

2023

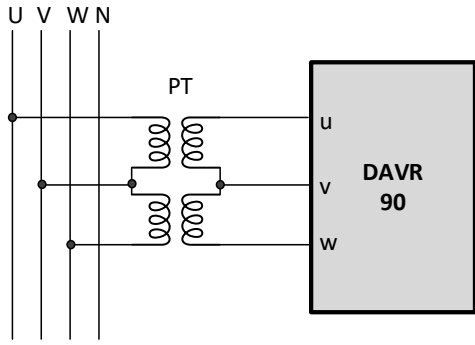
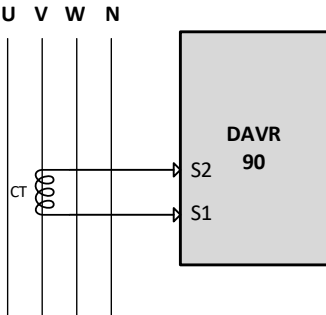
DAVR-90

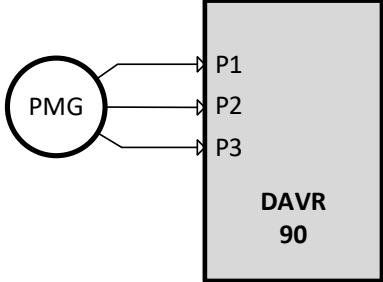
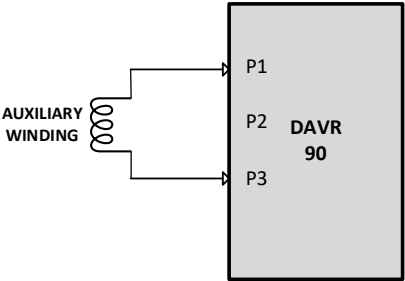
**TECHNICAL SPECIFICATIONS &
APPLICATION WIRING DIAGRAMS (R6)**

ENKO ELECTRONICS | Turkey

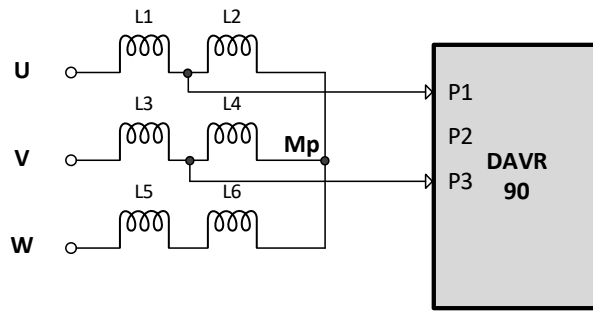
TECHNICAL SPECIFICATIONS

OPERATING MODE:	DESCRIPTION:
<p>AVR-mode operation only</p>	<p>Operation only in AVR mode, which regulates the stator voltage based on the SENSE signal connection configuration.</p>
GENERATOR VOLTAGE SENSING:	DESCRIPTION:
<p>Sense input voltage wiring configuration:</p>	<div style="text-align: center;"> </div> <p>2-phase or 3-phase connection, no neutral configuration (2W, 3W) 1-phase connection between phase and neutral Limited maximum sense voltage value: 480V_{AC}</p> <p><u>NOTE:</u> U, V and W phase voltage sensing inputs of the AVR can be also connected directly to alternator stator output terminals, provided that maximum set alternator voltage (nominal) does not exceed 480V_{AC} rms.</p>

<p>Sense input voltage configuration with high-voltage input ($V_{SENSE} > 480V_{AC}$)</p>	 <p>Transformer (PT) primary/secondary voltage ratio is S/W configurable</p>	
<p>Voltage sensing type:</p>	<p>True-RMS voltage reading, Phase-phase voltage sensing, Average voltage sensing of three-phase input,</p>	<p>Voltage transformer must be used for sense inputs if phase-phase sense voltage exceeds 480Vac rms (max. limit)</p>
<p>Voltage sensing range:</p>	<p>100Vac – 276Vac (1-phase) 100Vac – 480Vac (2-phase and 3-phase) Software configurable</p> <p><i>(Given sense voltage range values are referred to phase windings mid-point connection points)</i></p>	<p>25Hz to 75Hz operation</p>
<p>Voltage setting range:</p>	<ul style="list-style-type: none"> ○ Manual voltage setting of regulation level with on-board trimmer ($\pm 15\%$ of S/W configured voltage setting value) ○ Voltage setting via S/W using, PC configuration tool <p>(Voltage setting of the AVR MUST match the wiring configuration of the alternator in the system)</p>	
<p>GENERATOR CURRENT SENSING:</p>	<p>DESCRIPTION:</p>	
<p>Current sense input connection:</p>	 <p>Current sense transformer connection on “V” phase line Current transformer conversion ratio can be selected as X/1A or X/5A (CT connection must be made according to IEC61000-6-4)</p>	

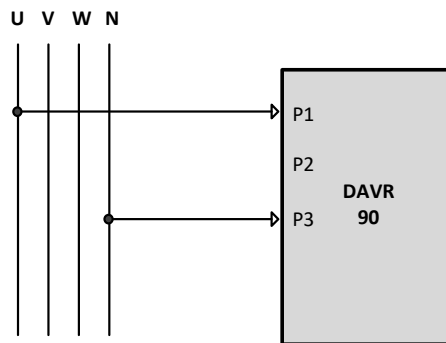
<p>CT ratio setting:</p>	<p>CT ratio setting via configuration S/W CT configuration: X / 1A or X / 5A</p>	<p>Rated overload level: 200% continuous max. 300% for 120 seconds</p>
<p>Current sense error:</p>	<p><1% of measured value, over full range</p>	<p>S1-S2 terminal inputs are galvanically isolated</p>
<p>Operation mode:</p>	<ul style="list-style-type: none"> ○ Quadrature droop for reactive load sharing (parallel operation) ○ Line droop compensation (+V/KVA) ○ Stator-load current monitoring, ○ Motor-start current limit according to set parameter value, <p><i>(If QUADRATURE DROOP function is selected, other functions cannot be selected)</i></p>	
<p>CT load burden:</p>	<p><1VA (over nominal operation range)</p>	
<p>POWER INPUT TO AVR:</p>	<p>DESCRIPTION:</p>	
<p>PMG CONNECTION:</p>	<div style="text-align: center;">  </div> <p>PMG type: 3-phase PM Phase output voltage (L – L): 220Vac (170Vac – 300Vac) Rated power: 300W max. continuous @ 60°C ambient, Operating frequency: 40Hz to 500Hz</p>	
<p>AVR POWER INPUT WITH AUXILIARY WINDING:</p>	<div style="text-align: center;">  </div> <p>AUXILIARY power winding voltage: Single phase, 170Vac – 300Vac (maximum allowed voltage limit) Rated power: 300W max. continuous @ 60°C ambient, Frequency range: 40Hz to 75Hz</p>	

AVR POWER INPUT WITH TWO PHASE SHUNT CONNECTION:



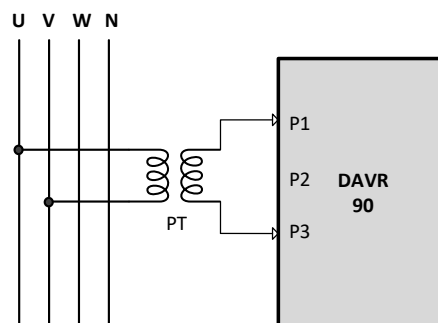
Two phase SHUNT connection across P1 and P3. (Voltage across terminals P1 and P3 is limited to 300Vac max)

AVR POWER INPUT WITH PHASE-NEUTRAL SHUNT CONNECTION

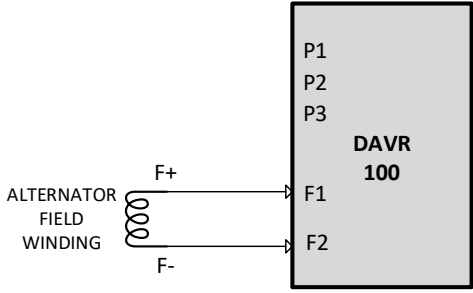
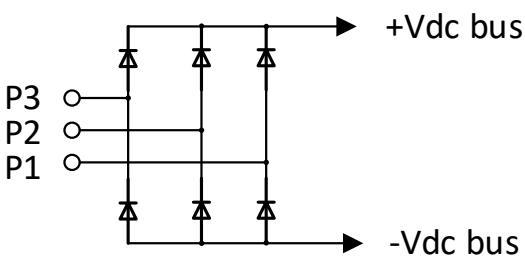


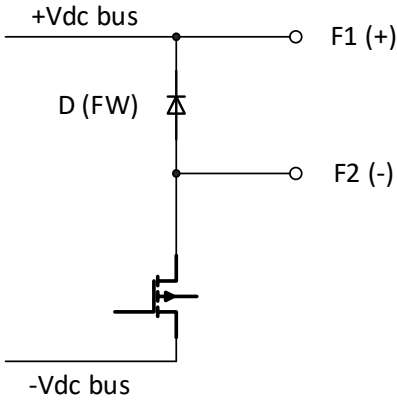
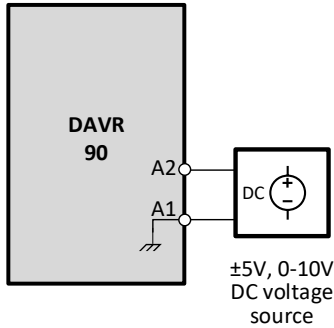
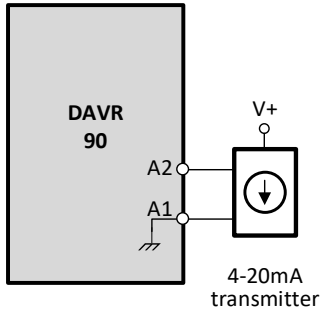
SHUNT connection between phase and Neutral line. (300Vac maximum allowed voltage limit across terminals P1 and P3)

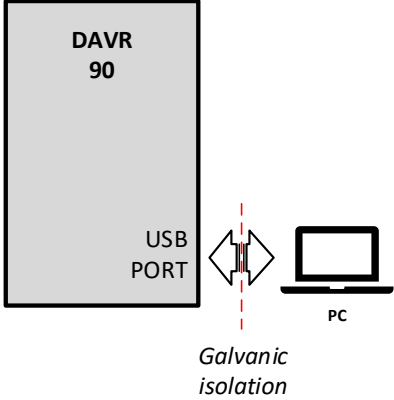
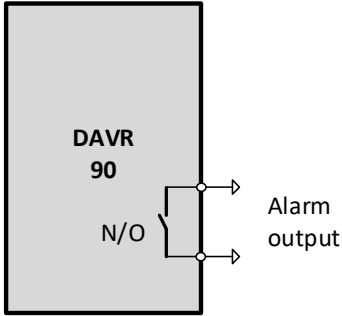
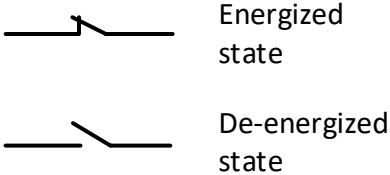
AVR POWER INPUT FROM HIGH POTENTIAL:

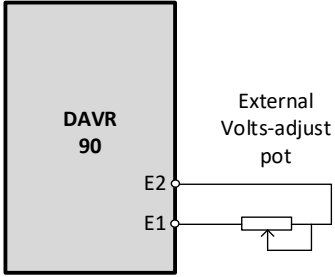
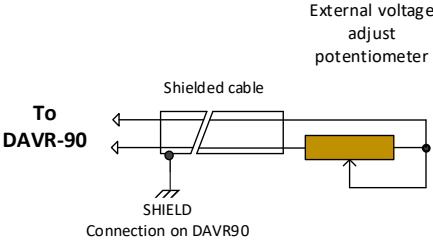


PT must be used if AVR power is connected from high potential. Voltage across P1 and P3 is limited to 300Vac max.

FIELD DRIVE OUTPUT:	DESCRIPTION:	
<p>FIELD WINDING WIRING CONFIGURATION:</p>	<div style="text-align: center;">  </div> <p>Cable length between AVR and Exciter winding should NOT exceed 5 meters maximum length.</p>	
<p>EXCITATION VOLTAGE RANGE:</p>	<p>Continuous drive: 140V_{DC} Overload status (20 sec): 220V_{DC} Overload status (10 sec): 300V_{DC}</p>	<p>Power into the EXCITER winding is limited with the available power across P1, P2 and P3 terminals of the AVR unit at any time.</p>
<p>EXCITATION CURRENT RANGE:</p>	<p>Continuous drive: 5A_{DC} Overload status (20 sec): 7A_{DC} Overload status (10 sec): 10A_{DC}</p>	
<p>FIELD WINDING IMPEDANCE:</p>	<p>Nominal: 15Ω Max: 50Ω Minimum: >5Ω (@ room temperature)</p>	<p>Wiring impedance from AVR to FIELD winding should NOT exceed 5% of FIELD winding nominal impedance at room temperature</p>
<p>AVR POWER INPUT CIRCUIT CONFIGURATION:</p>	<div style="text-align: center;">  </div> <p>For AUX and SHUNT connection, terminals P1 and P3 must be used</p>	

<p>FIELD WINDING POWER DRIVE CONFIGURATION:</p>		<p>IGBT drive with PWM FW diode internal to AVR</p> <p>5A_{dc} continuous @ 60°C 7A_{dc} for 20 sec 10A_{dc} for 10 sec (given at max. operating temperature limit)</p> <p>Power Limit: 300W max. continuous @ 60°C</p> <p>Derate: -5%/°C (+60°C to +70°C)</p>
<p>ANALOGUE INPUTS: DESCRIPTION:</p>		<p>DIFFERENTIAL ANALOG VOLTAGE SIGNAL INPUT (±5V_{dc} / 0-10V_{dc}):</p>  <p>0 – 10V_{dc} input</p> <p>±5V_{dc} input (configuration as -5V_{dc}/0V/+5V_{dc} with A1 terminal internally connected to GND)</p> <p>S/W configurable, no on-board trimmer</p> <p>Resolution: 1/1000 (non-isolated input)</p>
<p>DIFFERENTIAL CURRENT SIGNAL INPUT (4-20mA):</p>		<p>4 -20mA current input connection (A1 connected to GND internally)</p> <p>Burden load: 100Ω <4mA corresponds to “low level input” and 12mA set as mid-point,</p> <p>S/W configurable parameters, no on-board trimmer. Resolution: 1/1000 (Non-isolated input)</p>

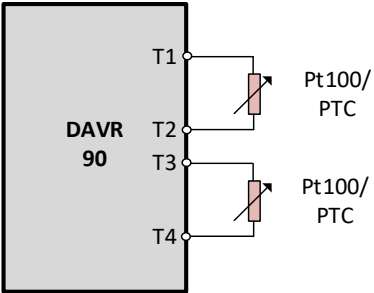
COMMUNICATION PORTS:	DESCRIPTION	
<p>USB COMMUNICATION PORT (ISOLATED):</p> <p><i>(Galvanic isolation from AVR power and SENSE terminals only)</i></p>	 <p style="text-align: center;"><i>Galvanic isolation</i></p>	<p>Device configuration port for PC connection</p> <p>Power supply (internal & external) MODBUS protocol Type-B socket on-board,</p> <p><u>USB port is galvanically isolated from AVR power inputs, but galvanically connected to AUX inputs and EXT Pot terminals.</u></p>
ALARM OUTPUT:	DESCRIPTION	
<p>ALARM OUTPUT:</p>		<p>N/O Alarm contact output.</p> <p><i>(Contacts are closed during normal operation and can be configured by the user)</i></p> <p>Contact rating: 1Adc @ 30Vdc</p>
<p>ALARM SETTABLE FUNCTIONS:</p>	<ul style="list-style-type: none"> ○ Threshold / Trigger status ○ Time Delay ○ Enable / Disable ○ Latched ○ Masked ○ Relay activation / Warning only, ○ TRIP activation ○ Automatic Fault Reset 	<p>Any or a combination of alarm functions can be allocated for each alarm state detection, using PC Tool software suite.</p>
<p>CONTACT CAPACITY:</p>	 <p style="text-align: right;">Energized state</p> <p style="text-align: right;">De-energized state</p>	<p>SPST Relay contact output 1.0 Adc (max) @ 30Vdc</p>

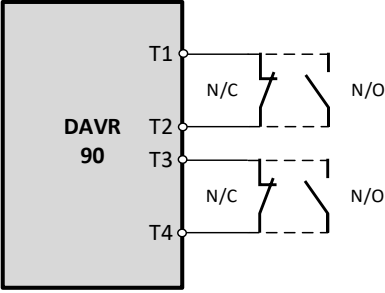
EXTERNAL VOLTS ADJUST:	DESCRIPTION	
EXTERNAL POT CONNECTION:		<p>External voltage adjust pot connected to terminals E1 and E2</p> <p>Adjustment range: $\pm 15\%$ of set voltage parameter (S/W configurable)</p>
POT VALUE:		<p>Value: 1KΩ</p> <p>Power rating: 1W</p> <p>Single turn or multi-turn</p> <p>(EXTERNAL POT cable should be shielded and GROUNDED, only at AVR side)</p>
DETECTION:	<p>Pot wiring open circuit detection</p> <p>Automatic pot connection continuity detection (Function is S/W configurable)</p>	
VISUAL INDICATOR:	DESCRIPTION	
<p>CONFIGURATION: One RGB LED is used for all indications. The colour code is defined below:</p>		
AVR NORMAL:	<p>Normal AVR operation with all the functions are running and no active alarms.</p>	<p>GREEN (continuous)</p>
ALARM condition:	<p>ALARM or TRIP function activated</p>	<p>RED (continuous)</p>
USB Communication:	<p>Communication is running and transmission is normal,</p>	<p>BLUE (flashing)</p>

OVER-EXCITATION PROTECTION:	DESCRIPTION	
FIELD CURRENT MONITORING:	Current limit set point $0 \leq I_F \leq 10A_{DC}$ Parameters are S/W configurable	Resolution: $\pm 0.1 A_{DC}$
TIME DELAY CONTROL:	Time delay set parameter: $0 \leq T_D \leq 10s$ for $I_F = 10A_{DC}$ $0 \leq T_D \leq 120s$ for $5A_{DC} < I_F < 7A_{DC}$ <i>(Inverse current / time thermal effect function IDMT, with I^*t or I^2*t characteristic selection)</i> Parameters are S/W configurable	Resolution: ± 0.1 sec
TRIP:	Alarm output activation (latching / non-latching) LED indicator activation Parameters are S/W configurable	
ROTOR DIODE FAILURE MONITORING:	DESCRIPTION	
ROTOR DIODE MONITORING:	Monitoring of ROTOR DIODE block behaviour during operation.	Continuous monitoring during running conditions.
TIME DELAY CONTROL:	Time delay set parameter: $0 \leq T_D \leq 7200$ seconds Parameter S/W configurable	Resolution: ± 1.0 second
TRIP/WARNING:	Alarm output activation (latching / non-latching), Enable/Disable control, LED indicator activation Parameters are S/W configurable	

LOSS-OF-SENSING PROTECTION:	DESCRIPTION	
PHASE-PHASE VOLTAGE MONITORING:	Phase sense voltage detection $-50\% \leq V_{\text{SETPOINT (EFF)}} \leq 0\%$ Parameters are S/W configurable	Resolution: $\pm 1.0 V_{\text{AC RMS}}$ (% reduction of phase voltage w.r.t effective setpoint)
TIME DELAY CONTROL:	Time delay setting: $0 \leq T_D \leq 25\text{s}$ Parameters are S/W configurable	Resolution: $\pm 1.0\text{ms}$
TRIP:	Alarm relay activation (latching / non-latching) LED indicator activation Parameters are S/W configurable	
GENERATOR OVER-VOLTAGE PROTECTION:	DESCRIPTION	
OVER-VOLTAGE MONITORING:	Alternator phase-phase STATOR voltage monitoring, Over-voltage set point: 100% to 150%	Resolution: $\pm 1.0\%$ (% of effective stator voltage setpoint)
OVER-VOLTAGE TIME DELAY CONTROL:	Time delay setting: $0 \leq T_D \leq 20\text{s}$	Resolution: $\pm 1.0\text{ms}$
TRIP:	Alarm relay activation (latching / non-latching) LED indicator activation Parameters are S/W configurable	
GENERATOR UNDER-VOLTAGE PROTECTION:	DESCRIPTION	
UNDER-VOLTAGE MONITORING:	Alternator phase-phase STATOR voltage monitoring, Undervoltage set point: 50% to 100%	Resolution: $\pm 1.0\%$ (% of effective stator voltage setpoint)
TIME DELAY CONTROL:	Time delay setting: $0 \leq T_D \leq 20\text{s}$	Resolution: $\pm 1.0\text{ms}$
TRIP:	Alarm relay activation (latching / non-latching) LED indicator activation Parameters are S/W configurable	

GENERATOR CURRENT LIMIT:	DESCRIPTION	
STATOR CURRENT MONITORING:	Alternator STATOR current monitoring, $100\% \leq I_{CL} \leq 300\%$ CT ratio S/W configurable	Resolution: $\pm 1.0\%$ of actual stator current value
TIME DELAY CONTROL:	Time delay setting: $0 \leq T_D \leq 120s$ <i>(Function is based on alternator I^2t thermal effect characteristic calculation)</i> Parameters are S/W configurable	Resolution: $\pm 1.0ms$
CONDITIONS:	STATOR current limit protection can only be active, if generator is not in parallel operation (reactive droop control active)	
TRIP:	Alarm relay activation (latching / non-latching) LED indicator activation Parameters are S/W configurable	
START MOTOR FUNCTION & FAULT PROTECTION:	DESCRIPTION	
MOTOR CURRENT MONITORING:	Alternator STATOR current monitoring, $100\% \leq I_{CL} \leq 200\%$ CT ratio S/W configurable	Resolution: $\pm 1.0\%$ of actual stator current value
TIME DELAY CONTROL:	Time delay setting: $0 \leq T_D \leq 60s$ Parameters are S/W configurable	Resolution: $\pm 1.0ms$
CONDITIONS:	Motor start fault protection can only be active if “reactive droop compensation” is not selected. During “Motor Start” function (if selected and activated), conflicting protection functions will be disabled automatically.	
TRIP:	Alarm relay activation (latching / non-latching) LED indicator activation Trip function parameters are S/W configurable	

STATOR VOLTAGE UNBALANCE DETECTION:	DESCRIPTION	
UNBALANCE DETECTION:	<p>3-phase STATOR voltage monitoring, (each phase voltage is monitored individually)</p> <p>$20 \leq V_{UNBALANCE} \leq 50\%$</p> <p>Parameters are S/W configurable</p>	Operates on percent phase voltage deviation with reference to 3-phase average voltage measurement value
TIME DELAY CONTROL:	<p>Time delay setting:</p> <p>$0 \leq T_D \leq 120s$</p> <p>Parameters are S/W configurable</p>	Resolution: ± 1.0 ms
TRIP:	<p>Alarm relay activation (latching / non-latching)</p> <p>LED indicator activation</p> <p>Parameters are S/W configurable</p>	
AUXILIARY INPUTS:	DESCRIPTION	
AVR TEMPERATURE PROTECTION:	<p>On-board sensor for microcontroller ambient temperature sensing, (also an indication of AVR ambient temperature)</p> <p>+10°C to +125°C</p>	Resolution: $\pm 1.0^\circ\text{C}$
AMBIENT TEMPERATURE SENSING:		
EXTERNAL TEMPERATURE SENSING & PROTECTION:	 <p>Monitoring of external temperature point $+40^\circ\text{C} \leq T_{EXT} \leq +300^\circ\text{C}$</p> <p>2 independent Pt100 (RTD) sensor inputs (Parameters S/W configurable)</p>	<p>Resolution: $\pm 1.0^\circ\text{C}$</p> <p>(non-isolated input)</p>

<p>EXTERNAL DIGITAL SIGNAL INPUT CONFIGURATION:</p>	 <p>N/O or N/C external DRY-CONTACT input for DIGITAL signal input detection (Parameter is S/W configurable)</p>	<p>T1/T2 and T3/T4 temperature inputs can be configured as DIGITAL signal INPUTS, (non-isolated input)</p>
<p>TIME DELAY CONTROL:</p>	<p>Time delay control setting, $0 \leq T_D \leq 30 \text{ sec}$</p>	<p>Resolution: $\pm 1.0 \text{ ms}$</p>
<p>TRIP:</p>	<p>Alarm relay activation (latching / non-latching) LED indicator activation Parameters are S/W configurable</p>	
<p>VOLTAGE REGULATION:</p>	<p>DESCRIPTION</p>	
<p>VOLTAGE REGULATION:</p>	<p>3-phase RMS voltage regulation (Continuous average measurement)</p>	
<p>REGULATION CONDITIONS:</p>	<p>Prime mover speed change: <4% Cosϕ: >0.8 THD (3-phase average): <5%</p>	
<p>TEMPERATURE DRIFT:</p>	<p>$0^\circ\text{C} < \Delta T < +40^\circ\text{C}$ $+0.01\%/^\circ\text{C} > +40^\circ\text{C}$ Unchanged load conditions</p>	
<p>SOURCES OF REGULATION SETPOINT:</p>	<ul style="list-style-type: none"> • S/W voltage regulation set-point • On-board trimmer voltage setting • External pot voltage setting • AUX input-controlled voltage setting (control from an external device) 	<p>All regulation source selections are S/W configurable during AVR set-up</p>

SOFT-START SEQUENCE CONTROL:	DESCRIPTION	
START TIME DELAY:	$0 \leq T_{\text{DELAY}} \leq 7200 \text{ sec.}$ Parameters S/W configurable	Time based start-delay in seconds
START FREQUENCY CONTROL:	$25\text{Hz} \leq F_{\text{START}} \leq 75\text{Hz}$ Parameters S/W configurable	Frequency based start-delay in Hz.
SOFT-START RAMP CONTROL:	$1 \leq T_{\text{SOFTSTART}} \leq 7200 \text{ sec.}$ Parameters S/W configurable	Soft-start ramp time in seconds
EXTERNAL START CONTROL:	Start function control with "External Start" input Parameters S/W configurable	Start signal from external input
DIGITAL START FUNCTION:	AVR function start from USB COM Bus	Start from PC Software Tool
STABILITY (PID) CONTROL:	DESCRIPTION	
PID PARAMETERS CONTROL:	$K_P / K_I / K_D$ PID parameters gain control, S/W configurable parameters	Automatic setting of PID parameter gain constants
TRIMMER CONTROL:	Manual setting of K_P / K_I constant	On-board trimmer controlled
FREQUENCY RESPONSE:	DESCRIPTION	
UFRO KNEE POINT CONTROL:	$40\text{Hz} \leq F_{\text{UFRO}} \leq 65\text{Hz}$ STATOR voltage roll-off point control Parameters S/W configurable	Resolution: 0.1 Hz increments
LAM FUNCTION DESCENDING_SLOPE CONTROL:	$0\text{V}/\text{Hz} \leq V_{\text{COEFF.}} \leq -80\text{V}/\text{Hz}$ Rate of volts control per Hz speed change Parameter S/W configurable	Resolution: -1.0 V/Hz increments
LAM FUNCTION ASCENDING-SLOPE CONTROL:	$0\text{V}/\text{sec.} \leq V_{\text{COEFF.}} \leq 500\text{V}/\text{sec}$ Rate of volts control per second time change, Parameter S/W configurable	Resolution: +1.0V/sec increments
LAM FUNCTION LOW PEDESTAL LIMIT VALUE:	$0\text{V} < V_{\text{PEDESTAL}} < 500\text{V}$ Low state pedestal voltage limit Parameter S/W configurable	Resolution: -1.0V
LAM FUNCTION DELAY TIME CONTROL:	$0 \text{ sec} \leq T_{\text{COEFF.}} \leq 100 \text{ sec}$ Delay time at low pedestal level, Parameter S/W configurable	Resolution: 0.1V/sec increments

QUADRATURE DROOP / LINE DROOP CONTROL:	DESCRIPTION	
REACTIVE DROOP COMPENSATION:	Manual DROOP control with on-board trimmer -5% ≤ DROOP ≤ +5% (Percent of the “droop” value set by S/W)	Set for parallel operation with automatic reactive load sharing
	Automatic DROOP control with S/W Initial set value: 5% (droop at full load) Droop control: >3% (stability limit) DROOP slope: -20% to +20% (S/W configurable)	
PHASE COMPENSATION:	Control of PHASE OFFSET ANGLE, -60° ≤ ρ ≤ +60° S/W configurable with automatic compensation	
LINE DROOP COMPENSATION:	Voltage line DROOP compensation -10% ≤ L _{DROOP} ≤ +10% Compensation of line drop per KVA output	Compensation of the load line drop per KVA power output of the generator
CONDITION:	If LINE DROOP is selected, REACTIVE Droop compensation cannot be active. (refer to CT function configuration selection list)	
DATA LOGGING:	DESCRIPTION	
ALARM LOG depth:	Last 20 alarms logged in memory, (Time stamping with reference to AVR operating hours)	FIFO register configuration (Logged data to be viewed via USB com port)
ALARM LOG Data:	<ul style="list-style-type: none"> • Stator voltage, • Load current, • AVR temperature, • AUX temperature (both channels), • Field current, 	
ENVIRONMENTAL LIMITS:	DESCRIPTION	
TEMPERATURE:	Operating temperature range:	-40°C to +70°C
	Excitation derating:	60°C < -5%/°C < 70°C
	Storage temperature range:	-40°C to +85°C
HUMIDITY:	Operating humidity range Non-condensing:	30%RH to 95%RH
	Storage humidity range Non-condensing:	0%RH to 99%RH
VIBRATION / SHOCK:	x, y, z axis	5g
	20Hz to 100Hz	1.2g
	53Hz to 500Hz	5g

MECHANICAL CONSTRUCTION:	DESCRIPTION	
ASSEMBLY:	Laid in PU encapsulation (UL compliant) Housed into a plastic tray (PA66GF20)	Solid assembly suitable for rigid mounting
HEATSINK:	Custom made aluminium heatsink (Horizontal or vertical mounting only)	No live parts exposed
TERMINALS:	Power terminals:	Fast-on terminals
	Signal terminals:	Spring mount terminals
IP PROTECTION:	Terminals	IP00
	Electronic assembly:	IP54
	Com ports:	IP00
MOUNTING:	Horizontal mounting Vertical mounting (no other mounting positions allowed)	Rigid mounting Mounting on AVMs
INDICATORS:	LED (8 LED indicators for alarm functions)	Integrated in AVR body
DIMENSIONS:	150mm(W) x 140mm(D) x 65mm(H)	Most outer dimensions
WEIGHT:	490gr	
COMPLIANCE:	DESCRIPTION	
EMISSIONS:	EN55011, Level B	
ELECTROSTATIC DISCHARGE:	IEC1000-4-2 / EN61000-4-2, Level B	
RADIATED IMMUNITY:	IEC1000-4-3 / EN61000-4-3, Level A	
ELECTRICAL FAST TRANSIENT:	IEC1000-4-4 / EN61000-4-4, Level B	
RADIO FREQUENCY (CONDUCTED):	IEC1000-4-6 / EN61000-4-6, Level A	
POWER FREQUENCY (MAGNETIC):	IEC1000-4-8 / EN61000-4-8, Level A	
DIELECTRIC STRENGTH:	IEC255	
SURGE IMMUNITY:	IEC1000-4-5 / EN61000-4-5, Level B	
VOLTAGE DIP, FLUCTUATION IMMUNITY:	IEC1000-4-11 / EN61000-4-11, Level C	
SAFETY, EMC:	UL508	
FLAMMABILITY:	UL94	
EARTHQUAKE:	EN60255-21-3	
SHOCK:	EN60255-21-2	
VIBRATION:	EN60068-6-2	

MECHANICAL DRAWINGS:

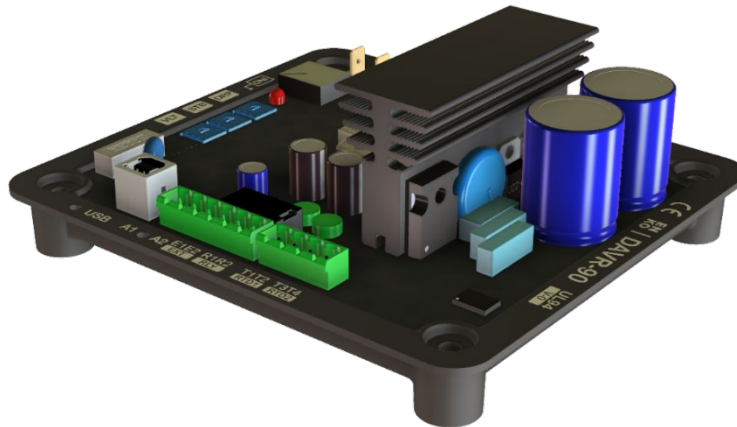


FIGURE 1: DAVR90 TRAY CONSTRUCTION

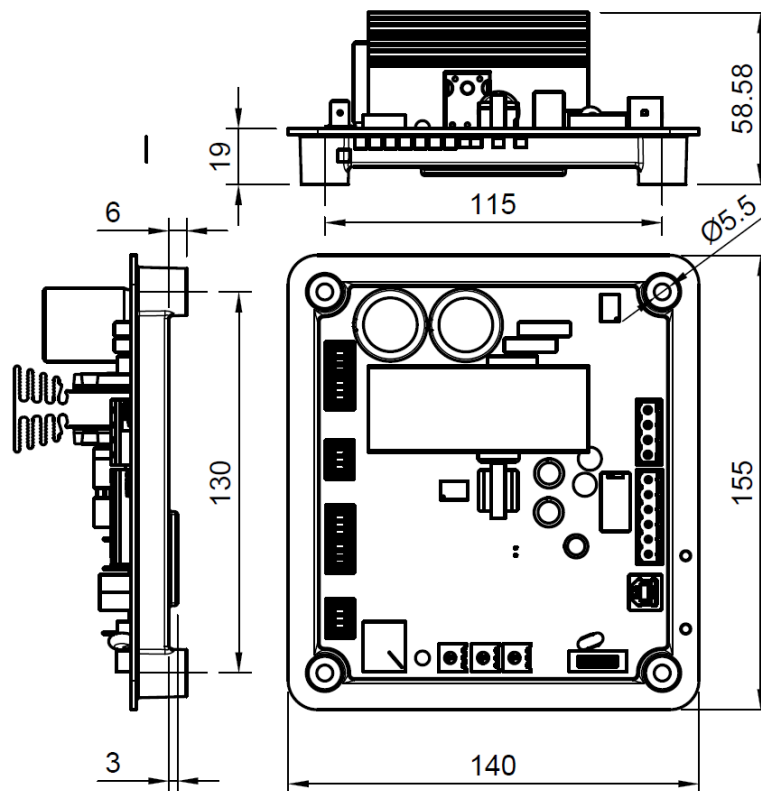
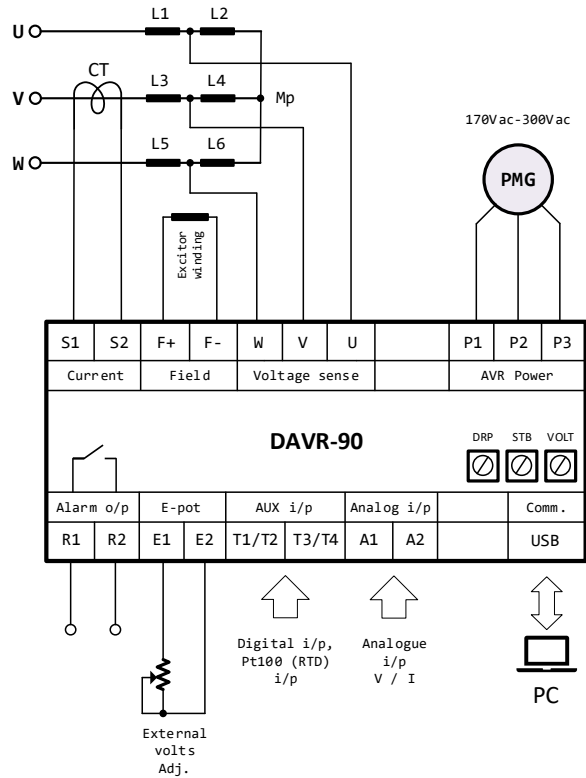


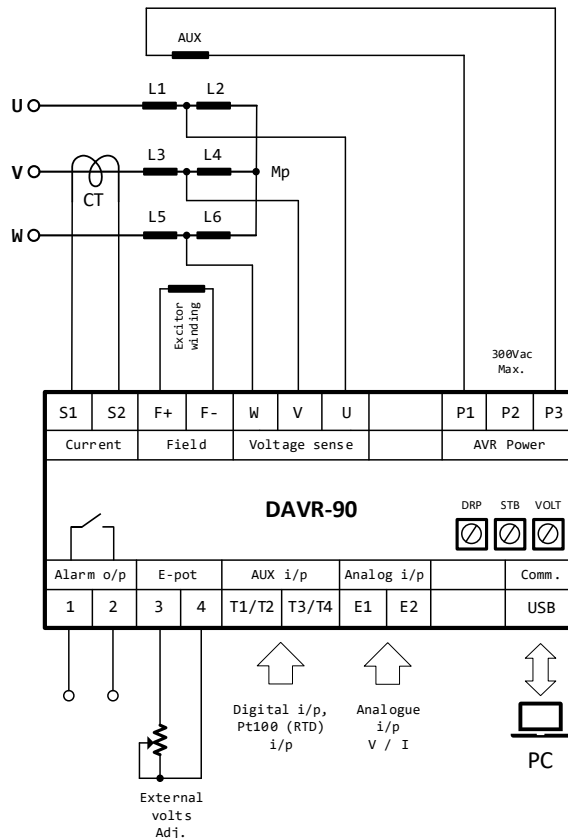
FIGURE 2: DAVR90 MECHANICAL DIMENSIONS (MM)

APPLICATION WIRING DIAGRAMS

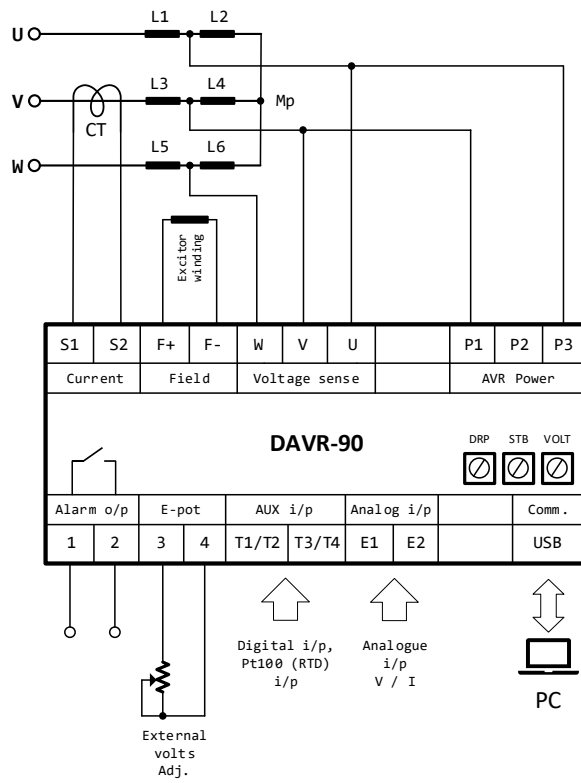
SYNCHRONOUS ALTERNATOR WITH PMG



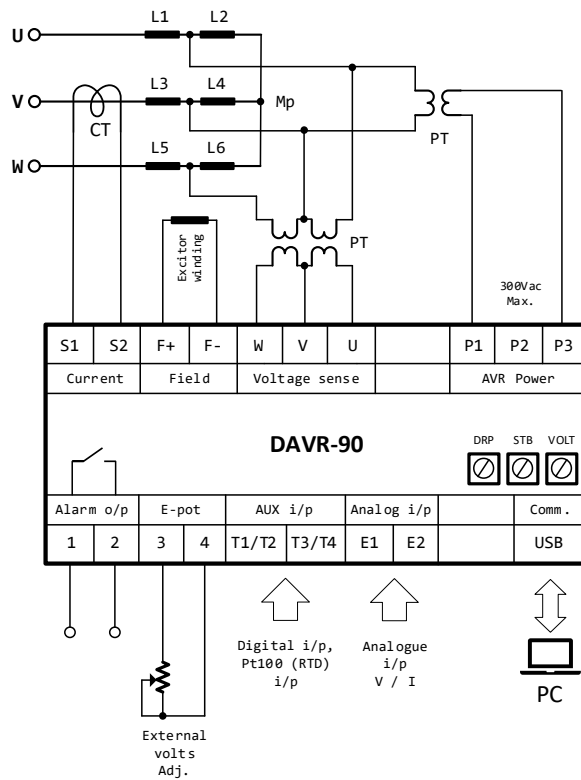
SYNCHRONOUS ALTERNATOR WITH AUX. WINDING



SYNCHRONOUS ALTERNATOR WITH SHUNT CONNECTION



SYNCHRONOUS ALTERNATOR SHUNT WIRING WITH HIGH POTENTIAL



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INTENTIONALLY