isolation, care should be taken that no connection from this return, or any other point in the control wiring is made to the traction battery wiring. The controller can withstand up to 1000 Volts between the two circuits. In <u>Non-isolated</u> systems, this pin is internally connected to the controller B- bus and must be left unconnected.

<u>Regen Enable (pin 9)</u>
<u>Drive Enable (pin 8)</u>
These are the control inputs to put the controller into the Drive or Regen operational modes. In <u>Isolated</u> control systems, these inputs are turned on by connection to the positive isolated supply (+12 Volts). In <u>Non-isolated</u> systems, full traction battery voltage is used.

<u>Regen Coil (pin 7)</u>
<u>Drive Coil (pin 10)</u>
These are contactor driver outputs which control the contactors to achieve the interlocks and fault protection functions described below. The contactor coil current may be as high as 2 Amps for <u>Isolated</u> models and 1 Amp for <u>Non-isolated</u> models. Coil suppression diodes are not required for the Drive and Regen contactor coils, as they are built into the controller.

## CONTACTOR CONFIGURATIONS

All installations should have a main contactor, wired as shown in the diagrams. A precharge resistor may be used if desired. The same considerations that apply to the main contactor for other Curtis PMC controller applications also apply here. In order to change the motor/controller wiring to provide the drive and regen braking functions, a rather specific contactor configuration is required. The configuration is different if the motor is reversed electrically. These contactor configurations are discussed below.

<u>Motor not reversed</u>
Two contactors are required, each having two normally open contacts (i.e., dpst, N.O.). In addition, as discussed below under Contactor Interlocks, each of the contactors must have an auxiliary low power contact that is normally closed (i.e., spst, N.C.). The paired Albright models work well for this, although only the outer links can be used because of the auxiliary switches. A typical Albright part number for this is SW192AB-46, but size depends upon current.

<u>Motor reversed electrically</u>
In this case, two dpst, N.O. contactors are required for the reversing function. These do not need auxiliary switch contacts, so the connecting links provided with the Albright paired sets may be fully utilized. In addition, two contactors each having one normally open contact (spst, N.O.) are required, and these must have the auxiliary spst, N.O. low power contacts. A typical Albright part number for this is SW200A-16, but size depends upon current. The reversing wiring also requires a small dpdt relay to interchange the coils of the reversing contactors. The contacts of this relay must be able to switch the coil currents of the contactors.

## CONTACTOR INTERLOCK

In order to prevent simultaneous operation of the Drive and Regen contactors, the two contactors are interlocked by using auxiliary microswitches on the contactors. Albright contactors fitted with these switches are specified by an "A" after the number (e.g. SW 192<u>A</u>). Note on the wiring diagrams that these auxiliary microswitches allow only one of the contactors to be operated at a time. These are the recommended contactors for the Drive and Regen contactors.



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Alternately, dual contactors with a mechanical interlock between them may also be used. This type of contactor is generally used for motor reversing and have a "teeter-totter" type arrangement, where only one contact may be closed at a time. This also provides positive protection from both contacts being closed simultaneously.

## REGEN CURRENT CONTROL

Curtis PMC controllers usually operate in such a way as to translate the throttle input demand into a corresponding output duty cycle, which forces a certain voltage across the motor. During the drive mode, the R series controllers operate this way. During regenerative braking, however, the controller operates as a motor current control rather than as a voltage control. The motor current during regenerative braking is determined by the regen demand signal.

The regen current demand signal may be either variable or fixed. In general, the ability of the driver to vary the motor current during braking will give far better vehicle performance. If this type of operation is desired, it will be necessary to provide a potentiometer input to the controller for the regen demand signal. This potentiometer must be mechanically operated by the vehicle brake pedal in such a way that its travel precedes or overlaps the operating stroke of the mechanical (hydraulic) brake system. As the vehicle brake pedal is depressed, the following sequence of actions should occur:

1) The brake light switch should close,
2) the regen enable switch should close (this may be the same switch as 1),
3) the regen demand pot should move through its travel, and then
4) the mechanical brake should move through its operating stroke.

The mechanical design of the brake pedal linkage to achieve this operation may be quite tricky, and careful attention should be given to it. Take care that the actions of the switch(es) and pot are correct and that excessive forces are not applied to them during any conditions of brake adjustment or wear.

Any type of potentiometer that is mechanically suitable and has a resistance in the range of 2kΩ to 5kΩ may be used. A Curtis PMC potbox, such as the model PB-1 may be used. A 3-wire true potentiometer type connection is employed, rather than the 2-wire rheostat type as is used for the drive throttle input, so that potentiometers that have a high wiper resistance (such as linear slide types) can be used. The choice of what type of potentiometer used should be made on the basis of what will work best with the particular mechanical arrangement of the vehicle's brake pedal and linkage.

The regen current demand signal may also be fixed during the regen braking interval. That is, the regen current may be adjusted to some fixed value and when the regen mode is entered, by closing the switch on the vehicle brake pedal, the controller will cause regenerative braking at that current until the vehicle is stopped. The fixed braking current may be set by a potentiometer external to the controller connected as shown in the wiring diagrams, or the potentiometer may be omitted, and the current adjusted by means of the trimpot located where the plug current adjustment is located on standard Curtis PMC controllers. Note that if the external regen current pot is not used, a 4.7kΩ fixed resistor must be connected between pins 1 and 2 of the control connector, so that the controller does not sense the lack of a pot as a fault.



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## ADJUSTMENTS

The four adjustments available on the controller (See Figure 2) are: Acceleration Ramp, Main Current Limit, Regen Current Limit, and Charge Voltage Limit. All parameters are user adjustable, but Charge Voltage Limit is critical and should not be adjusted unless the proper equipment is available. Charge Voltage is properly adjusted at the factory and no further adjustment should be necessary.

## CHARGE VOLTAGE LIMIT ADJUSTMENT

These controllers have a feature which causes the regeneration current to be reduced as the battery reaches full charge. In this way, overcharging of the traction battery is avoided. This could occur, for example, by braking down a long hill with an already fully charged battery. While this feature is effective in preventing battery damage due to overcharging (by overheating, excessive gassing, etc.), it will cause a reduction or elimination of available regen braking effort when the battery is fully charged.

The end-of-charge voltage is adjustable by a trimpot located near the rear of the controller and on the side opposite the other trimpot adjustments (see Figure 2). The end-of-charge voltage can be adjusted over the range from 2.2 to 2.5 Volts per cell (clockwise = higher voltage), and is factory set to 2.4 Volts per cell. For proper operation, the controller model must be chosen for the exact nominal battery voltage (i.e. number of cells x 2.0 volts per cell). Adjustment of the charge voltage trimpot will be required if the end-of-charge voltage appropriate for the particular battery used in the vehicle is different from the 2.4 Volts per cell set at the factory (other factory settings are available on request). The best setting may be a compromise since the appropriate voltage will vary with battery temperature and life.

The adjustment may be performed by trial-and-error, changing the setting and driving the vehicle downhill with fully charged batteries to verify that overcharging does not occur. Alternately, the adjustment can be made by applying the desired battery end-of-charge voltage to the controller (e.g. with an adjustable power supply), selecting the regen mode, and adjusting the trimpot so that the controller M- output just turns off. This can be observed by preventing operation of the regen contactor (M- output is disconnected) and measuring the voltage from M- to B-. When the adjustment is properly made, the voltage should increase to nearly full battery voltage.



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## ADJUSTMENTS

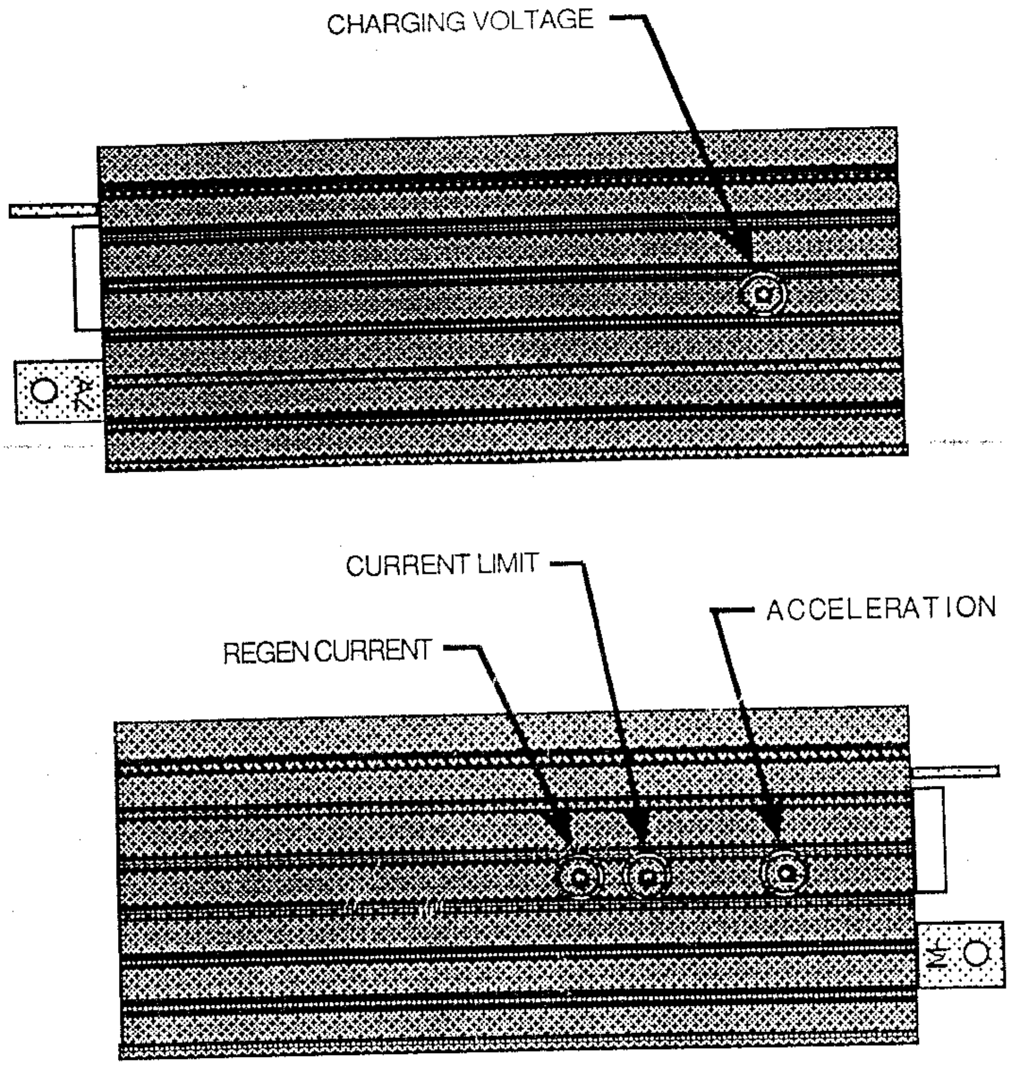


Figure 2

## WIRING DIAGRAMS

Wiring diagrams for the four basic configurations are shown on the following pages. These are; **12 volt isolated** wiring without electrical reversing, 12 volt isolated wiring with electrical reversing, **non-isolated** wiring without electrical reversing and non-isolated wiring with electrical reversing.

***CAUTION:** When using the Curtis PMC Regen Controllers, no deviation from the applications shown in the wiring diagrams should be attempted without express approval from the Curtis PMC Engineering Department.*



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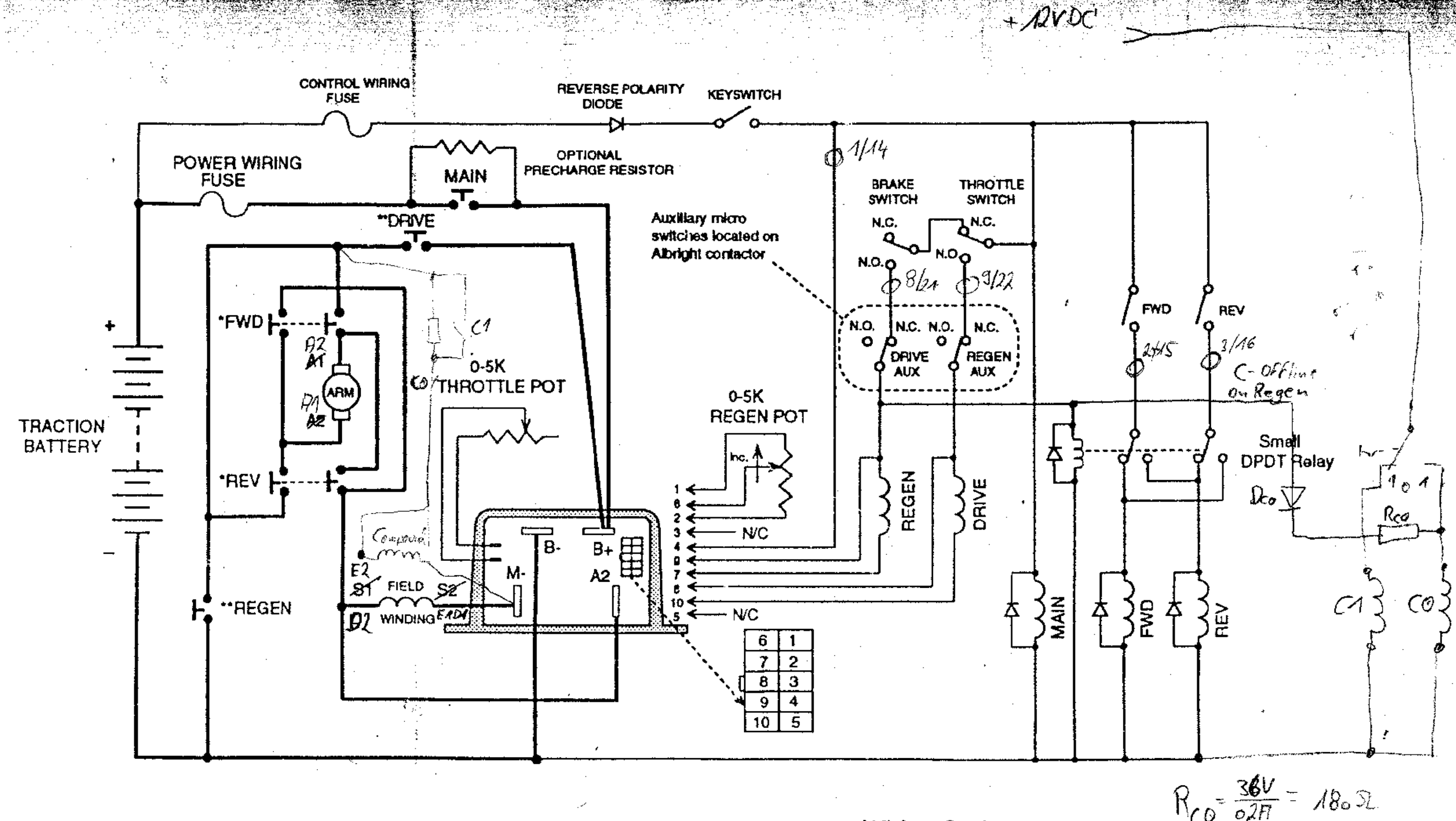


$R_{CO} = \frac{36V}{0.2A} = 180\Omega$

*Albright SW192B contactors must be used for FWD and REV contactors
**Albright SW200A contactors must be used for Drive and Regen contactors

Wiring Option:
Non-isolated Control and Reverse operation

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| Q.A. | | |
| ENGNR. | BP | 4/16/93 |
| CHECKED | STL | 4/16/93 |
| DRAWN | BP | 4/16/93 |
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN | | |

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Wiring Diagram
Regenerative Braking Controller

| CODE IDENT NO. | SIZE | | REV. |
|---|---|---|---|
| 18583 | A | WD14495R004 | A |