

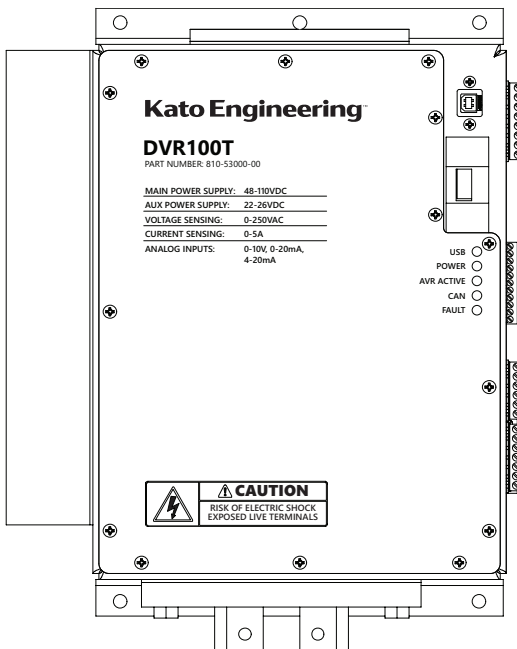
# Instruction Manual

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Installation  
Operation  
Maintenance

DVR100T  
Digital Voltage Regulator  
810-53000-00

Publication  
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***Nidec***

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**Warning:** *To prevent injury or equipment damage, all personnel involved in the installation, operation, and maintenance of this equipment must be qualified and informed of the current safety standards that govern his or her work.*



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## Forward

Please read this manual and all included manual package information in entirety before unpacking, installing, or operating the DVR100T. If this manual came on a CD, read all files included on the CD.

To prevent injury and equipment damage, everyone involved in installing, operating and maintaining the equipment described in this manual must be qualified and trained in current safety standards governing his or her work.

Because of rapid changes in designs and processes and the variability of Kato Engineering's products, information in this manual must not be regarded as binding; the information is subject to change without notice. Images are for representation only. Refer to supplementary information in the Manual Package for specific information for your equipment.

## SAFETY FIRST

While "common-sense" prevention of injury or equipment damage cannot be completely defined by any manual (nor built into any piece of equipment), the following paragraphs define notices used in this manual:

**Warning:** Identifies an installation, operation or maintenance procedure, practice, condition or statement that, if not strictly followed, could result in death or serious injury to personnel.

**Caution:** Identifies a hazardous situation that, if not avoided, could result in minor or moderate injury.

**Note:** Identifies an installation, operation or maintenance procedure, practice, condition or statement that, if not strictly followed, could result in destruction of or damage to equipment or serious impairment of system operation.

**Important:** Identifies information for emphasis or clarity.

## Revision History

The following tables contain the revision history for this instruction manual (Table 1), firmware (Table 2), and software (Table 3).

*Table 1 Instruction Manual Revision History*

Revision	Date	Description
1.0.0	8/2017	Original release

*Table 2 Firmware Revision History*

Revision	Date	Description
1.0.0	8/2017	Original release

*Table 3 Software Revision History*

Revision	Date	Description
1.0.0	8/2017	Original release
1.0.1	9/2017	Moved flashing routine

## Introduction

This manual contains the instructions to properly install, operate, and maintain Kato Engineering's DVR100T. The DVR100T is a digital voltage regulator used for brush excitation systems, and is used primarily on synchronous alternators in locomotive and traction applications.

## SYSTEM DESCRIPTION

The DVR100T digital voltage regulator provides brush-type excitation control for alternators in locomotive and traction applications. It uses a current mode pulse with modulated output that can be sourced from a battery or other DC supply. This regulator is essentially a "buck" type regulator that can deliver up to 96% of the source voltage to the load. An internal 130A fuse provides protection against short circuit faults. MOSFETs are used as the main switching component and have been designed to minimize losses while providing high reliability. The DVR100T can provide up to 80A continuously and up to 100A for short periods of time.

The DVR100T has the ability to precisely monitor, control and protect using a modern user interface. There is also the ability to monitor remotely with the universal interface card.

## DVR100T Features

This section describes the functional features and parameters provided with the DVR100T. Access all programmable features through the graphical user interface or through the universal communications card. The initial setup for the DVR100T allows the user to configure the device to their system. See Table 4.

**Table 4 Device Features**

Parameter	Feature
Overview	<ul style="list-style-type: none"> <li>Digital excitation control using an advanced microcontroller with digital signal processing capabilities</li> <li>Programmable Soft Start and V/Hz</li> <li>Four programmable digital inputs</li> <li>Three programmable relay outputs</li> <li>One service relay output</li> <li>Auxiliary DC power supply input</li> <li>Four programmable analog inputs</li> <li>DC supply outputs (+24V, +/-15V) for powering analog sensors</li> <li>USB for connecting to user interface</li> <li>Universal communications card for remote monitoring and connecting to user interface</li> </ul>
Excitation Control Modes	<ul style="list-style-type: none"> <li>Automatic voltage regulation (AVR)</li> <li>Field excitation regulation (FCR)</li> </ul>
Monitoring Features	<ul style="list-style-type: none"> <li>Three phase voltage (RMS) (Volts L-L (V))</li> <li>Three phase current (RMS) (Volts L-N (V))</li> <li>Average voltage</li> <li>Average current</li> <li>High phase voltage</li> <li>Low phase voltage</li> <li>High phase current</li> <li>Low phase current</li> <li>Real power (KW)</li> <li>Reactive power (KVAR)</li> <li>Apparent power (KVA)</li> <li>Power factor (PF)</li> <li>Frequency voltage</li> <li>Frequency current</li> <li>Exciter field voltage (V)</li> <li>Exciter field current (A)</li> <li>DC input bus voltage (V)</li> <li>Power stage temperature (°C)</li> <li>Control board temperature (°C)</li> <li>PWM duty cycle</li> </ul>

## Protection Features and Limitations

The DVR100T contains protection features that can be adjusted to meet the needs of the system. This section describes the internal protection features (see Table 5) and programming protection limits (see Table 6).

**Table 5 Internal Protections**

Feature	Parameter
DC Bus Overvoltage	Fault produced when voltage exceeds factory limitation for the DC bus.
Overfield Current	Fault produced when field current exceeds 100A for more than :02 (two seconds)
Power Stage Protection	Overfrequency set point (in Hz) Time delay (in seconds)

**Table 6 Programmable Protections**

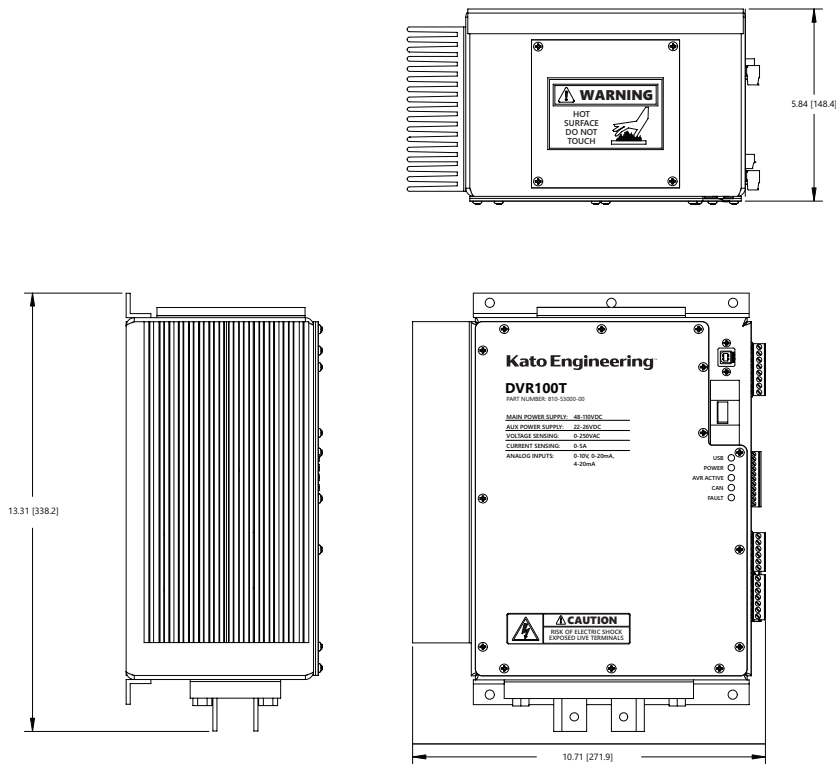
Feature	Measurement	Programmable Elements
Overvoltage	Timed fault and alarm only	Overvoltage set point (percentage of rated voltage) Time delay (in seconds)
Undervoltage	Timed fault and alarm only	Undervoltage set point (percentage of rated voltage) Time delay (in seconds)
Overfrequency	Timed fault and alarm only	Overfrequency set point (in Hz) Time delay (in seconds)
Underfrequency	Timed fault and alarm only	Underfrequency set point (in Hz) Time delay (in seconds)
Overcurrent	Instantaneous overcurrent fault	Instantaneous overcurrent fault (percentage of rated current) Time delay (in seconds)
	Timed overcurrent fault	Timed overcurrent fault (percentage of rated current) Time delay (in seconds)
V/Hz Limiting	Preset value	V/Hz knee and slope

## Specifications

This section contains the dimensional, electrical and environmental specifications, as well as the certifications for the DVR100T.

### DIMENSIONS

The DVR100T dimensions are 13.31 x 10.71 x 5.84" (338.2 x 271.9 x 148.4 mm). See Figure 1.



**Figure 1 Dimensions**

## ELECTRICAL SPECIFICATIONS

This section provides electrical specifications for the DVR100T. See Table 7.

*Table 7 Electrical Specifications*

Element	Parameter	Specification
Main Power Supply	DC Voltage Nominal	72V
	DC Voltage Range	43V - 110V
	DC Current Cycle	Dependent on Output Current and Duty
	Polarity Protected	No
Auxiliary Power Supply	Voltage Nominal	24VDC
	Voltage Range	+22VDC - 26VDC
	Burden	7W
Alternator Voltage Sensing	Type	1-phase, 3-phase (3-wire)
	Burden	<1VA
	Voltage Range	0VAC - 25VAC-RMS (Isolated)
	Frequency Range	0Hz - 420Hz
Alternator Current Sensing	Type	1-phase or 3-phase
	Burden	<1VA
	Current Range	5A AC nominal
	Frequency Range	0Hz - 420Hz
Analog Inputs	Type	0-20mA/4-20mA/0-10V
	Resistance	1k $\Omega$ (0-10V) 500 $\Omega$ (0-20mA)
	Conversion Range	0-20mA/4-20mA/0-10V
	Accuracy	1% full scale
DC Supply Outputs (For External Sensors Only)	24VDC Max Burden	12W
	+15VDC Max Burden	3W
	-15VDC Max Burden	3W
Digital Inputs	Type	Non-isolated, Dry Contact
	Resistance	3.8k $\Omega$
Relay Outputs	Type	Form A x 3 Sealed
	Contact Material	Ag5In
	Operator Time	10ms
	Release Time	5ms
	Minimum Load	100mA@5VDC
	Maximum Load	3A@150VAC Resistive 3A@24VDC

## ENVIRONMENTAL SPECIFICATIONS

This section provides environmental specifications for the DVR100T. See Table 8.

*Table 8 Environmental Specifications*

Element	Parameter	Specification
Temperature	Operating	-40 to +70°C
	Storage	-40 to +85°C
Shock	TBD	
Vibration	TBD	

## FUNCTIONAL BLOCK DIAGRAM

The DVR100T uses a Digital Signal Processor (DSP) to manage the conversion of data and all communications, controls the field power and relay outputs, and monitors the protection parameters and digital inputs. See Figure 2.

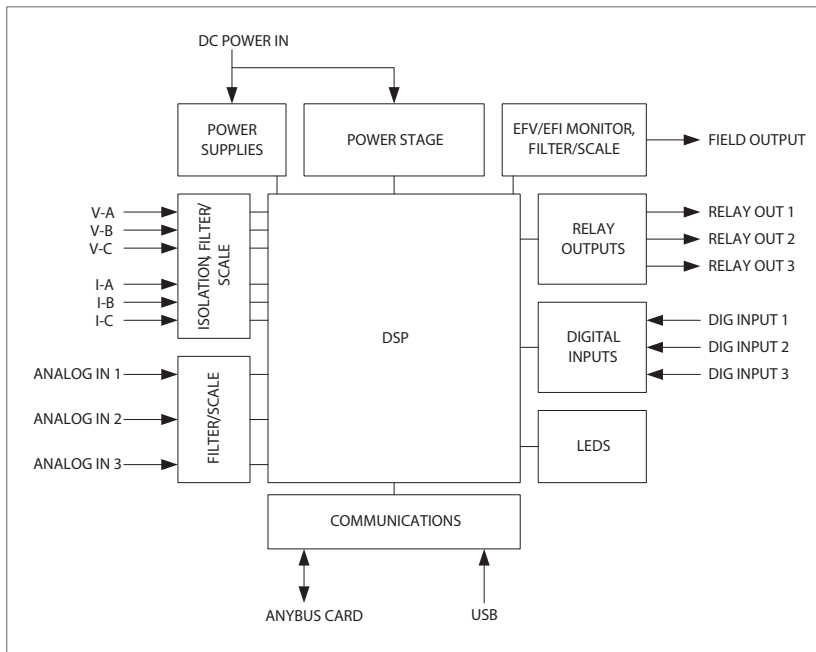


Figure 2 Functional Block Diagram

## FRONT PANEL INTERFACE

The front panel of the regulator contains the communication interfaces and the LED status indicators. See Figure 3 and Table 9.

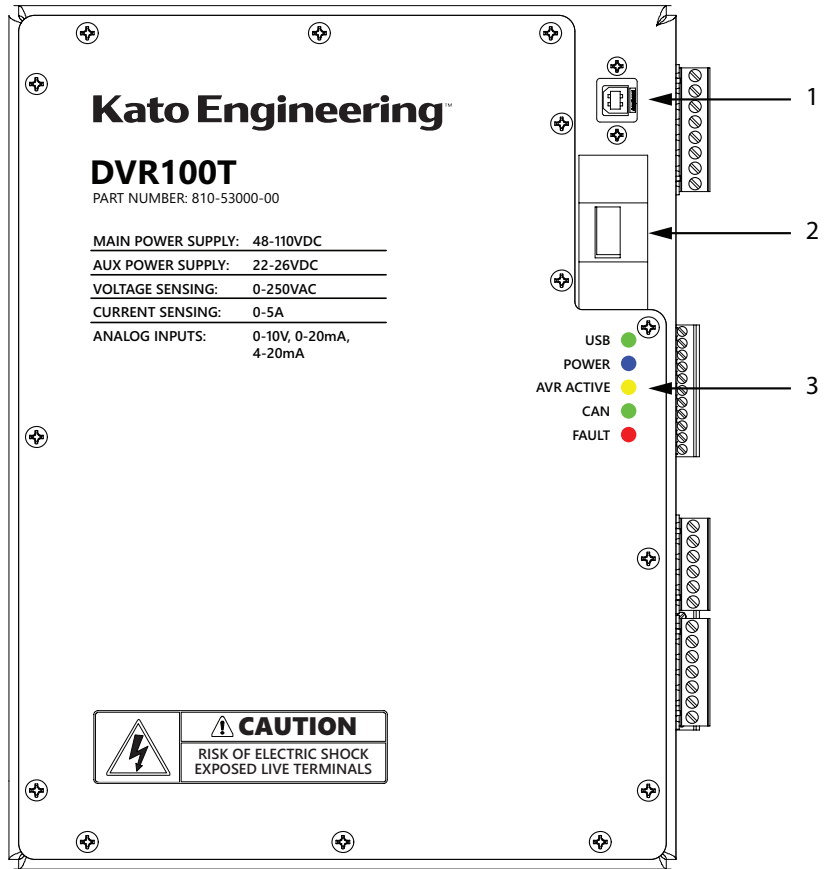


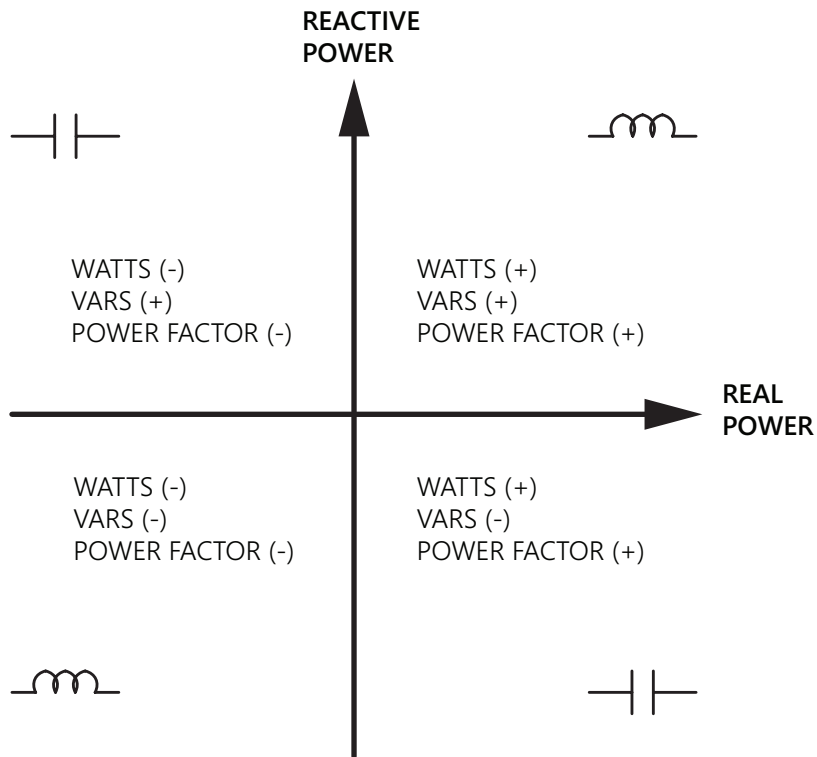
Figure 3 Front Panel Interface

Table 9 Front Panel Information

Item	Description
1	USB Type-B isolated communication port used to connect to the general user interface. This port can also power some of the internal power supplies with the use of external power.
2	Universal communications card port.
3	LED status indicators: <ul style="list-style-type: none"> <li>• <b>USB:</b> A solid green LED indicates the USB is connected.</li> <li>• <b>POWER:</b> A solid blue LED indicates there is power to the regulator. The main operating power input, auxiliary supply input and USB illuminate this LED.</li> <li>• <b>AVR ACTIVE:</b> A solid yellow LED indicates that regulation is active.</li> <li>• <b>CAN:</b> The CAN interface is not used in this design revision.</li> <li>• <b>FAULT:</b> A solid red LED indicates a fault has occurred.</li> </ul>

## Power Factor Sign Convention

The DVR100T follows the IEC power factor sign convention shown in Figure 4.



*Figure 4 Power Factor Sign Convention*

# Installation

This section describes the mechanical and electrical installation requirements for the DVR100T.

## MOUNTING

The DVR100T must be mounted vertically to allow proper airflow through both the heat sink and the snubber plate. Proper heat rejection from the heat sink and the snubber plate each require a 3.0" clearance. For easy removal, maintain a clearance minimum of 1.5" from the terminal blocks and from the Main Operating Power/Field Power Output terminals. See Figure 5 for mounting provisions.

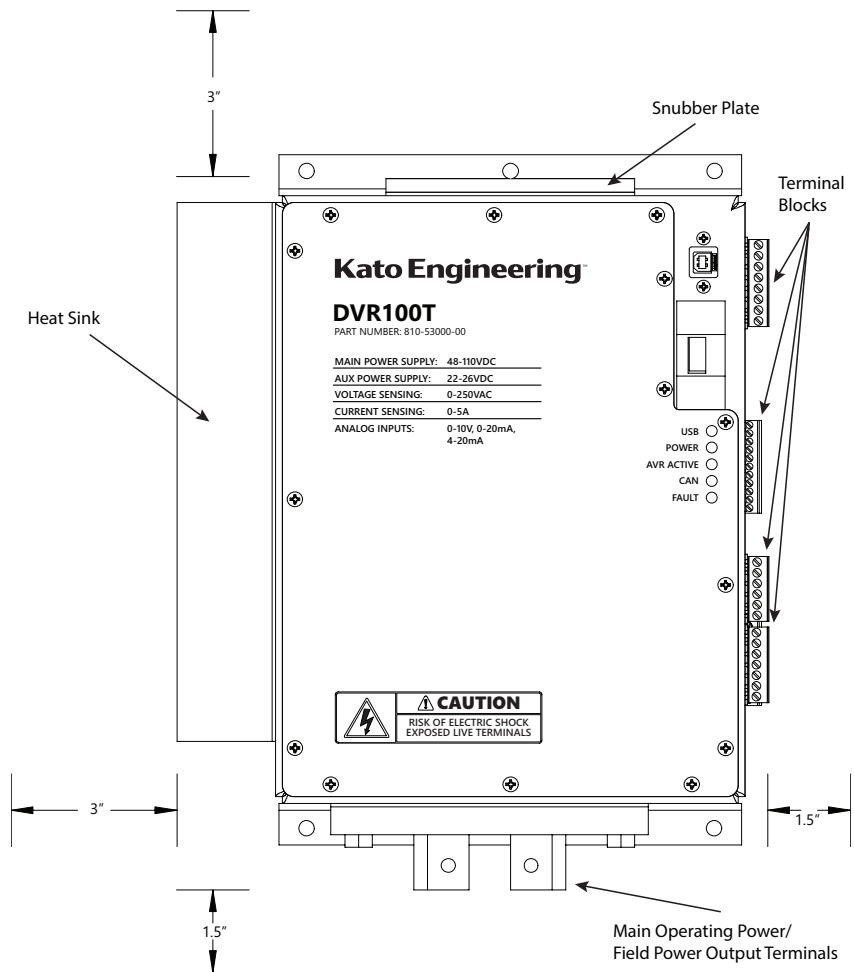
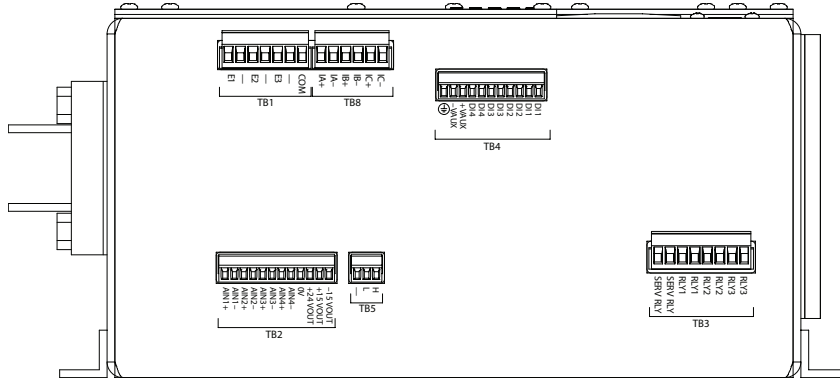


Figure 5 Mounting Provisions

## SYSTEM CONNECTIONS

The following section defines the terminal requirements and overall system connections for the DVR100T. Connections must be made as instructed in this manual and/or by any outside system drawings governed by Kato Engineering only. Make connections through the terminal blocks as shown in Figure 6.



**Figure 6 Terminal Connections**

Terminal block connection descriptions are listed in Tables 10-15. Typical system connections are shown in Figure 7 and Table 16 contains notes about the typical system connections.

**Table 10 Terminal Block 1 Connection Descriptions**

Terminal No.	Terminal Name	Description
TB1	E1	Voltage sensing input, Phase-A
	E2	Voltage sensing input, Phase-B
	E3	Voltage sensing input, Phase-C
	COM	Common - isolated

**Table 11 Terminal Block 8 Connection Descriptions**

Terminal No.	Terminal Name	Description
TB8	IA+	Current sensing input, Phase-A
	IA-	Current sensing input, Phase-A common
	IB+	Current sensing input, Phase-B
	IB-	Current sensing input, Phase-B common
	IC+	Current sensing input, Phase-C
	IC-	Current sensing input, Phase-C common

**Table 12 Terminal Block 4 Connection Descriptions**

Terminal No.	Terminal Name	Description
TB4	Ground	Chassis (safety) ground
	-VAUX	24VDC auxiliary input common
	+VAUX	24VDC auxiliary input (+)
	DI4	Digital input 4 dry contact
	DI4	Digital input 4 dry contact
	DI3	Digital input 3 dry contact
	DI3	Digital input 3 dry contact
	DI2	Digital input 2 dry contact
	DI2	Digital input 2 dry contact
	DI1	Digital input 1 dry contact
DI1	Digital input 1 dry contact	

**Table 13 Terminal Block 2 Connection Descriptions**

Terminal No.	Terminal Name	Description
TB2	AIN1+	Analog input 1 (+)
	AIN1-	Analog input 1 return
	AIN2+	Analog input 2 (+)
	AIN2-	Analog input 2 return
	AIN3+	Analog input 3 (+)
	AIN3-	Analog input 3 return
	AIN4+	Analog input 4 (+)
	AIN4-	Analog input 4 return
	0V	Analog input/sensor output common
	+24VOUT	+24VDC sensor power output
	+15VOUT	+15VDC sensor power output
	-15VOUT	-15VDC sensor power output

**Table 14 Terminal Block 5 Connection Descriptions**

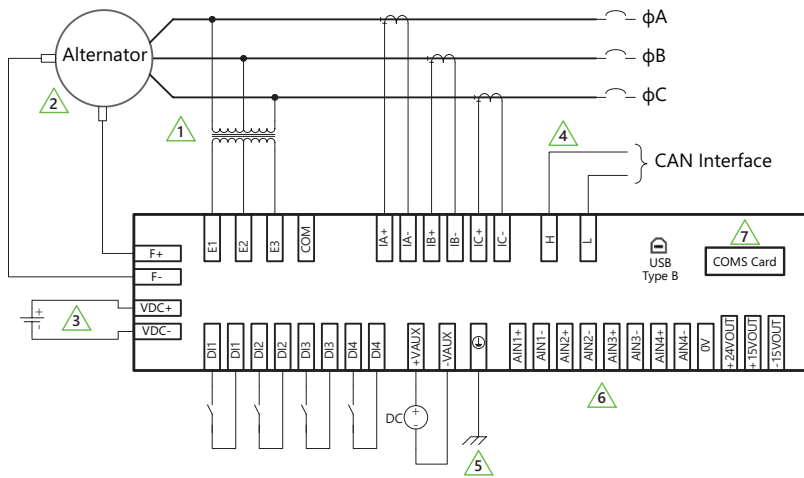
Terminal No.	Terminal Name	Description
TB5	-	No connect
	L	CAN interface low (see Note 1)
	H	CAN interface high

Note 1: CAN interface not used in this revision.

**Table 15 Terminal Block 3 Connection Descriptions**

Terminal No.	Terminal Name	Description
TB3	SERV RLY	Service relay output NC (see Note 2)
	SERV RLY	Service relay output NC
	RLY 1	Auxiliary relay 1 output NO
	RLY 1	Auxiliary relay 1 output NO
	RLY 2	Auxiliary relay 2 output NO
	RLY 2	Auxiliary relay 2 output NO
	RLY 3	Auxiliary relay 3 output NO
	RLY 3	Auxiliary relay 3 output NO

Note 2: The service relay is a Form A contact, but is operated like a NC contact.



**Figure 7 Typical System Connections**

**Table 16 Typical System Connection Notes**

Item	Description
1	If voltage is greater than 300VAC, a potential transformer is required.
2	Diagram represents connection to the main field using brushes. This regulator can also be used in a brushless excitation system.
3	Use caution when connecting the main DC power inputs. Refer to "Main Operating Power Input" on page 18 under Electrical Installation for more information.
4	CAN connections are represented but they are not implemented in the current revision. Contact Kato Engineering for more information.
5	This connection represents chassis ground.
6	See "Analog Inputs" on page 25 under Electrical Installation for proper connection information.
7	Universal communications card slot. For more information, see Configure TCP/IP Settings of Communication Modules under Appendix.

**Note:** To prevent injury or equipment damage, all personnel involved in the installation, operation, and maintenance of this equipment must be qualified and informed of the current safety standards that govern his or her work.

All local and national electrical codes that apply must be followed. Failure to do so may result in equipment damage.

**Caution:** To prevent injury or equipment damage, it is important that all procedures are followed as stated in this manual during the installation and operation of this product.

**Caution:** These terminals are exposed. There is a risk of electrical shock when power is applied.

## ELECTRICAL INSTALLATION

This section provides detail for the electrical installation procedure. The intent of this section is to provide the most typical connection schemes available to this device. It is not possible to present all of the available connection types in this manual.

### Main Operating Power Input

The main operating power input can be connected to a battery or other DC supply. The input provides power for all internal components and the excitation output for the alternator. The terminals are located on the bottom of the DVR100T. See Figures 8, 9 and 10.

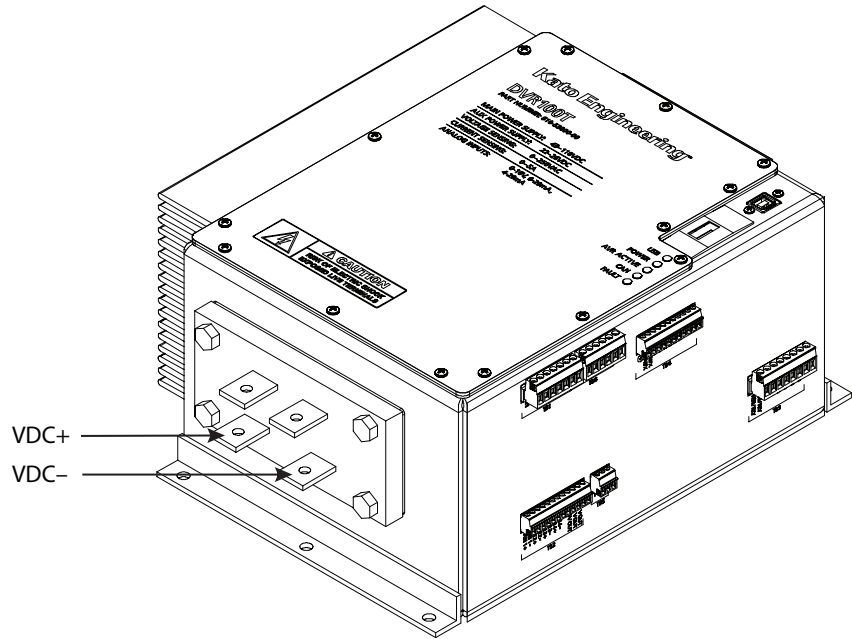


Figure 8 Main Operating Power Terminal Location

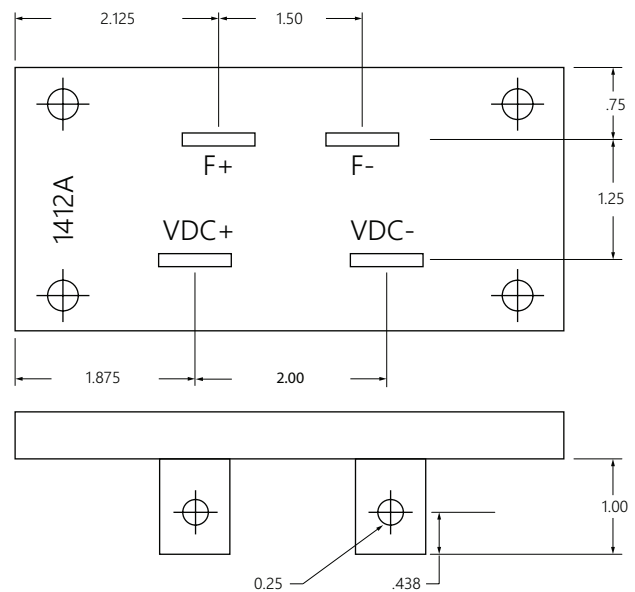


Figure 9 Main Operating Power Terminal Dimensions



Figure 10 Main Operating Power Connections

**Note:** The operating power inputs are not polarity protected. It is extremely important the positive (+) and negative (-) inputs are terminated properly. Permanent damage to the regulator will occur if this is not followed.

### Field Power Output

The field power output can be connected to the (F+) and (F-) terminals of either a brushed or brushless excitation system on the alternator. See Figures 11 and 12.

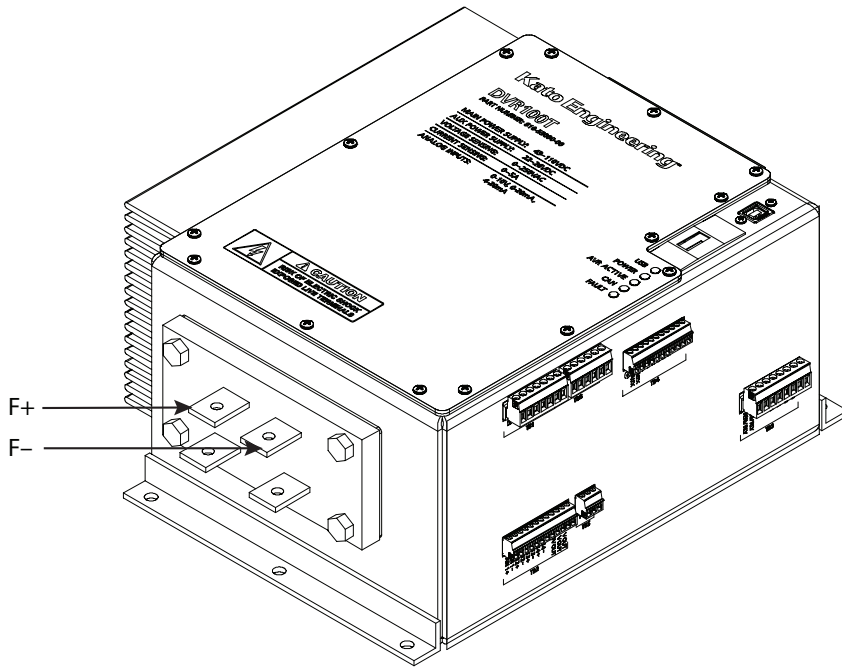


Figure 11 Field Power Output Terminals



Figure 12 Field Power Output Connections

## Auxiliary Power Input

The auxiliary power input is provided for testing and calibration purposes. It also provides a low voltage supply option for the end user. See Figure 13.

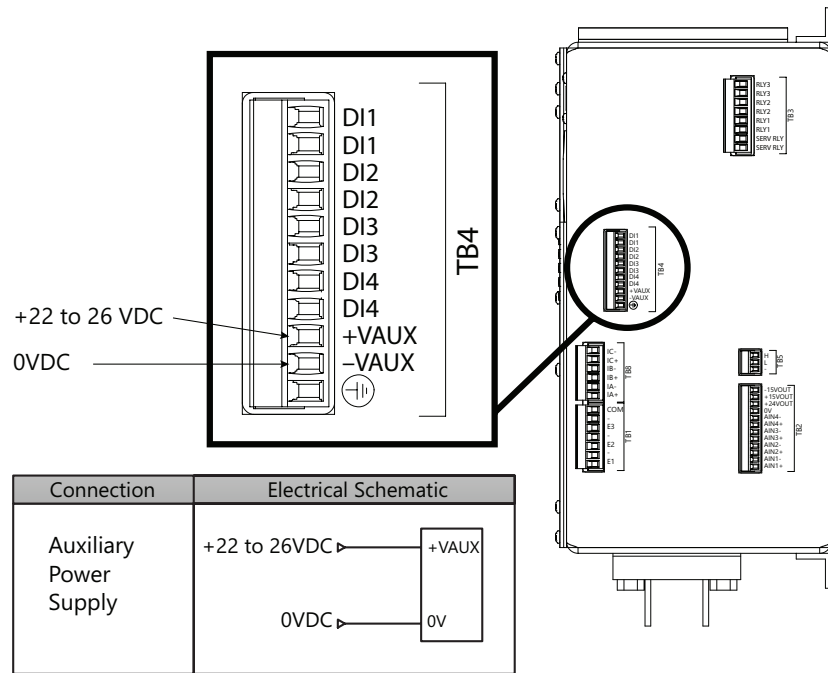


Figure 13 Auxiliary Power Input Connections

## Voltage Sensing Inputs

The DVR100T has three inputs (3-wire) for the main voltage sensing. The maximum voltage at any of these inputs is 250VAC. The maximum programmable PT primary setting is 20000.0. The maximum PT secondary setting is 350.0. These maximum settings also apply to the bus voltage input. The inputs are isolated internally through board mounted transformers, providing a low burden (<1VA) connection. See Figure 14.

**Caution:** Correct polarity of these inputs is important for correct power measurements as well being able to parallel units on the correct phase. Failure to verify these inputs can result in damage to equipment and/or injury and possible death to personnel.

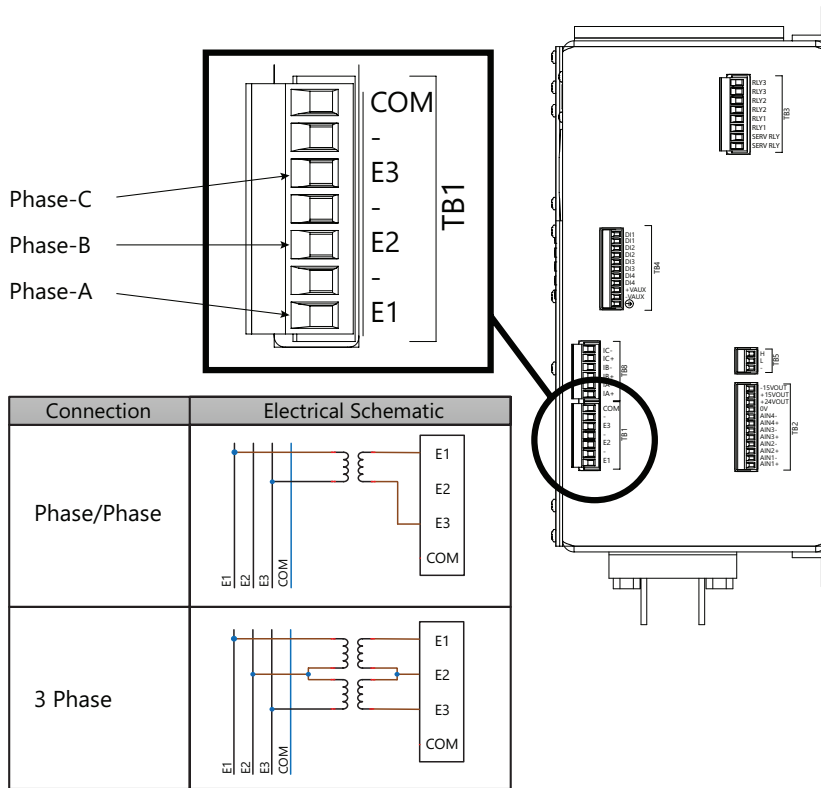


Figure 14 Voltage Sensing Input Connections

**Caution:** Dangerous voltages can be present at the current transformer terminals and/or leads if there is a disconnection when current is passing through the CT primary windings.

## Current Sensing Inputs

There are three 5A current inputs; the maximum CT primary setting is 20000.0. The current inputs are internally isolated through a board mounted CT, providing a low burden (<1VA) connection. See Figure 15.

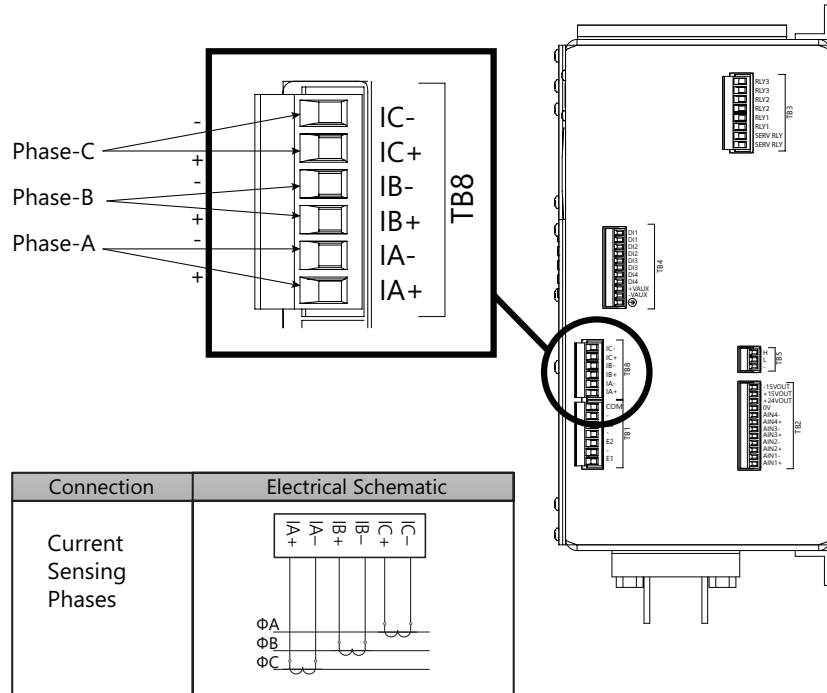


Figure 15 Current Sensing Input Connections

## Digital Inputs

There are four programmable digital inputs on the DVR100T. The digital inputs can accept either a dry contact input or an open drain sink circuit. See Figure 16.

**Caution:** Do not impose the voltage at the digital inputs. Imposed voltage may result in damage to the device.

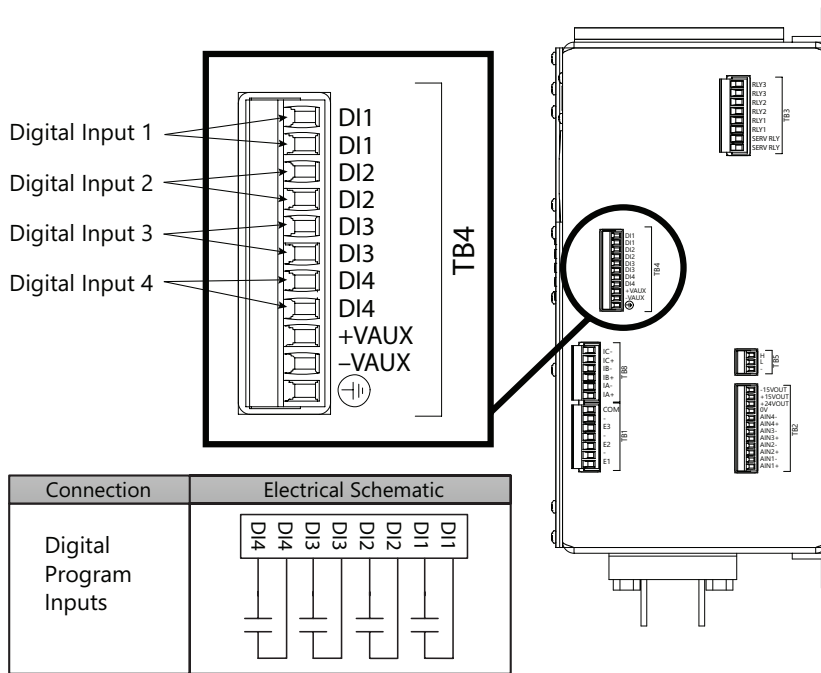


Figure 16 Digital Input Connections

## Relay Outputs

There are three programmable relay outputs and one service relay output. Relays 1-3 are a Form A sealed type that can be programmed to be normally open (NO) or normally closed (NC). During normal operation, the service relay contact closes when power is applied. The service relay contact opens when power is removed or an internal error occurs. See Figure 17.

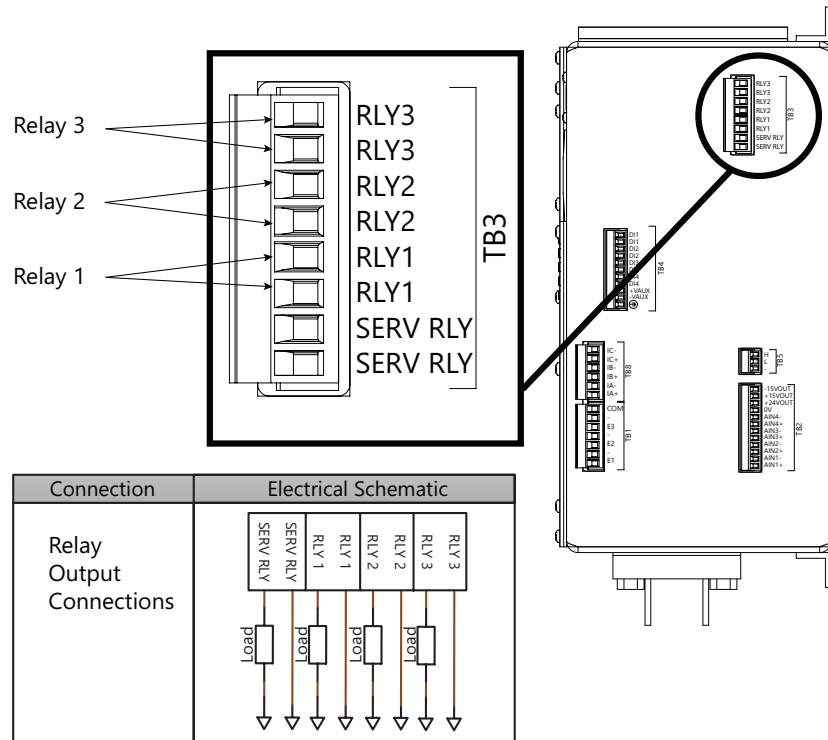


Figure 17 Relay Output Connections

## Analog Inputs

Each input is defined by its signal type (0-20mA, 4-20mA, 0-10V) and by its minimum and maximum limits. The 10V is only present on the terminal block to create a voltage reference or to use potentiometers with a value >1k Ohms configured in 0-10V mode. See Figure 18.

**Caution:** Due to the direct connection to the generator windings, isolation requirements must be taken into consideration based on safety regulation requirements. The analog inputs are non-isolated. The 0V is referenced to the product earth.

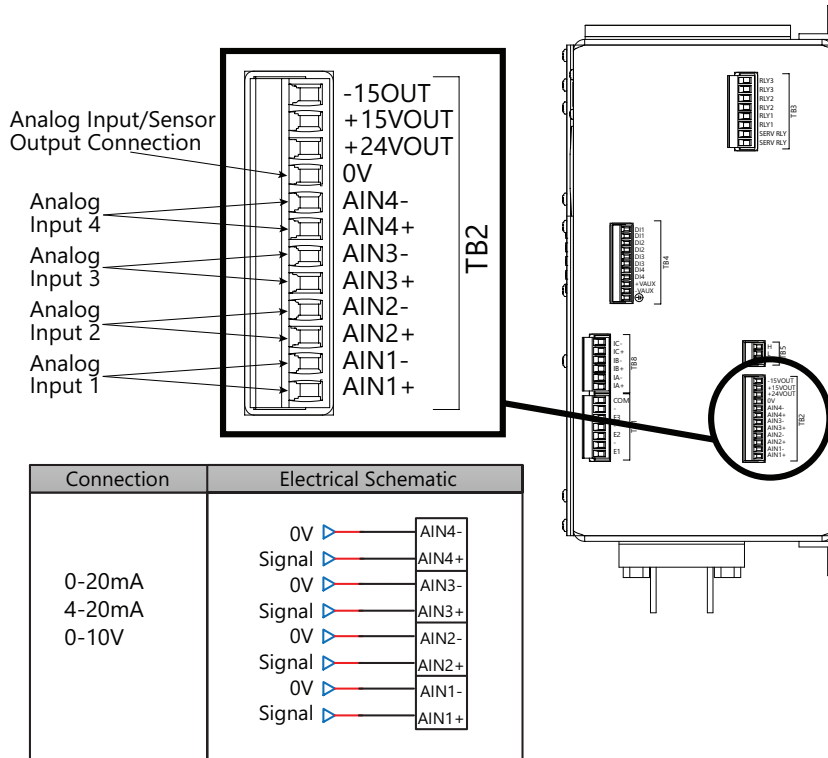


Figure 18 Analog Input Connections

## Sensor Power Supply Outputs

The sensor power supply outputs provide voltage source for various metering/sensing instruments. See Figure 19.

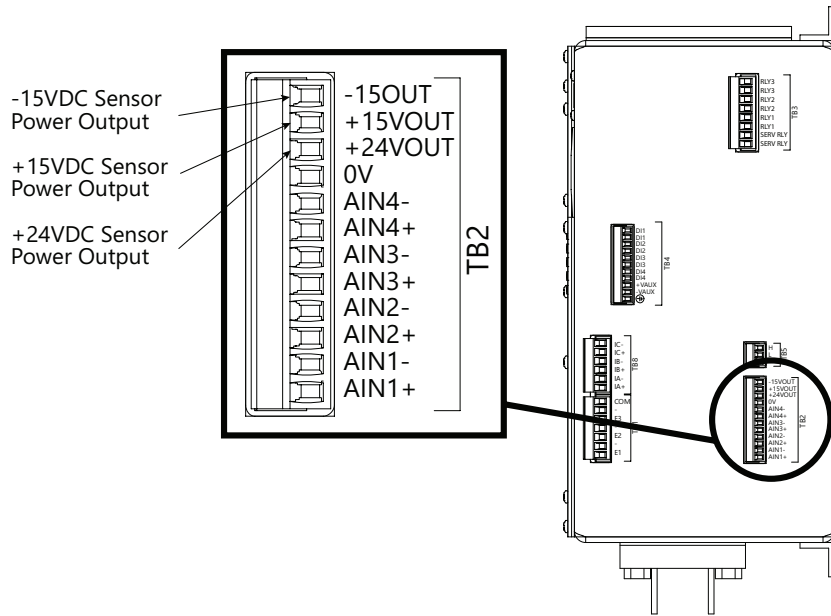


Figure 19 Sensor Power Supply Output Connections

## CAN Interface

The CAN interface feature is not implemented in this design revision. See Figure 20.

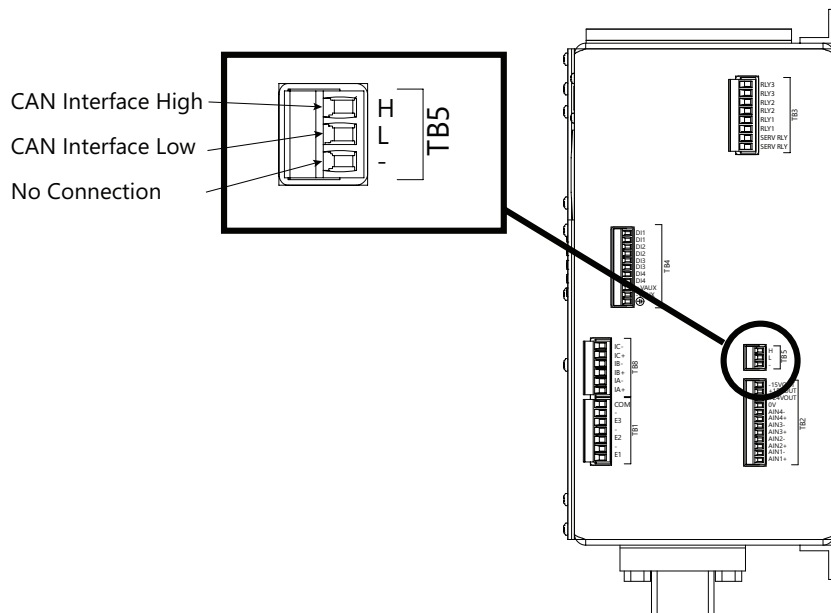


Figure 20 CAN Interface Connections

## **Maintenance**

Perform preventive maintenance when the alternator is stopped and all power sources are switched off and isolated.

During phases of alternator downtime, check wire connections (torque should be between 0.6 Nm and 0.8 Nm). Blow dry air through to remove any dust that may have accumulated. Ensure free air circulation around the aluminum heat sink.