

VEC205F

Generator Static Exciter



Description

The VEC 200 series is a family of products that includes AVRs (Automatic Voltage Regulators) for Generators, Static Excitators and Drives for Synchronous Motors and Alternators, high-current Controlled Rectifiers or simple 1-quadrant Drives for DC motors. VEC205F is an AVR - (Automatic Voltage Regulator) / Static Exciter for use in all types of alternators.

VEC205F is economical, with single-board architecture, Plug-In and highly reliable. VEC205F has some built-in functions and protections. The type of control signal can be chosen when purchased. Voltage sensing is done synchronously via Sample & Hold integrated circuit and after filtering (Averaged), which enables low second-order delay and fast response time.

VEC205F has independent P + I + D settings which is different from a single PID circuit, which together with the Sensing features allows it to operate virtually on any machine. Five settings are available on the front panel. Seven LEDs signal functions and fault conditions. Eight DIP switches on the front panel simplify function selections. The removable connector enables easy control module replacement.

VEC205FC control module is the heart of the system when plugged into the power module, from 10 to 2000 Amps. It forms the final equipment, which could be an AVR, a compact Exciter, or if mounted inside a panel, with auxiliary equipment (such as Circuit Breaker, Crowbar, fuses and transformers), a complete Static Excitation system.

VEC205F is a good choice for an economical and reliable device with good performance. The single-board architecture with encapsulated modules allows high tolerance to harsh environments and vibrations, as well as easy maintenance with a simple module change. The power semiconductors are encapsulated module type, with an isolated base in equipment up to 1250 Amps, allowing clean and reliable assembly.

The control module can control a fully controlled or semi-controlled three-phase or single-phase thyristor bridge. There are two KVAR compensation modes available for generator paralleling: by an external power factor transducer or by an internal power factor transducer included in the module. The P.F. read by the Power Factor transducer is added to the voltage readings to obtain the Droop by the Reactive Power Factor Compensation method.

The Firing modules are completely encapsulated in high insulation epoxy resins (20000 V/mm) with optical insulation.

> Main Features

- › **Applications:** AVR and Static Exciter for Synchronous Alternators.
- › **Available Control Signals:** 0 to 5V, 0 to 10V, Potentiometer, 0 to 20mA, 4 to 20MA.
- › **Modes:** Voltage regulation with Droop per KVAR (with pound), allowing Reactive Droop Compensation for generators operated in parallel or with the mains (Cogeneration).
- › **Trips:** Overvoltage, Underfrequency, Overtemperature and Signal loss.
- › **Signaling:** Power On, Enabled, Droop, Signal Loss, Overvoltage, Underfrequency and Overtemperature.
- › **Functions Selections:** Inhibit on Fault. Internal/External P.F.; P.F. Polarity; Wide/Strong Adjustment Range; Proportional Enable; Integration Enable; Derivative Enable; Auto/Manual Mode Enable.
- › **Bridges:** 3 Phases or 2 Phases, semi-controlled or fully controlled.

VEC205F (VEC 20X series) is a good choice for generator excitation. It can be used as an AVR/Exciter for generators with an auxiliary mechanical Exciter or a Brushless generator, or as a Static Exciter for generators with slip rings.

The design was developed primarily to achieve high reliability and simplicity. It can be applied to machines up to 30,000 KVA or more. The encapsulated single-board architecture allows for clean and reliable assembly. It allows easy commissioning and use.

LED signals and DIP switches make the equipment user-friendly and intuitive. Five input signal options are available. A complete range of Excitators is available.

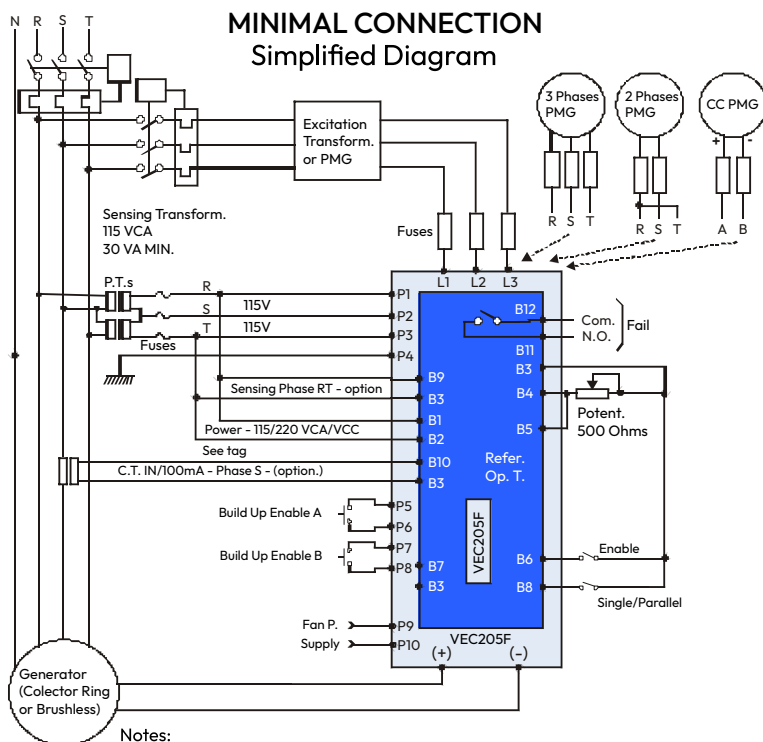
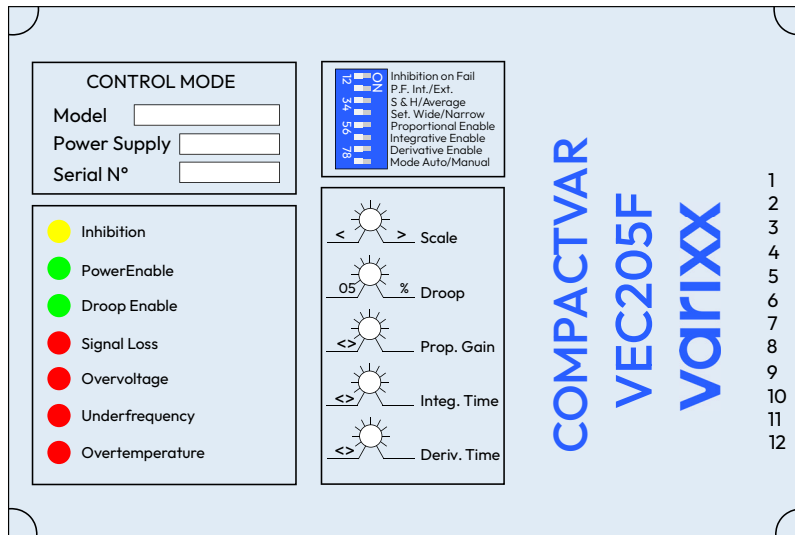
Generator Excitation

- › **AVR (Automatic Voltage Regulator):** Voltage Regulator for Brushless Alternator or with External Auxiliary Rotary Exciter for up to 50 Amps of Field Current.
- › **Static Exciter for Collector Ring Generator for up to 2000 Amps of Field Current:** It allows constant voltage to be maintained at the generator output and with Droop by KVAR (Reactive Current Compensation) in generators operated in parallel to share the KVAR with other machines or with the company's power grid. The reactive load is divided using the Droop method proportional to the machine's Power Factor.

The Power Factor is measured digitally, by means of P.T. and C.T. signals in the stator circuits or by an external transducer, such as the GE Multilin model SPM. In both cases, the Droop rate can be adjusted from 0 to 10%. The regulation mode can be selected by an external command, for Constant Voltage or Constant Voltage with Reactive Droop Compensation (Compound).

The Signal Loss, Generator Overvoltage, Generator Under-Rotation and Exciter Overtemperature are active in this application. Some parameters can be adjusted on the front panel: Proportional Gain (P; proportional action), Integration Time (I; integrative action), Derivation Time (D; derivative action), Voltage Scale and Droop Percentage from 0 to 10%. Automatic priming with manual enable available.

The operating mode can be selected as Automatic or Manual. Manual operation can be used for a full-range generator voltage setting, especially with an auxiliary power supply, for testing and characteristic measurement purposes or for emergency operation as a second manual channel or manual Follow Up. Manual mode (or Drive mode) can be used as a Drive for an external regulator acting on the operating point input (Setting).



- Notes:
1. The Circuit Breaker CB2 and its connections is not used in case of PMG - Permant Magnet Generator.
 2. The Build Up Enable button is not used in case of use with PMG.
 3. If used with PMG with 2 Phases connect input T together input R.
 4. Connect Power Input (1 and 2) to PMG if its voltage range is adequate.
 5. All Wires to connector 3 (Common) must be connected straight to it.

Selections on DIPs Switches

- › **S1 - Fault Inhibit:** Selects the output Inhibit function in the event of a fault. If not selected, the only action will be a signal from the Fault relay.
- › **S2 - Internal/External Droop:** Selects the Power Factor signal transducer for Droop.
- › **S3 - Sensing Type:** Selects the type of Sensing used: **Sample & Hold** which provides faster response but is slightly sensitive to distortion of the generator waveform and **Average** which has a second-order delay but is more insensitive to distortion of the generator waveform.
- › **S4 - Selects Wide/Narrow Arrowing:** Selects narrow or wide arrow range (100%/20% of scale).
- › **S5 - Proportional Gain:** Enables the proportional gain error amplifier. The value should be adjusted on the front panel for the best response, no oscillations and minimum Undershoot and Overshoot. Normally used in almost all applications.
- › **S6 - Integration Time:** Enables the portion I of the error amplifier. The integration time should be set on the front panel for the best stability and to obtain the minimum Overshoot and Undershoot with the fastest possible reaction time. Normally used in some applications.
- › **S7 - Derivative Time:** Enables the derivative gain error amplifier. The value should be set on the front panel to obtain the fastest reaction time, but without oscillations, and to obtain the minimum Overshoot and Undershoot. Used in some applications.
- › **S8 - Automatic/Manual or Regulator/Drive:** OFF selects Automatic (or Regulator) mode, with regulation based on the error signal. ON selects Manual (or Drive) which means that the output is only proportional to the setpoint reference signal. In this mode there is no local closed loop and the device is simply a Drive for external regulators or a manual Exciter.

LEDs Signaling

- › **L1 - Inhibit:** Yellow; signals that the equipment is powered.
- › **L2 - Power Enable:** Green; signals that the device is enabled by a signal on the corresponding connector.
- › **L3 - Droop Enable:** Green; signals that there is a Droop command on the corresponding connector.
- › **L4 - Signal Loss:** Red; signals Loss Signal (setage). This function is enabled by the control signal on the corresponding connector. The condition is stored until the power is switched off.
- › **L5 - Overvoltage Trip:** Red; signals a Trip due to excess voltage generated.

- › **L6 - Underfrequency Trip:** Red; signals a Trip by a machine under-rotation.
- › **L7 - Overtemperature:** Red; signals an overtemperature condition in the exciter's heat sinks.

NOTE: There is a delay of 2 to 3 seconds to prevent erroneous Trip. The Trip condition is memorized until the power is switched off, if the auxiliary power supply is used. Otherwise, if Fault Inhibit is selected or the signaling relay is used to trip the system, the indication will be lost because the power supply is zero. To reset a memorized fault indication, the module must be de-powered and powered up again.

Front Panel Settings

- › **P1 - Scale:** End-of-Scale calibration if 100% is selected on DIP S4, or Mid-Scale Nominal Value calibration if 20% (Narrow) is selected on DIP S4.
- › **P2 - Droop:** Adjustable from 0 to +10%. The 10% computation is obtained with a 90° Polar Angle on the rotor. Normally used from 0 to 5% for generators operating in parallel to maintain the correct division of reactive loads. Compensation will start at the Droop command. In single generator systems, without cogeneration, this function is not used.
- › **P3 - Proportional Gain:** Adjustable from 1 to 20. Active if selected on the corresponding DIP. As this is a pure proportional amplifier, this setting has an influence on dynamic regulation and static regulation. It should be adjusted to achieve the fastest compensation of input variations but without instability.

- › **P4 - Integration Time:** This is an amplifier with Integral gain and adjustable Integration time from 0.01 to 1 second. Active if selected on the corresponding DIP. It should be adjusted to obtain the best possible stability with minimum Overshoot and Undershoot. This portion of the error amplifier is mainly responsible for static regulation and should be selected in almost all cases.
- › **P5 - Differentiation Time:** Adjustable from 0.01 to 1 second. Active if selected on the corresponding DIP. Allows quick compensation for dynamic variations. Normally used for generators with a slow response time. It should be adjusted to obtain the fastest response and best stability. This portion of the error amplifier is mainly responsible for dynamic regulation.

> Control Modules

Electrical Features

TOP CONNECTOR	CONNECTOR (X/Common)		Minimum	Nominal	Maximum	
0 to 5V Setting	B4/B3	Input Impedance	—	10K	—	Ohms
0 to 10V Setting	B4/B3	Input Impedance	—	10K	—	Ohms
0/4 to 20mA Setting	B4/B3	Input Impedance	—	250	—	Ohms
500 Ohms Pot Setting	B4-B5/B3	Output Current	—	10	—	mA
0 to 5V P.F. Signal	B7/B3	Input Impedance	—	10K	—	Ohms
0 to 10V P.F. Signal	B7/B3	Input Impedance	—	10K	—	Ohms
0/4 to 20mA P.F. Signal	B7/B3	Input Impedance	—	250	—	Ohms
Ext. P.F. Input	B7/B3					
Voltage Phase Sensing (Internal P.F.)	B9/B3	Input Impedance	—	10K	—	Ohms
Voltage Phase Sensing (Internal P.F.)	B9/B3	Input Voltage	20	115	150	Volts
Current Phase Sensing (Internal P.F.)	B10/B3	Input Impedance	—	1	—	Ohms
Current Phase Sensing (Internal P.F.)	B10/B3	Input Current	0,1	—	1	Amper
Power Enable Input	B6/B3	Current Source	—	10	—	mACC
Droop Enable Input	B8/B3	Current Source	—	10	—	mACC
Fail Relay Contact	B11/B12	Voltage	—	—	240	VAC
Fail Relay Contact	B10/B11/B12	Voltage	—	—	30	VCC
Fail Relay Contact	B11/B12	Current	—	—	1	A AC
Fail Relay Contact	B11/B12	Current	—	—	0,25	A CC
Power Supply (115/220)	B1/B2	Voltage	92/176	115/220	138/264	VAC/CC
Power Supply	B1/B2	Power	—	4	—	Watts

DB15 CONNECTOR	CONNECTOR		Minimum	Nominal	Maximum	
Over Temp. Input (Dry Contact N.C.)	DB2/DB1	Source Current	—	2,5	—	mA CC
Sensing Input	DB6 to DB8/DB9	Input Voltage	—	18	—	VAC
Firing Signal	DB10 to DB15/DB9	Volts Output	10	11	12	Volts CC
Firing Signal	DB10 to DB15/DB9	Current Output	—	—	20	mA CC

TB/POWER CONNECTOR	CONNECTOR		Minimum	Nominal	Maximum	
Sensing	P1 to PB	Voltage Input	92/176	115/220	138/264	VAC
Power/Sincro	R/S/T	Voltage	30	—	254	Volts
Build Up Enable (Dry Contact N.O.)	P5/P6 P7/P8	Current	—	—	1	Amper
Fan Power Supply	P9/P10	Voltage	—	110/220	—	Volts
Fan Power Supply	P9/P10	Power		See tag		

The tables above show the electrical input and output data of the control module, for both connectors (the front connector and the rear - DB15 connector).

Some signals connected to the power module (P) are also shown. Some signals are chosen on request. The various options are therefore shown separately. The type and actual data are filled in on a Data sheet that is sent with the equipment.

The Data sheet shows some important information, including Signals, Power components, Delivery date, Warranty period, Input and Output characteristics, etc. The user manual includes this bulletin, electrical drawings, mechanical drawings, Start Up, instructions and the Data sheet.

Functions by Type of Application

FUNCTIONS	Type/Default	Dispositive
0 to 10 Volts Set	Option	Opt.
0 to 5 Volts Set	Option	Opt.
0 or 4 to 20mA Set	Option	Opt.
Potentiometer Set	Option	Opt.
100%/10% Set Selection	Select	S4 OFF/ON
Proportional Gain 1 to 20	Select./ Adjust	S5 ON/P3
Integrative Time TI= 0,01s to 1s	Select./Adjust	S6 ON/P4
Derivative Time TD= 0,01s to 1s	Select./Adjust	S7 ON/P5
Pure Voltage Regulation	Select	B8/B3 Open
Reactive Droop Compesation	Sel./Adj. 0 to 10%	B8/B3 Closed
Scale Adjust	Adjust	P1
Inhibition on Fall	Select	S1 ON
Sensing Selection	Sample & Hold/Average	S3 OFF/ON
P.F. Source	Select Inter./Exter.	S2 OFF/ON
Droop Range (adj. 0 - 5%)	Select/Adjust	B8-B3/P2
Setting Signal Loss	OK	L4
Over Voltage Trip	120%/0,5 sec.	L5
Underfrequency Trip	-15%/2 sec	L6
Over Temperature Trip	90°C	L7
Droop Enable Indication	OK	L3
Power Enable Indication	OK	L2
Inhibit Command Indication	OK	L1
Auto/Manul Selection	Select	S8 OFF/ON

Model VEC205F	Nominal Current (A)	Maxim. Current (1 min) (A)	Surge Current (10mS) (A)	Cooling Forc./Natural	Wide (W) mm	Tall (T) mm	Long (L) mm
0025	25	50	100	N	225	290	200
0050	50	100	200	N	240	290	270
0100	100	200	400	F	290	290	270
0150	150	300	600	F	340	290	270
0200	200	400	800	F	377	290	270
0250	250	500	1000	F	377	330	270
0300	300	600	1200	F	377	380	300
0400	400	800	1600	F	377	430	300
0500	500	1000	2000	F	377	480	300
0650	650	1300	2600	F	377	530	330
0750	750	1500	3000	F	377	580	330
1000	1000	2000	4000	F	540	850	315

The tables above show the available functions, with the type of action (selection or adjustment) and the scale of the adjustment.

In the event of Trip, the output will be inhibited (if S1 ON), the corresponding LEDs will be activated and the Trip relay will be energized. There is a time delay of approximately 3 seconds for the protection to take effect.

The error amplifier is selectable as type P + I + D. Note that this is different from a single PID amplifier. It can therefore be adapted to virtually any process due to its versatility. The user can select and adjust the required response types. The second portion, the error amplifier I, is mainly responsible for static regulation. Its Integration time is adjustable from 0 to 100% (0.01 to 1 sec). This portion of the error amplifier needs to be selected in almost all applications.

The first part of the error amplifier is a pure proportional gain amplifier and is responsible for dynamic regulation and static regulation. It is needed in almost all applications to reduce response time and obtain corrections quickly. It should be set as high as possible to obtain low response time, while avoiding instability and obtaining low Overshoot and Undershoot.

The third part of the error amplifier is a pure derivative gain amplifier and acts mainly in dynamic regulation. It is needed in some applications to increase stability and obtain quick corrections. It should be set as low as possible to obtain stability and better response time. Avoid using if not necessary.

> Control Module VEC205F

The diagram on the following page shows the connections for the VEC205FC's front connector and rear connector (DB15).

Connectors 1 and 2 are the 110 or 220 VAC control voltage inputs, depending on the model. Connector 3 is the common connector for all inputs. Connector 4 is the Setting input. This signal can be chosen on request (0 to 5 VCC or 0 to 10 VCC or 500 Ohms or potentiometer with digital scale, 0 to 20mA or 4 to 20mA).

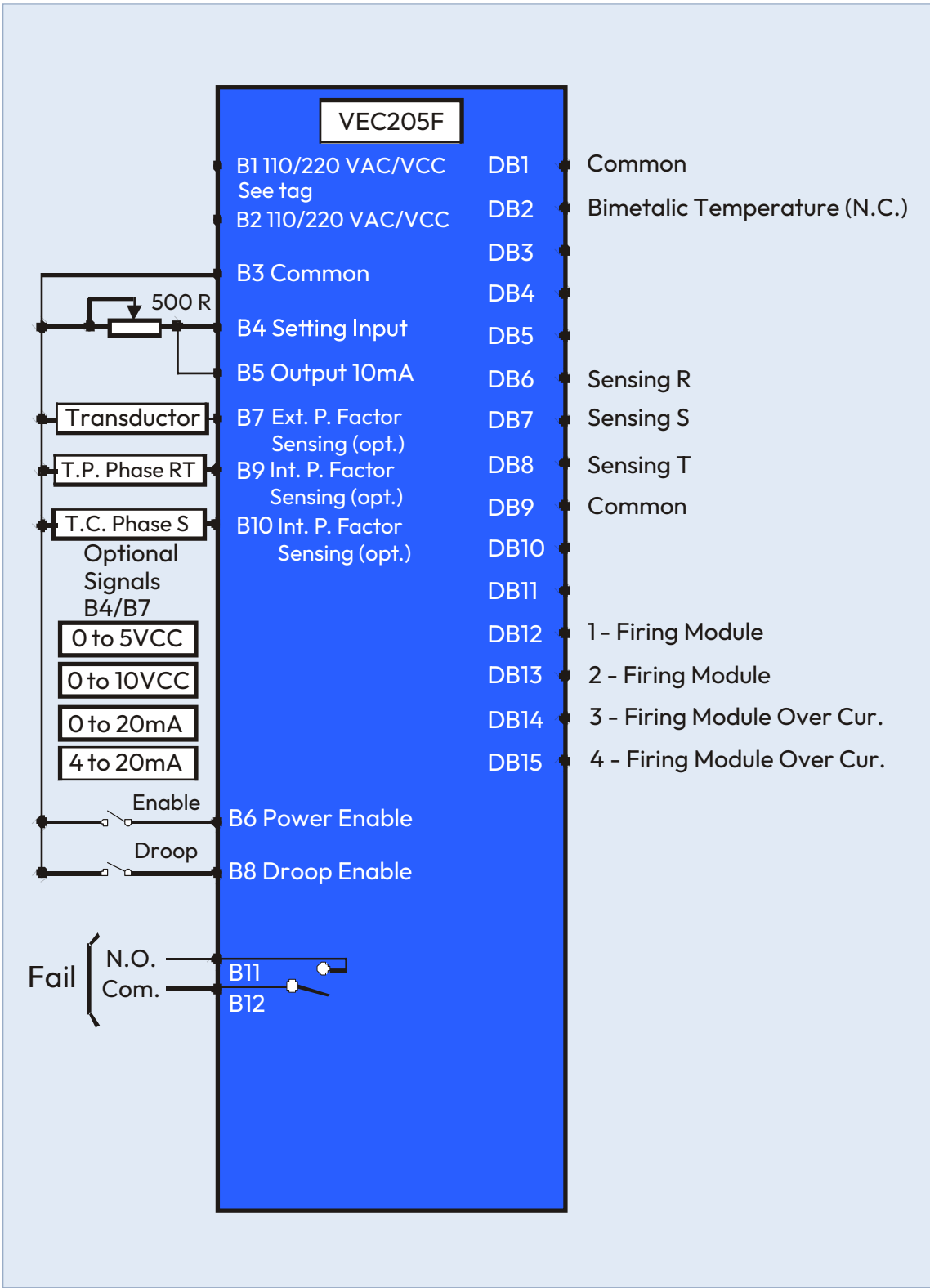
Connector 5 is an auxiliary current source (10mA) for direct use by a potentiometer to set the working point (500 Ohms in a 5 VDC model or 1K Ohms in a 10 VDC model). This output must be connected to connector 4 for use by the potentiometer. Connector 7 is the input for an optional secondary signal or Droop (same scaling options). This signal can be provided by a Power Factor transducer for example (Ex: GE-Multilin SPM), Hall effect sensor, Tachogenerator, etc.

Connector 9 is the input for an optional voltage transformer for the internal Power Factor transducer (for sensing the Polar Angle), obtaining internal Droop signal generation. Connector 10 is the input for an optional current transformer for sensing the Power Factor (sensing the Polar Angle), obtaining internal Droop signal generation.

Connector 6 is the input for a dry contact for the Power Enable command. Connector 8 is the input for a dry contact for Droop Enable. Connectors 11 and 12 are Normally Open (N.O.) dry contacts for fault indication.

DB1 and DB9 are the common inputs of the DB type connector (Rear). DB2 is an input for a dry contact Normally Closed (N.C.) from a temperature sensor (common to DB1). DB3, DB4 and DB5 connectors are used for synchronizing thyristor firing. Connectors DB6 to DB8 are voltage sensing inputs (common in DB9). DB10 to DB15 connectors are the outputs for firing the thyristors (common in DB9).

Signals for connectors 4/5, 6, 7, 8/9 and 10 should preferably be routed with shielded cable with shielding mesh connected to connector 3 (Common).



Exciters for Generators

This application is for all types of alternator (Collector Ring, Brushless or Collector Ring with auxiliary rotary Exciter).

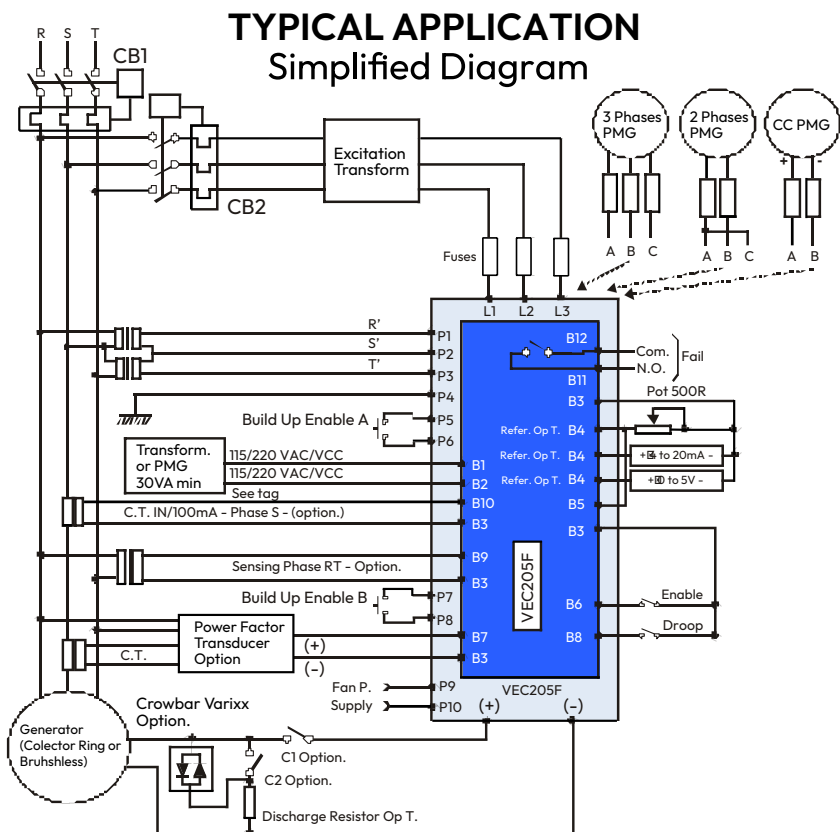
Important points for connections and Start Up:

- › Select the DIP as required. Normally S1 ON, S2 ON, S3 ON, S4 ON, S5 ON, S6 ON, S7 OFF.
- › The Phasing must be exactly as shown. The phases entering the R, S and T power terminals must be clockwise.
- › The excitation transformer must have the right voltage and power to obtain the correct Ceiling Voltage.
- › The fuses must be ultra-fast types with suitable I²T (see Data sheet).
- › The synchronizing transformer (30VA) must be connected to the primary of the excitation transformer. The secondary voltage must be in accordance with the table of characteristics.
- › C.T. for Power Factor sensing must be on the correct motor cable.
- › C.T. must have a 100mA secondary (maximum 1 Ampere and minimum 15mA - C.T. with a 5 Ampere secondary will damage the module).
- › P.T for voltage phase angle sensing for the internal P.F. transducer must be connected to the cables not used for current phase angle sensing (the middle cable in this example below). The nominal voltage is 115VAC +10%, -30%.
- › If the user chooses to use a transducer, they must provide the correct voltage for the module corresponding to the full scale, from fully inductive to fully capacitive. The central voltage of the scale must be equal to the unit P.F.
- › The control signals are commented on the sheet with the control module diagram.
- › Excitation should only be applied at rated speed.
- › At Start Up, before enabling the Droop/ Power Factor function definitively, the correct polarity of the signal must be checked. You have to load the generator with inductive loads until you get at least 0.80 inductive. Open and close the Droop control. With Droop active, the generator's output voltage must drop a little. If not, change the polarity of the C.T. in normal operation, the Droop control should be closed for parallel operation and should be open for single mode operation. This improves static regulation in single mode. Build Up Enable is used to enable the self-priming circuit. It must be a momentary contact type switch. Try operating with the two types of sensing selectable on DIP S3 to choose the one that best suits your system.

Operating Instructions: Once the generator has reached its rated speed, close the Power Enable. Then momentarily close the Build Up Enable contact. If the generator's remaining voltage is at least 10 VAC, the voltage will rise until it approaches the nominal voltage. Adjust the nominal voltage if necessary (level pre-set at Start Up). The voltage doesn't need to be readjusted at any time after this. Put the generator on the busbar (closing the main Circuit Breaker). If it is a multi-generator system, must be done with a synchronism indicator/relay. The Droop command contact must be closed simultaneously with the Main Circuit Breaker. Divide the active load (KVA) on the machine's speed governors. The AVR's will automatically divide the reactive loads (KVAR). Avoid changing the voltage setting of the regulators to try to split loads.

The loads must be divided proportionally to the generator powers. **Note:** During Start Up, all regulators should be set to the same Gain and Droop. The Droop rate should be as low as possible, especially if the machines are identical. Usually a level of 1% to 3% is a good choice.

To shut down a generator, first discharge it by acting on the speed governors, then open the main circuit breaker to remove it from the busbar, then inhibits its output on the Power Enable contact by opening the switch and finally reduce the machine speed to zero. See specific bulletin for operating generators in parallel.



- Notes:
1. The Circuit Breaker CB2 and its connections is not used in case of PMG - Permanent Magnet Generator.
 2. The Build Up Enable button is not used in case of use with PMG.
 3. If used with PMG with 2 Phases connect input T together input R.
 4. Connect Power Input (1 and 2) to PMG if its voltage range is adequate.
 5. All Wires to connector 3 (Common) must be connected straight to it.

Notes

- › The diagram is a simplified version.
- › It is recommended that signal connections are made using shielded cables with the shield connected to connector 3.

> Accessories

- › Ultra Fast Fuses.
- › Power Transformers.
- › Synchronizing and Sensing Transformers.
- › Shunt Amplifier: VSA605A (60mv/5V isolated).
- › Digital Potentiometer/Servo Potentiometer: (VSP510A).
- › Panel with Multiturn Potentiometer and digital scale: VPI020E.
- › Field Application Relay: VR9045.
- › Ground Fault Relay: VR9030A.
- › Field Overvoltage Relay: VR9031A.
- › Step Out Relay: VR9035A.
- › Field Loss Relay: VR9034A.
- › Other protection relays.
- › Crowbar.

Spare Parts

- › **Control Module:** VEC205FC/X/X/X/X/X.
- › **Trigger Modules:** VDE115A.
- › **VV1 and VRN2:** Fans; see customization Data sheet in manual.
- › **VC12:** 12-way female connector.
- › **VS204/3E:** Synchronization module.

ORDER CODE	
VEC205F/X/XXXX/XXX/X/X/X/X	
<div style="display: flex; justify-content: center; gap: 10px;"> A B C D E F G </div>	
A Power Supply	1= 110 VAC 2= 220 VAC 3= Other - (Type)
B Current	Nominal Current
C Voltage	Nominal Voltage
D Setting Point Adjust	1= 0 to 5 Volts/Potentiom. 2= 0 to 10 Volts/Potentiom. 3= 4 to 20mA 4= 0 to 20mA
E Ext. P.F. Signal	1= 0 to 5 Volts/Potentiom. 2= 0 to 10 Volts/Potentiom.
F Fan Voltage	0= W/o Fan 1= 120 VAC 2= 220 VAC

EXAMPLE:
VEC205F/1/0050/150/1/2/0: Generator Exciter; Control Power Supply: 110 VAC; Nominal Current: 50 Amper; Nominal Voltage: 150 Volts; Setting Point Adjust: 0 to 5 VCC or Potentiometer; External Power Factor Signal: 0 to 10 VCC, w/o Fan.

Varixx Complete Solutions

Varixx or its integrators can offer complete systems, including panels, circuit breakers, fuses, instruments, GE Multilin relays, PLCs and many others. The equipment can be designed and sized by our engineering staff to meet the customer's needs. Our field staff can provide Start Up.

VEC205F

Generator Static Exciter

TECHNICAL BULLETIN VEC205F

varixx

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