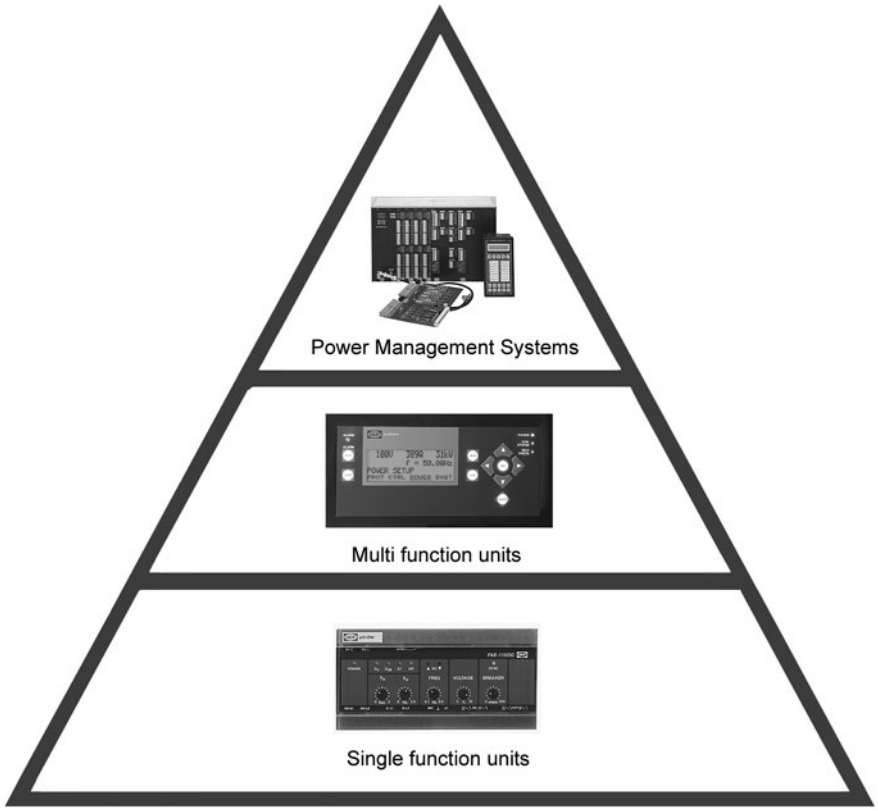
Interfacing DEIF equipment to governors and AVRs

4189340149I



DEIF A/S

***DEIF A/S**, Frisenborgvej 33*
DK-7800 Skive, Denmark

Tel.: +45 9614 9614, Fax: +45 9614 9615
E-mail: deif@deif.com, URL: www.deif.com

Table of contents

WARNINGS AND LEGAL INFORMATION 4

ABBREVIATIONS AND NAMES 5

GENERAL COMMENTS REGARDING ADJUSTMENT OF GOVERNORS AND AVRS 6

DEIF PI STEP REGULATORS 6
DEIF PI ANALOGUE OUTPUT REGULATORS 6

COMMISSIONING 7

THE PRIME MOVER AND GENERATOR 7
SPEED DROOP ON SPEED GOVERNOR 7
VOLTAGE DROOP ON AVR 7
INITIAL SETTING OF SPEED GOVERNOR/AVR 7
ADJUSTING DEIF CONTROLLERS 8
UNI-LINE LOADSHARERS AND SYNCHRONISERS ADJUSTMENT 11

GOVERNOR INTERFACES 13

BARBER-COLMAN DYNA I 13
BARBER-COLMAN DYNA DPG 2200 GOVERNOR 14
BARBER-COLMAN DYNA 8000 GOVERNOR 15
BARBER-COLMAN DYNA 1 DIGITAL CONTROLLERS 16
CATERPILLAR® ADEM ENGINE CONTROLLER 18
CATERPILLAR® PEEC ENGINE CONTROLLER 18
CUMMINS EFC GOVERNOR 19
CUMMINS ECM CONTROLLER 19
CUMMINS POWER COMMAND CONTROL (PCC) LOAD SHARING SYSTEM AND MULTI-LINE 2 20
DETROIT DIESEL DDEC-III ELECTRONIC GOVERNOR 21
DEUTZ EMR ELECTRONIC CONTROLLER 22
GAC TYPE ESD 5111, 5221 AND 5131 22
GAC TYPE ESD 5330 23
GAC TYPE ESD 5500 24
HEINZMANN TYPE E1-D AND E1-F SPEED GOVERNOR 25
HEINZMANN TYPE E6, E6V, E10, E16 AND E30 SPEED GOVERNOR 25
HEINZMANN OLYMPUS FOR GAS TURBINES 26
HEINZMANN KG 6 - 04 TO KG10 - 04 26
MTU MDEC 4000 GOVERNOR 26
SCANIA TYPE DEC2 GOVERNOR 27
TOHO ELECTRONIC GOVERNOR SPEED CONTROLLER XS-400B-03 27
VOLVO TYPE D12 CONTROLLER 28
WOODWARD TYPE 1724 AND 1712 GOVERNOR 28
WOODWARD TYPE 2301A SPEED CONTROL GOVERNOR 29
WOODWARD TYPE 2301A LOAD SHARING 29
WOODWARD TYPE 701A 30
WOODWARD UG8 DIGITAL CONTROL 30
WOODWARD GENERATOR LOAD SENSOR 31
WOODWARD PROACT DIGITAL SPEED CONTROL SYSTEM TYPE I AND II 31
WOODWARD 721 DIGITAL SPEED CONTROL 31
WOODWARD PEAK™ 150 DIGITAL CONTROL FOR STEAM TURBINES 31

AVR INTERFACES 32

AVK COSIMAT AVR 32
BASLER ELECTRIC DIGITAL EXCITATION CONTROL SYSTEM (DECS) 33
BASLER ELECTRIC SR 4A/6A/8A/9A/32A AVR 33
BASLER ELECTRIC SSR 32-12, 63-12, 125-12 AVR 34
CATERPILLAR® VR3 35
CATERPILLAR® DVR 35
LEROY SOMER TYPE R448 LS/C OR D AVR 36
LEROY SOMER TYPE R449 AVR 37

LEROY SOMER TYPE R610 AVR 37
LEROY SOMER TYPE R610 3F AVR 38
MARATHON MAGNAMAX AVR 38
MECC-ALTE TYPE U.V.R. AVR 39
STAMFORD NEWAGE TYPE MA325, MA327, MX321, MX341, SR465, SX421 AND SX440 39

TROUBLESHOOTING 40

Warnings and legal information

This is a guide how to connect various speed governors/AVRs (Automatic Voltage Regulators) with DEIF equipment. Installing and operating gen-sets implies the generation of dangerous voltages and currents. Therefore only qualified personnel should do this. DEIF A/S takes no responsibility for operating or installing gen-sets or any other equipment. If there is any doubt how to install or operate the gen-set, the company responsible for the installation or the operation must be contacted.

Abbreviations and names

The following abbreviations and names are used for DEIF units:

- Uni-line: A family of single-function components. The uni-line synchronisers and load sharers all have relay control outputs
- EP-Q96 and EPN-110DN: Electronic potentiometers giving a DC voltage output
- Multi-line 2: A family of multifunctional components. These have relay control outputs as standard (for both speed governor and AVR), and analogue (+/-20mA) as well as Pulse Width Modulated (PWM) outputs as option
  - PPU: Paralleling and Protection Unit
  - GPC: Generator Paralleling Controller
  - AGC: Automatic Generator Controller (Automatic Mains Failure unit with engine control)
  - BGC: Basic Generator Controller (Automatic Mains Failure unit with limited control functions)
- Delomatic: A multifunctional system capable of power management functions besides all generator control and protection functions. The SCM-1 mentioned is the generator control plug-in module in delomatic with relay or analogue outputs for speed governor and AVR

General comments regarding adjustment of governors and AVRs

DEIF PI step regulators

PI step regulator is usually the most used regulator for speed control. Also when interfacing to an electronic governor/AVR. In this case an electronic potentiometer type EP-Q96 or EPN-110DN is used to convert the relay outputs from PI step regulator into an analogue signal which can be used by the governor/AVR.

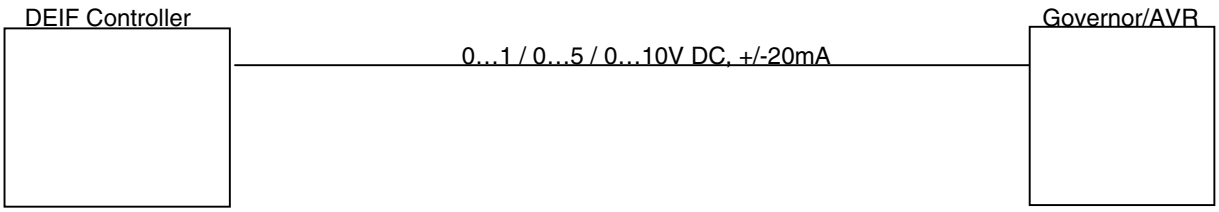
Usually the most accepted signals are voltage signals as shown above.

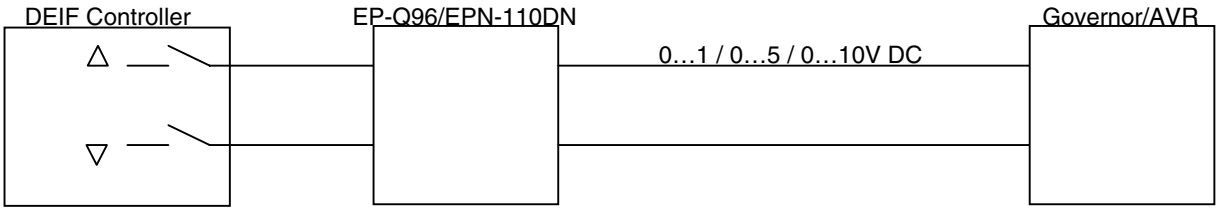
DEIF PI analogue output regulators

Only max. scale outputs are shown in the following. Any scaling within the max. values can be achieved.

The DEIF analogue output regulators are available in:

- Delomatic multifunction generator control and protection system +/-20mA
- Multi-line 2 units PPU and GPC +/-20mA, PWM
- Multi-line 2 unit BGC +/-20mA
- Electronic potentiometer EP-Q96 and EPN-110DN +/-10V DC





Commissioning

The prime mover and generator

The prime mover can be diesel engine, gas turbine or steam turbine. The type of prime mover is unimportant. The generator must be a synchronous generator with adjustable Automatic Voltage Regulator (AVR).

Speed droop on speed governor

The speed governor **is recommended to have a speed droop of 3-4%** (speed dropping 3-4% from no load to full load when the DEIF equipment is not in control). To ensure equal load sharing on parallel running machines, all governors must have the same droop setting.

NOTE: Some governor types are without speed droop possibility (isochronous governors). These are best for stand alone applications, but can be used in parallel running applications if multi-line units are used for control, and only with analogue or PWM speed governor control outputs. In case the system is based on delomatic or uni-line, the paralleling of generators with isochronous governors is not possible.

Voltage droop on AVR

The AVR controls the generator voltage in a manner comparable to the speed governor controlling the prime mover speed.

This means that **the generator AVR must have a voltage droop of 3-4%** (voltage dropping 3-4% from no load to full load, when the DEIF equipment has no control). To ensure equal var sharing on parallel running generators, the voltage droop must be the same for all generators.

Initial setting of speed governor/AVR

With relay output(s) directly connected

- Disable the outputs from the DEIF controller(s)
- Run the generator with no load
- Adjust the frequency (on the speed governor) to be base frequency (50 or 60Hz) plus 50% of the droop (4% droop means +2% = 1Hz for 50Hz)
- Adjust the generator voltage (on the AVR) to nominal voltage plus 50% of the voltage droop (4% voltage droop means +2%)

With electronic potentiometer analogue output

As especially governors are sensitive to the external circuit impedance, it is essential that the initial settings of speed governor/AVR is done with the electronic potentiometer connected but disabled (turn off the power supply). If you fail to do this, you may experience control problems later on. The only exception from this rule is the Woodward load sensor (please see the chapter Woodward generator load sensor). After this:

- Run the generator with no load
- Adjust the frequency (on the speed governor) to be base frequency (50 or 60Hz) plus 50% of the droop (4% droop means +2% = 1Hz for 50Hz)
- Adjust the generator voltage (on the AVR) to nominal voltage plus 50% of the voltage droop (4% voltage droop means +2%)

With delomatic analogue output

The analogue output from delomatic is +/-20mA, which in most cases must be converted into a voltage using a resistor across the terminals (250Ω gives 5V DC at 20mA).

As especially governors are sensitive to the external circuit impedance, it is essential that the initial settings of speed governor/AVR is done with the delomatic connected and live but disabled (set the delomatic in "switchboard mode" by de-activating the AUTO input on the module SCM-1 (terminals 26-28)). This will "disable" the control outputs, but the generator protection is still active. If you fail to do this, you may experience control problems later on. After this:

- Run the generator with no load
- Adjust the frequency (on the speed governor) to be base frequency (50 or 60Hz) plus 50% of the droop (4% droop means +2% = 1Hz for 50Hz)
- Adjust the generator voltage (on the AVR) to nominal voltage plus 50% of the voltage droop (4% voltage droop means +2%)

After this you can activate the AUTO input again.

With multi-line 2 PPU/GPC/AGC/BGC analogue output

The analogue output from PPU/GPC/AGC/BGC is +/-20mA, which in most cases must be converted into a voltage using a resistor across the terminals (250Ω gives 5V DC at 20mA).

As especially governors are sensitive to the external circuit impedance, it is essential that the initial settings of speed governor/AVR is done with the PPU/GPC/AGC/BGC connected and live but disabled (set the PPU/GPC/AGC/BGC in "manual" by de-activating the "start sync/contr." input on terminals 25 (input)-28 (com.)). This will "disable" the control outputs, but the generator protection is still active. If you fail to do this, you may experience control problems later on. After this:

- Run the generator with no load
- Adjust the frequency (on the speed governor) to be base frequency (50 or 60Hz) plus 50% of the droop (4% droop means +2% = 1Hz for 50Hz)
- Adjust the generator voltage (on the AVR) to nominal voltage plus 50% of the voltage droop (4% voltage droop means +2%)

After this you can activate the "start sync/contr." input again.

With multi-line 2 PPU/GPC/AGC PWM output for Caterpillar®

Since the PWM initial setting has an influence on the start-up speed of the engine, the first thing to do is to set this (setting 2272 for multi-line, 2202 for AGC):

- Make sure that the generator cannot start
- Turn the PPU/GPC/AGC OFF and ON again (to make sure that the PWM output is reset)
- Start the generator (no load)
- Adjust setting 2272/2202 until the correct speed (and frequency) is achieved

Adjusting DEIF controllers

The first attempt is always an "I hope settings are OK". For this purpose DEIF has with experience over the years come to some initial settings, which may not be perfect but can be used to start the adjustment of regulators/controllers.

Adjusting PI (Proportional Integral) step regulators (with relay outputs) and PID (Proportional Integral Differential) (with analogue outputs) controllers is not easy. The following is a shortcut, giving you an acceptable result (maybe not perfect, but acceptable):

Delomatic/PPU/GPC/AGC/BGC

The equipment is delivered with a factory setting, which will be acceptable in 90% of the cases. Start the generator and test it. The worst thing that can happen is a generator trip, in which case a new attempt must be made.

Analogue output PI

The analogue speed output can be used for engines with electronic governors.

Both delomatic and PPU/GPC/AGC/BGC accept push-button inputs for manual speed control and can be connected directly, even if manual running is required.

The analogue voltage output can be used for generators with electronic AVRs.

Both delomatic and PPU/GPC/AGC/BGC accept push-button inputs for manual voltage control and can be connected directly, even if manual running is required.

The output is +/-20mA.

1) The integral time (the time to compensate for deviations from set point) should be as short as possible, but to avoid hunting the setting is recommended to give a fairly long integral time, so, as a beginning, the integral time (Ki factor in multi-line) can remain as factory setting
2) The gain is now adjusted. Increase the value until the speed governor/AVR becomes unstable, and decrease until it stabilises again
3) Repeat 2) but this time by lowering the integral time (increase Ki in multi-line, decrease Tn in delomatic) until instability and increase the integral time again until stability is reached
4) Testing it is easiest done by (if possible) using a load bank, applying "jumps" in generator load and thereby testing the speed/AVR control

Relay output PI step

Delomatic and uni-line:

There are 2 settings: Time pulse, which is the shortest relay "ON" signal time
Gain Kp, which is the amplification factor for the proportional part

The shortest acceptable time pulse time is dependent on the reaction of the governor/AVR and connection type. Slow reaction => long time pulse.

Multi-line:

Apart from the Kp (proportional gain) and Ki (integrator gain) there are settings for:

- Pulse width time (the output is a Pulse Width Modulated output)
- Shortest acceptable pulse ON length

Electronic potentiometer:

If an electronic potentiometer is being used to convert the relay signals into analogue value, both the time pulse and the gain factory setting can be used. In this case the adjustments are easiest done on the electronic potentiometer, gain = a combination of ΔU_o (full scale output) and TIME (sec.). Higher ΔU_o/shorter TIME = higher gain.

Direct connection to mechanical speed governor:

If the connection is directly onto a mechanical governor with pilot motor, it may be necessary to increase the time pulse value. This depends on the mechanical characteristics of the governor system.

After finding the proper time pulse length, the gain Kp is adjusted. Increase the value until the speed becomes unstable, and decrease until it stabilises again.

Direct connection to AVR with binary voltage up/down inputs:

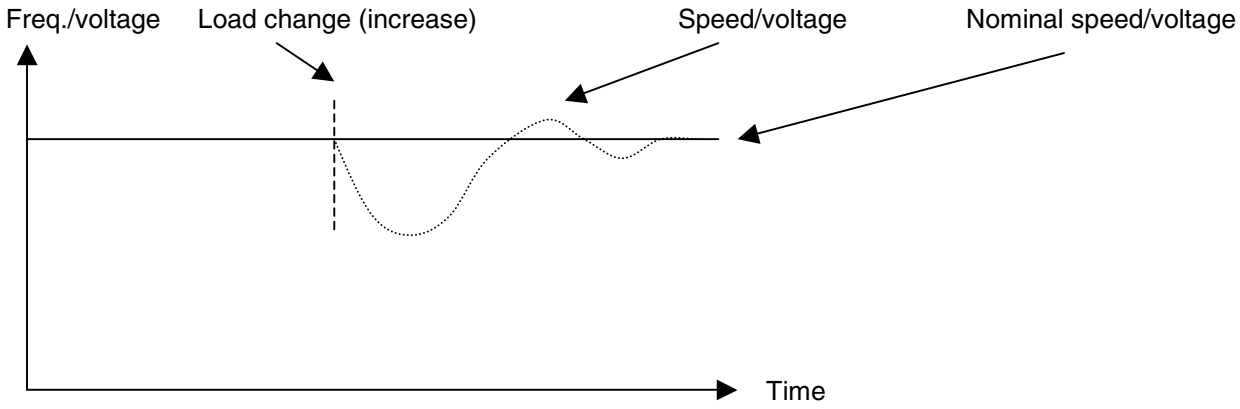
If the connection is directly onto binary inputs, it may be necessary to increase the time pulse value. This depends on the characteristics of the AVR.

After finding the proper time pulse length, the gain Kp is adjusted. Increase the value until the voltage becomes unstable, and decrease until it stabilises again.

Resulting speed/voltage curve upon load change

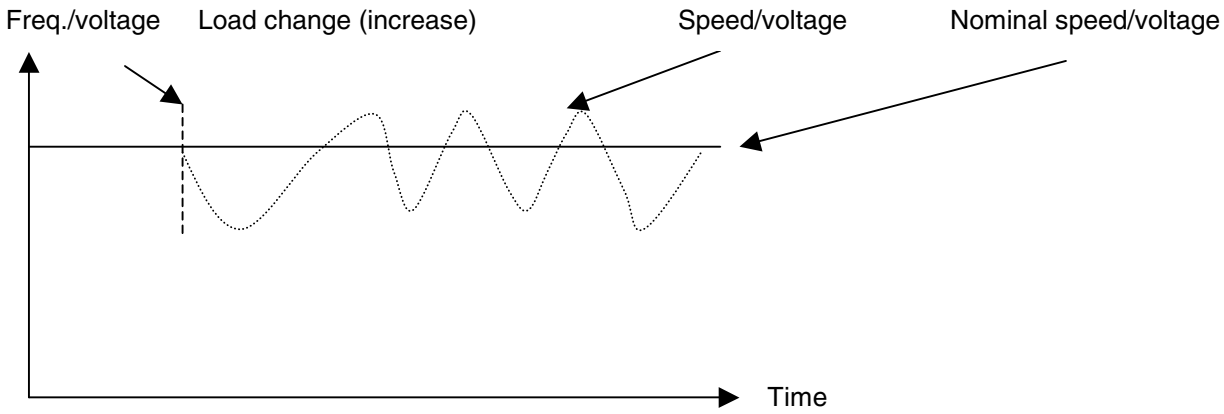
Testing it is easiest done by (if possible) using a load bank, applying "jumps" in generator load and thereby testing the speed/voltage control.

The optimal result should look like this curve:



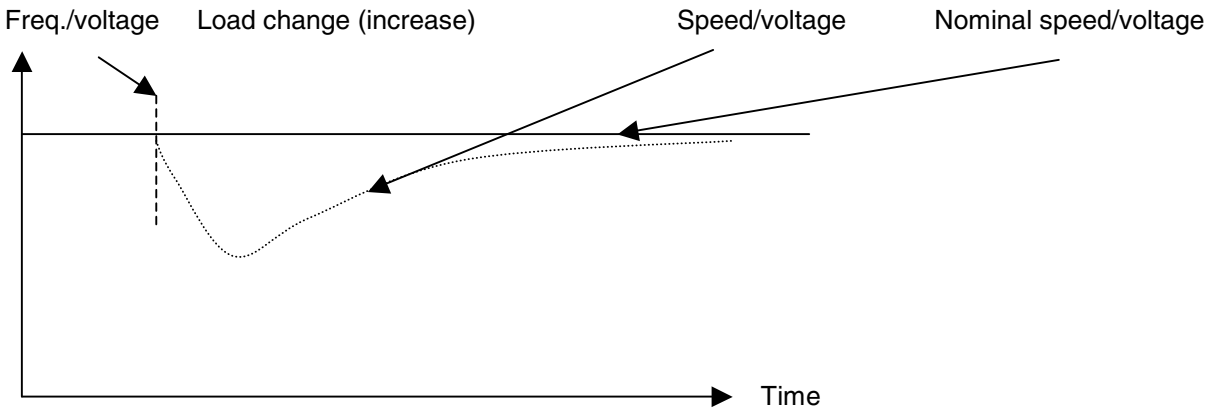
As it can be seen, 2-3 "overshoots" before stabilising after a sudden change is OK. If more "overshoots" are present, decrease the gain (= increase TIME on the electronic potentiometer) and try again.

Gain too high:



If there are no "overshoots" the time to get to nominal value may be too long.

Gain too low:



Uni-line loadsharers and synchronisers adjustment

There are 2 settings: Tn, which is the shortest relay signal "ON" time
Xp which is the amplification factor for the proportional part

The shortest Tn is dependent on the reaction of the governor/AVR and connection type. Slow reaction => longer Tn.

As a beginning, place both potentiometers in centre position.

Electronic potentiometer:

If an electronic potentiometer is being used to convert the relay signals into analogue value, both the time pulse and the gain potentiometer centre position can be used. In this case the adjustments are done on the electronic potentiometer, gain = a combination of ΔU_o (full scale output) and TIME (sec.). Increase ΔU_o/ decrease TIME = increase gain.

Direct connection to mechanical speed governor:

If the connection is directly onto a mechanical governor with pilot motor, it may be necessary to increase the time pulse value. This depends on the mechanical characteristics of the governor system, but the shortest possible time pulse value is preferable.

After finding the proper time pulse length, the gain Xp is adjusted. Increase the value until the speed becomes unstable, and decrease until it stabilises again.

Direct connection to AVR with binary voltage up/down inputs:

If the connection is directly onto binary inputs, it may be necessary to increase the time pulse value. This depends on the characteristics of the AVR. Slower reaction => longer time pulse.

After finding the proper time pulse length, the gain Kp is adjusted. Increase the value until the voltage becomes unstable, and decrease until it stabilises again.

NOTE: On the uni-line synchroniser FAS-115DG the voltage control relay output settings are fixed and cannot be adjusted. This is done under the assumption that the outputs are used for an electronic AVR or an electronic potentiometer, where adjustments can be made.

Resulting speed/voltage curve upon load change

Testing it is easiest done by (if possible) using a load bank, applying "jumps" in generator load and thereby testing the speed/voltage control.

For resulting speed/voltage curves please refer to the chapter Resulting speed/voltage curve upon load change.

As it can be seen, 2-3 "overshoots" before stabilising after a sudden change is OK. If more "overshoots" are present, decrease the gain (increase TIME on the electronic potentiometer) and try again.

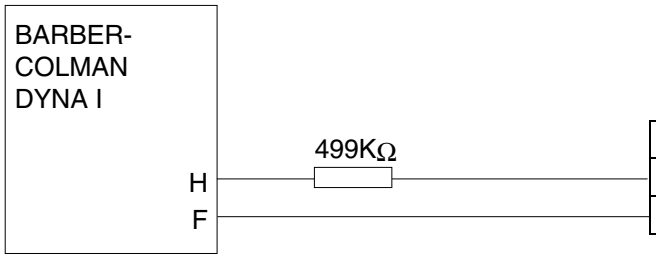
Governor interfaces

Barber-Colman DYNA I

DYNA I is intended for a potentiometer connected to terminal D (+8V DC), H (wiper) and F (+4V DC). When moving the wiper towards terminal D the speed increases.

There are two possibilities:

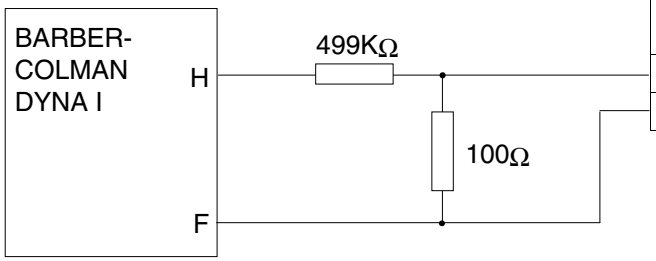
Direct coupling



DEIF equipment terminals

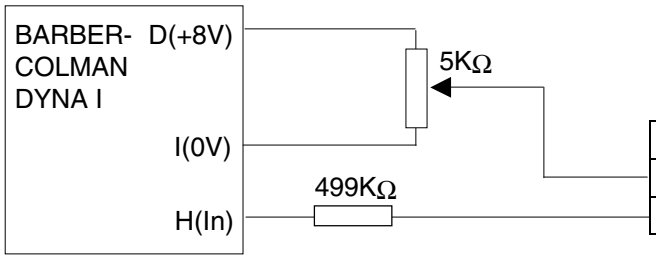
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 2V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

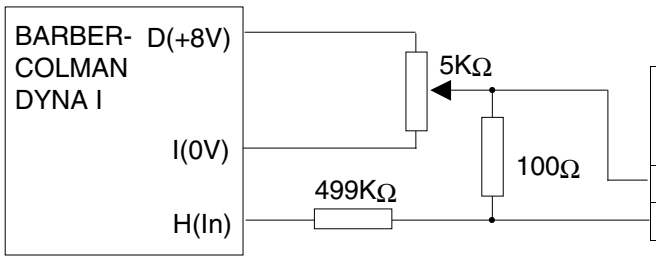
Paralleling with a remote speed adjust potentiometer (5K)



DEIF equipment terminals

EP-Q96	EPN-110DN
9 (⊥)	24 (⊥)
10 (+)	23 (+)

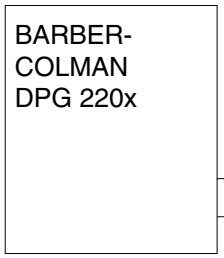
DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
30 (⊥)	67 (⊥)	65 (⊥)
29 (+)	66 (+)	66 (+)

Barber-Colman DYNA DPG 2200 governor

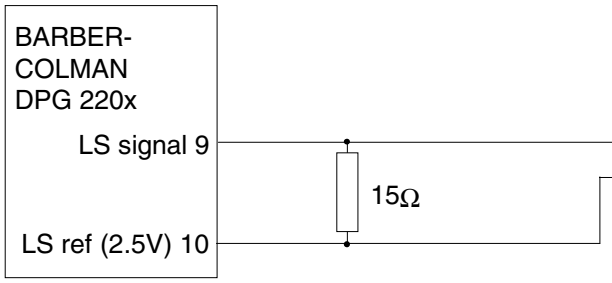
NOTE: The EP-Q/EPN electronic potentiometers must be set to lowest range, +/-300mV ~ +/-3Hz.



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 300mV DC range:



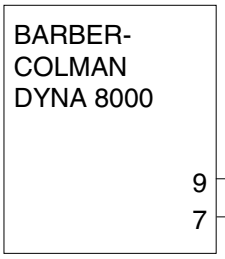
DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Barber-Colman DYNA 8000 governor

DYNA 8000 is similar to DYNA I, i.e. it is intended for a remote potentiometer speed control - terminal 6 (+8V DC), 7 (+4V DC), 9 (wiper) and 10 (0V). When moving the wiper towards 6 the speed increases.

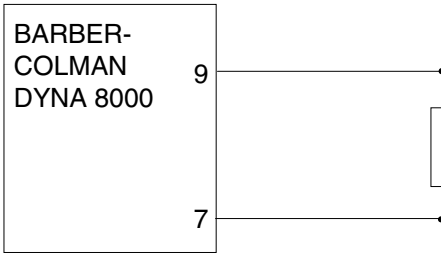
There are two possibilities:

Direct coupling



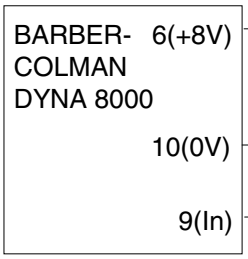
DEIF equipment terminals	
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 4V DC range:



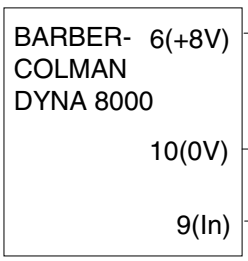
DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Paralleling with a remote speed adjust potentiometer (5K)



DEIF equipment terminals	
EP-Q96	EPN-110DN
9 (⊥)	24 (⊥)
10 (+)	23 (+)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 4V DC range:

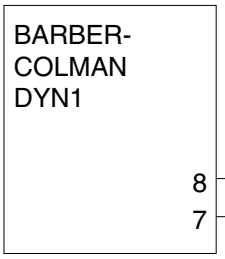


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
30 (⊥)	67 (⊥)	65 (⊥)
29 (+)	66 (+)	66 (+)

Barber-Colman DYNA 1 digital controllers

Model DYN1 10502/3/4/6

Replace the remote speed potentiometer as follows:

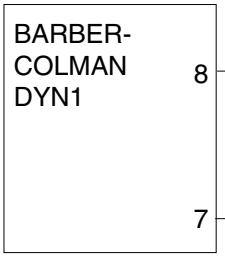


499KΩ

DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 2V DC range:



499KΩ

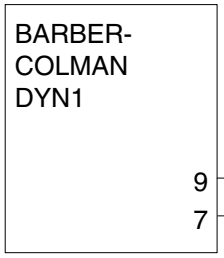
100Ω

DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Model DYN1 DYNA 2000

Replace the remote speed potentiometer as follows:

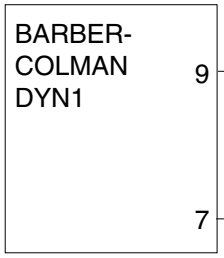
The input accepts 0…2V DC signals.



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 2V DC range:



100Ω

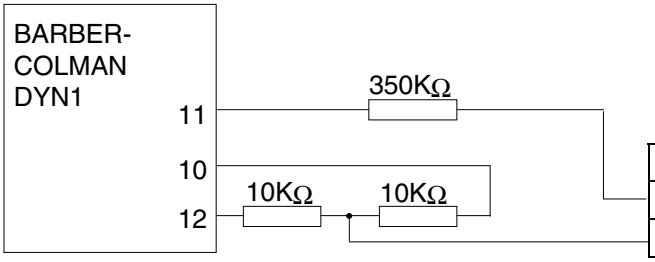
DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Model DYN1 10871

There are 2 possibilities:

1) Use the speed increase (term. 15)/decrease (term. 16) binary inputs and relay outputs from the DEIF equipment. Inputs activate when connected to terminal 1 (+9…30V DC).
2) Replace the remote speed potentiometer

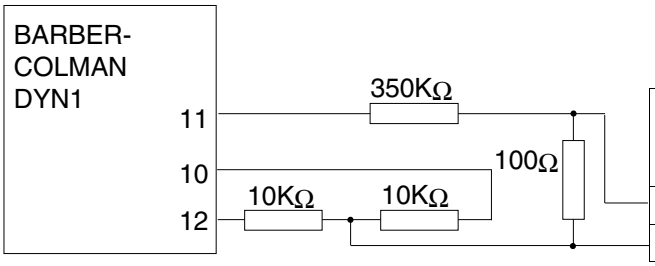
The input is quite sensitive. Therefore the circuit is a bit special:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 2V DC range:

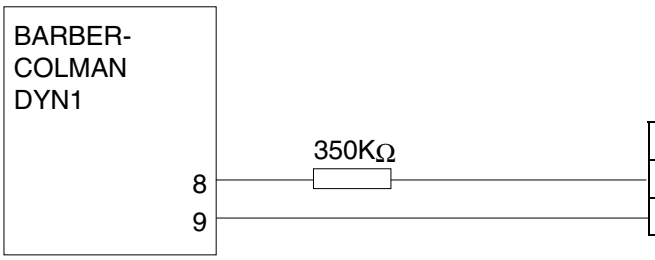


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Model DYN1 10794

Replace the remote speed potentiometer as follows:

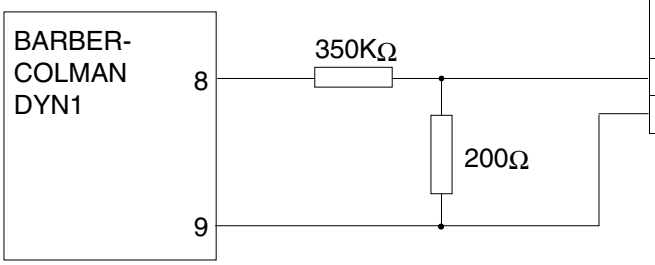
The input accepts 0…3.75V DC signals.



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

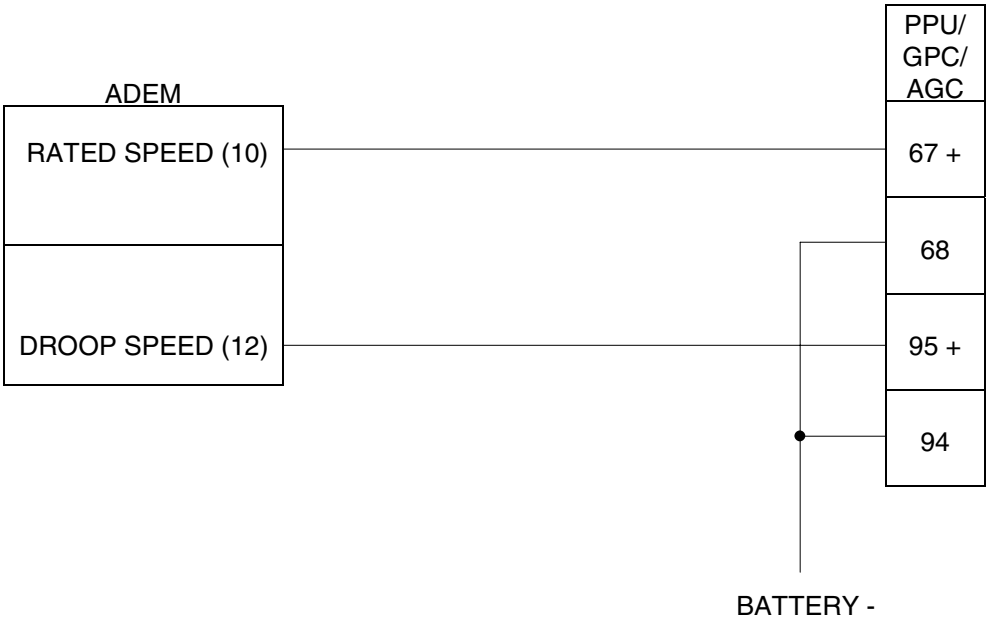
DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 4V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Caterpillar® ADEM engine controller

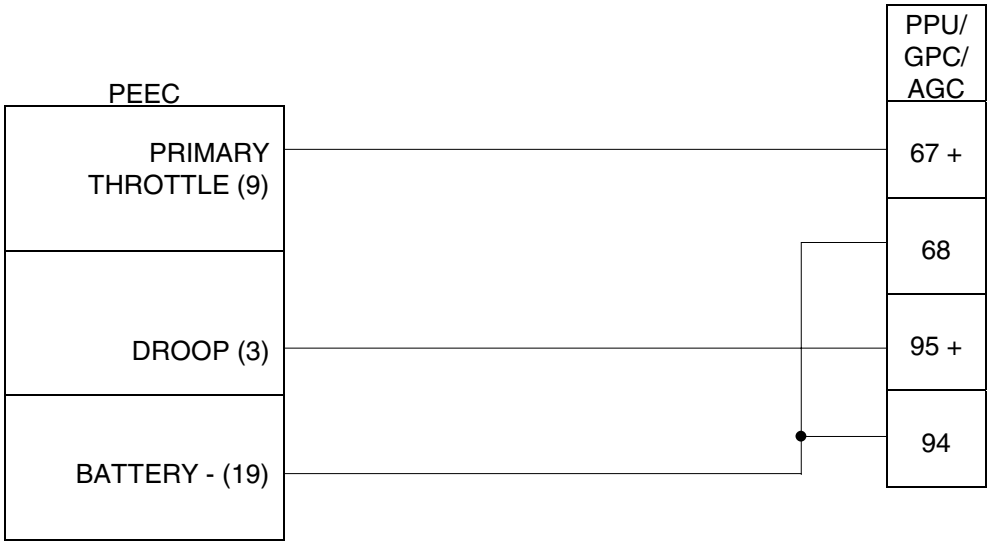
The ADEM requires PWM signals for speed and droop settings. These can only be obtained with multi-line 2 units, all other DEIF units do not have this capability.



Terminal numbers are plug numbers.

Caterpillar® PEEC engine controller

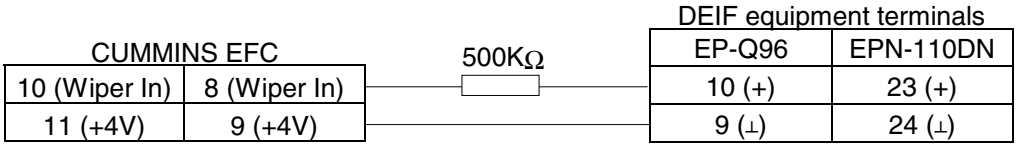
The PEEC requires PWM signals for speed and droop settings. These can only be obtained with multi-line 2 units, all other DEIF units do not have this capability.



Terminal numbers are plug numbers.

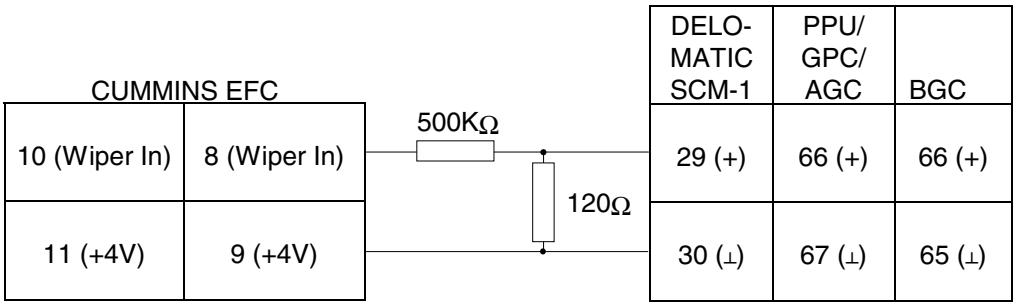
Cummins EFC governor

Cummins EFC governor accepts voltage signals directly, but the range is below the DEIF standard range. Therefore a voltage drop resistor (500KΩ) is needed. In the following 2 sets of terminals are shown. This is due to the fact that the EFC comes with 2 different terminal strip layouts.



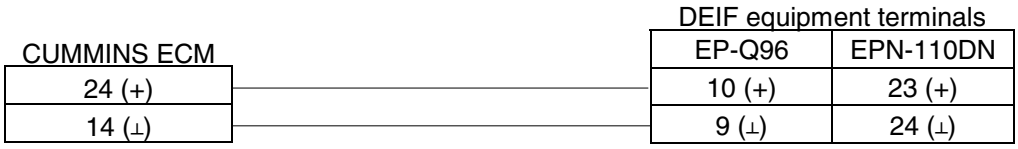
Set the DEIF equipment range to +/-5V DC.

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a 120Ω resistor is needed to convert into voltage:



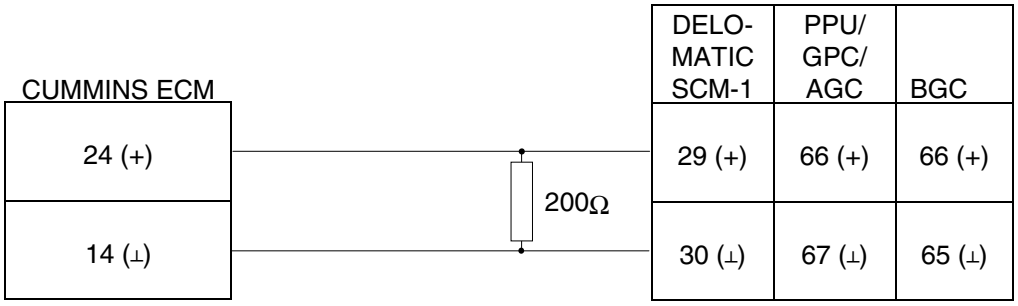
Cummins ECM controller

NOTE: The ECM gain must be set OFF.



Set the DEIF equipment range to +/-4V DC.

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a 200Ω resistor is needed to convert into voltage:



Cummins Power Command Control (PCC) load sharing system and multi-line 2

Since the multi-line 2 (ML-2) uses a 0…5V DC load sharing line which is not compatible with the PCC load sharing line, a conversion must be made.

As the same problem occurs with other manufacturers' systems (Barber-Colman (BC)/Woodward/GAC), Cummins has made an interface unit called "Isochronous Load Sharing (ILSI) kit", Cummins part no. 300-5456, which is the one to be used for ML-2 connection to PCC.

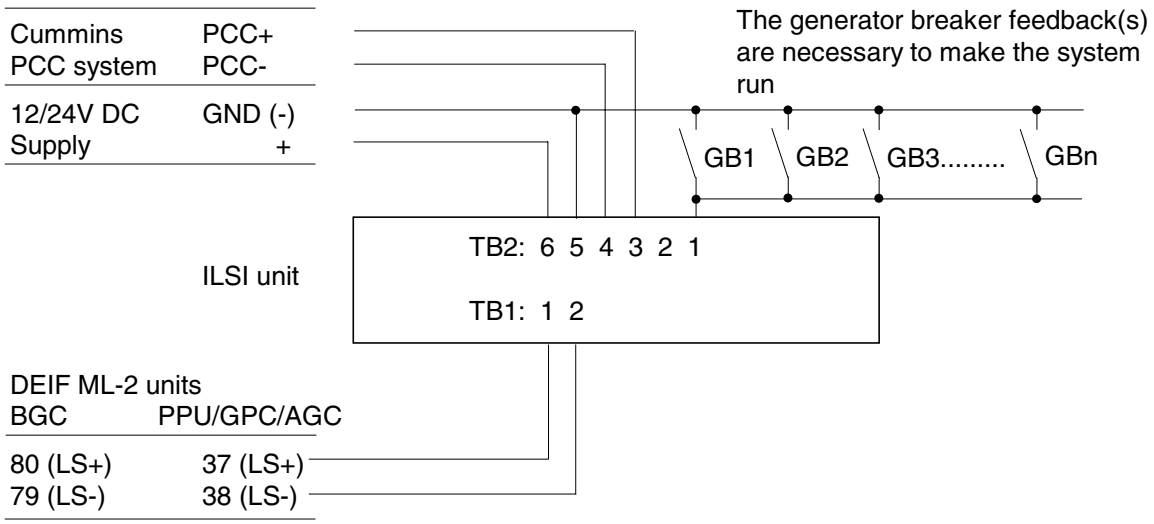
The load sharing is for power load sharing only, Kvar load sharing must be made using different units.

Following the Cummins instruction sheet C-604 11-01, the procedure is as follows:

1) The 100% kW ML-2 load share line voltage is 5V DC
2) Power up the ILSI module by applying 12-24V DC on TB2 terminals 5 (gnd) and 6 (+). Do not connect the load sharing lines yet
3) Set "Calibration Switch" to Cal
4) Set "ILS Type Switch" to BC
5) Adjust the "Load Share Gain" potentiometer to 5V DC (measured on terminals TB1 1 (+) and 2 (-))
6) Measure the "Calibration Voltage" on terminal TB2 5 (-) and "Calibration Voltage Test Point" (+). Typical value is 2.10V DC
7) Adjust "PCC Matching Potentiometer" until "PCC Voltage" is equal to "Calibration Voltage" in 6) (measured on terminals TB2 3 (+) and 4 (-))
8) Move "Calibration Switch" back to normal position

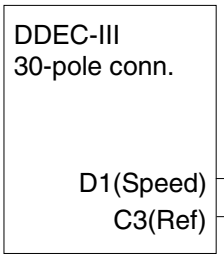
It is important that the "Calibration Switch" is moved back to normal position before starting the generators. Failure to do this will provoke reverse power trips.

Load sharing lines diagram:



Detroit Diesel DDEC-III electronic governor

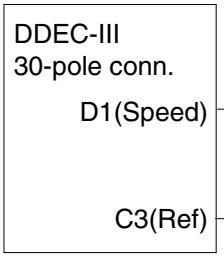
The DDEC-III accepts 0…5V DC signals directly:



DEIF equipment terminals

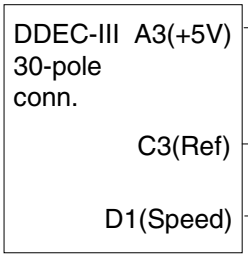
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

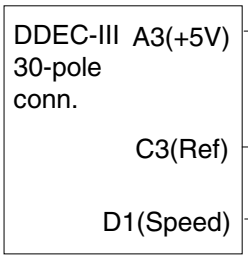
If the external manual speed setting potentiometer is required, the wiring must be:



DEIF equipment terminals

EP-Q96	EPN-110DN
9 (⊥)	24 (⊥)
10 (+)	23 (+)

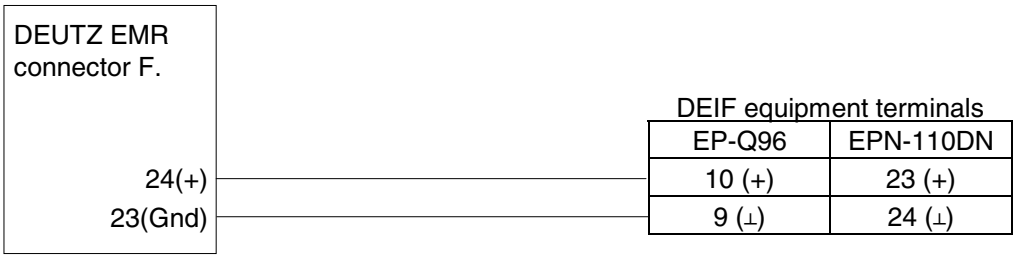
DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
30 (⊥)	67 (⊥)	65 (⊥)
29 (+)	66 (+)	66 (+)

Deutz EMR electronic controller

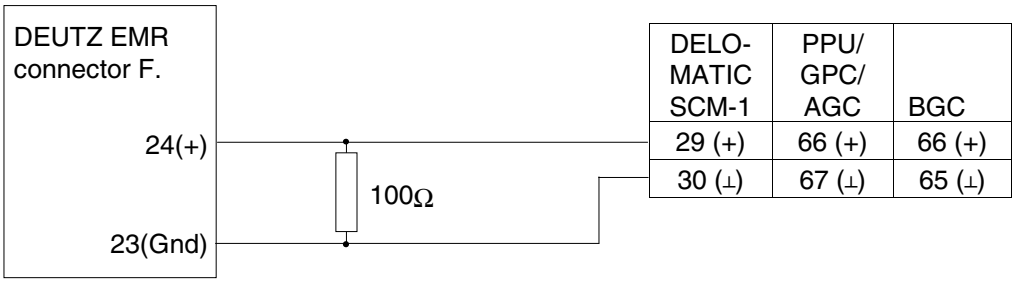
The EMR accepts a 0.5...4.5V DC signal, but only half the range is needed, so 2V DC is sufficient:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 2V DC range:



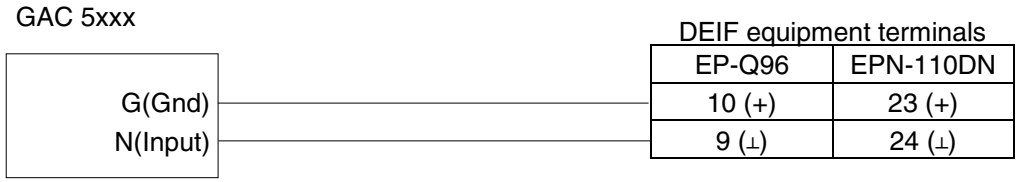
DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

A higher voltage range can be used (200Ω to give 4V DC). In this case the EMR frequency setting must be checked to be 49-51Hz.

GAC type ESD 5111, 5221 and 5131

Direct coupling

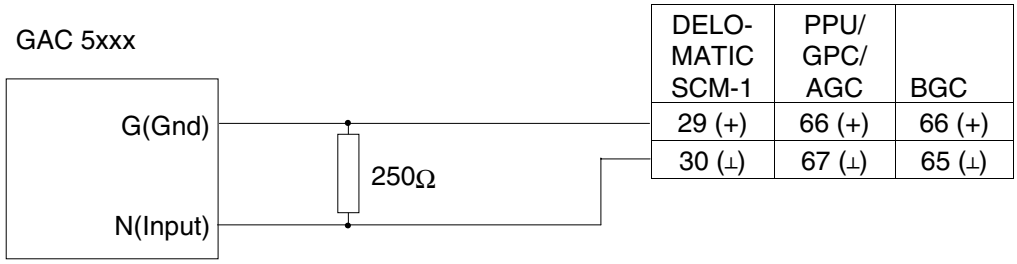
This GAC range has a terminal for external equipment. This terminal accepts +/-5V DC signals, so most of the DEIF controllers can be connected directly:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

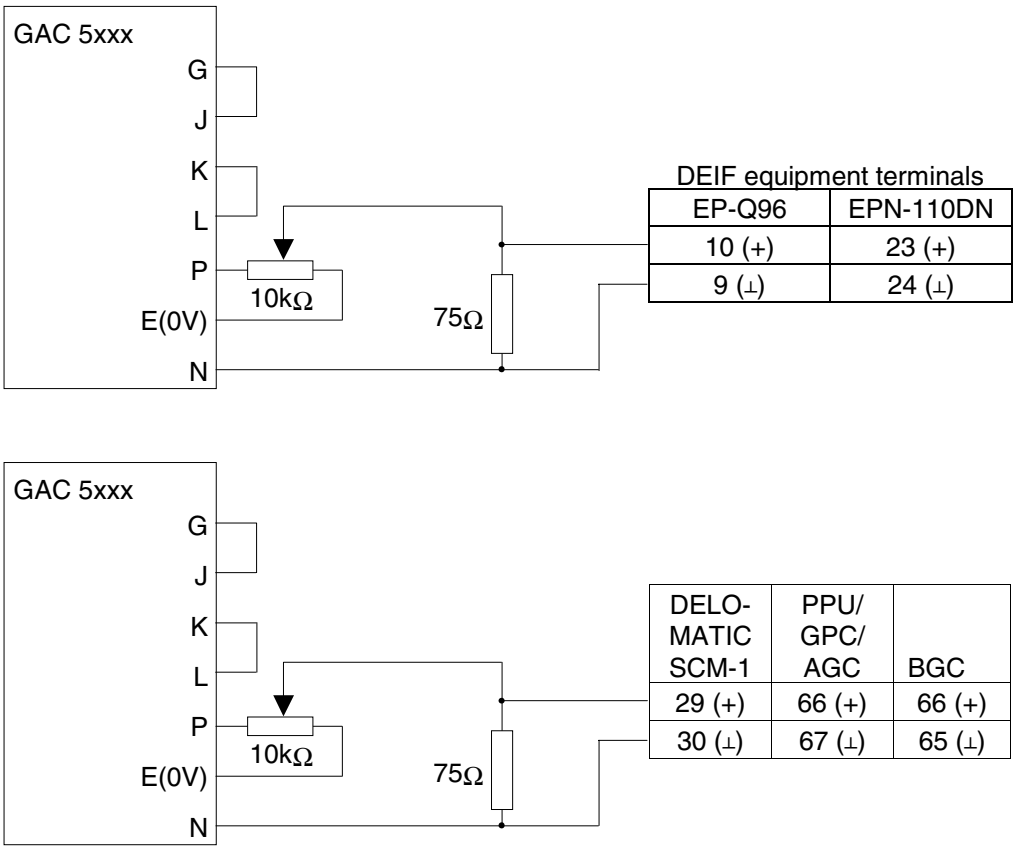
DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

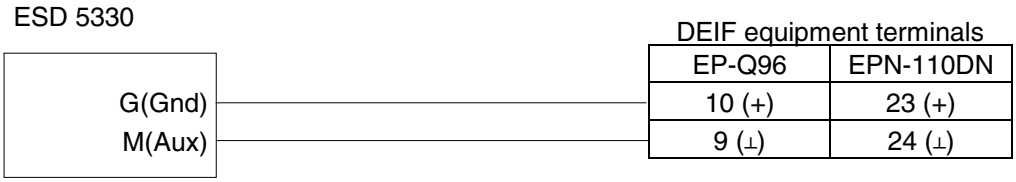
Coupling via potentiometer

For EP-Q and EPN the output range must be set to 1.3V DC:

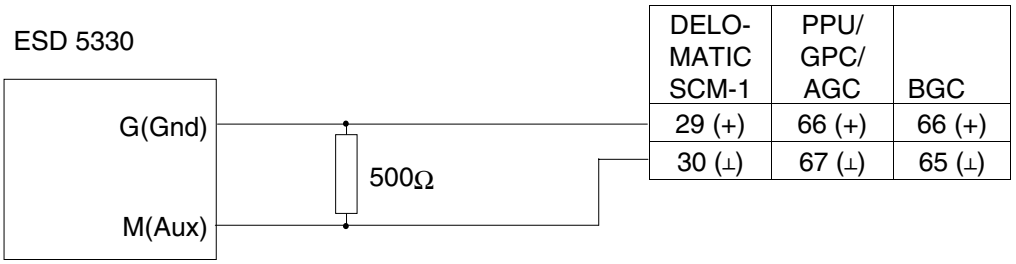


GAC type ESD 5330

The ESD 5330 has an input for 0…10V DC control as follows:



DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 10V DC range:



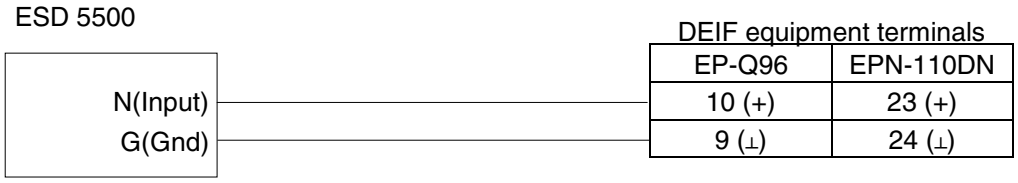
GAC type ESD 5500

The output signal from EP-Q/EPN must be set to give +2.5V after power up.

For EP-Q/EPN the "up" input will result in a decreasing speed, and the "down" input will result in an increasing speed.

For delomatic/multi-line the output signal must be set to give -10.0mA on power up. Since the connections are reversed, the ESD 5500 will see a +2.5V DC across the 250Ω resistor, and increase/decrease will work properly.

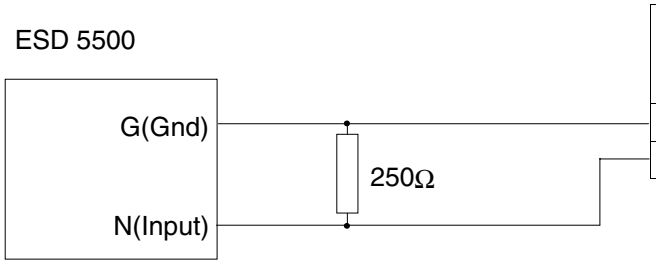
NOTE: On the ESD 5500 terminal J can be used instead of N. The J input has a lower impedance (5kΩ) than N (1MΩ). The G terminal on the ESD 5500 is connected to battery -.



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 10V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

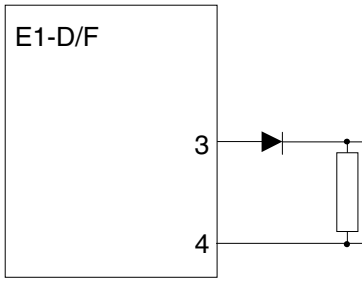
Heinzmann type E1-D and E1-F speed governor

Type E1-D/F accepts control voltage signals (0-5V DC) directly on terminal 3 (-) and 4 (+), so most of the DEIF controllers can be connected directly (note that the signal is protected by a diode and as such only the negative slope of the bi-polar output is used):

DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

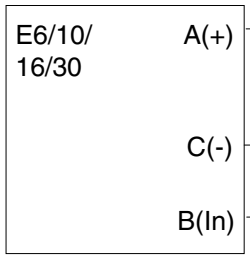
DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Heinzmann type E6, E6V, E10, E16 and E30 speed governor

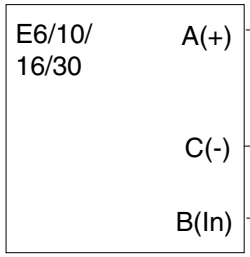
The E6...E30 series is intended for a 5K speed trim potentiometer. The DEIF equipment giving a voltage output can be connected in series with the wiper of the potentiometer:



DEIF equipment terminals

EP-Q96	EPN-110DN
9 (⊥)	24 (⊥)
10 (+)	23 (+)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
30 (⊥)	67 (⊥)	65 (⊥)
29 (+)	66 (+)	66 (+)

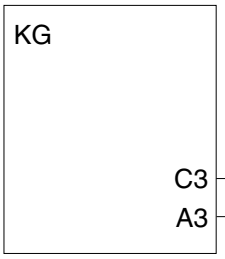
Heinzmann Olympus for gas turbines

Heinzmann Olympus accepts binary (relay) control signals as follows:

- Raise speed: Connect terminal H (connector 2) to +24V DC supply
- Lower speed: Connect terminal S (connector 2) to +24V DC supply

Heinzmann KG 6 - 04 to KG10 - 04

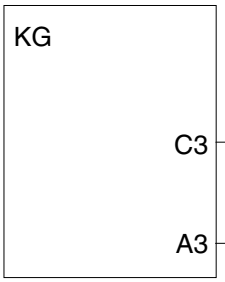
The Heinzmann KG series accepts voltage signals (1…5V DC) directly connected:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

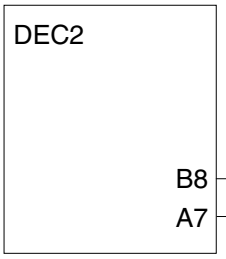
MTU MDEC 4000 governor

Even though analogue signals are accepted by the MDEC, it is not recommended for generators running parallel in island. The reason is that the MDEC detecting the analogue input being used will set the droop to 0 and by this make load sharing difficult. So, the binary (discrete) inputs can be used. The inputs are optocoupler inputs requiring 24V DC as follows:

Speed raise: X1-EE (cable wire 4) to gnd, X1-FF (cable wire 3) to +24V DC.
Speed lower: X1-u (cable wire 14) to gnd, X1-v (cable wire 13) to +24V DC.

SCANIA type DEC2 governor

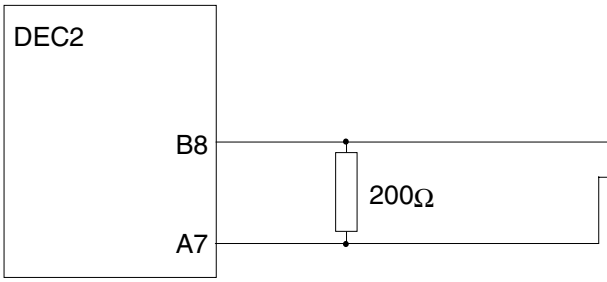
The DEC2 accepts 0…3V DC input for 0…100% speed, max. 5V DC to avoid damage, so the DEIF equipment can be connected directly. NOTE: The electronic potentiometers **must** have the range 5 V DC:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

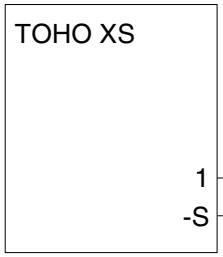
DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 4V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

TOHO electronic governor speed controller XS-400B-03

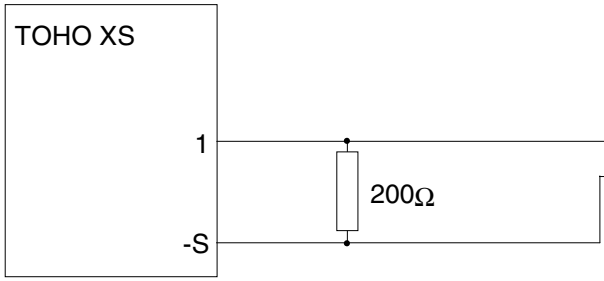
The TOHO speed controller accepts voltage signals and therefore DEIF equipment can be connected directly. NOTE: As the TOHO unit operates at 4V DC as base setting, the initial adjustment must be carried out with the DEIF equipment connected and powered up, but set at 0V (0mA for delomatic/PPU/GPC) output.



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 4V DC range:

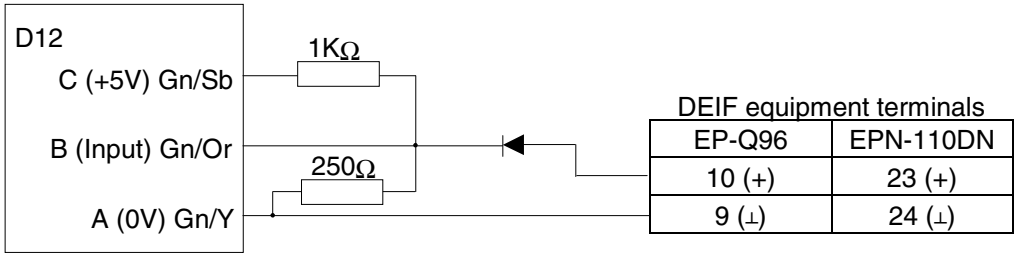


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Volvo type D12 controller

Volvo type D12 controller accepts 1.0 to 4.7V DC signals only, with an active range of 2.85V DC. In order to meet these requirements, the following network must be made:

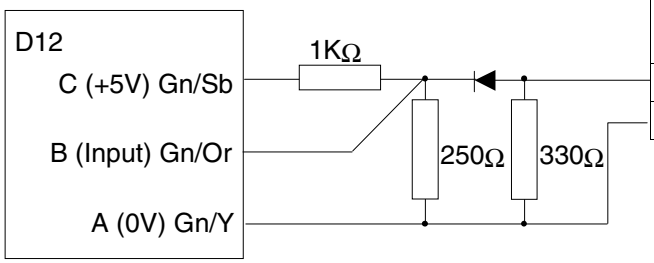
NOTE: The diodes are to prevent negative signals to the D12 which it cannot accept.
NOTE: Set the EP-Q/EPN output range to 3V DC.



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor circuit is needed to convert into 2.85V DC range:

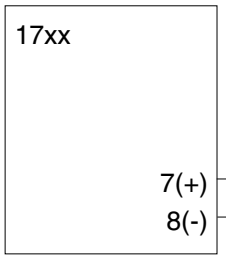


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Abbreviations for wire colours on D12: Gn/Sb: Green/black, Gn/Or: Green/orange, Gn/Y: Green/yellow.

Woodward type 1724 and 1712 governor

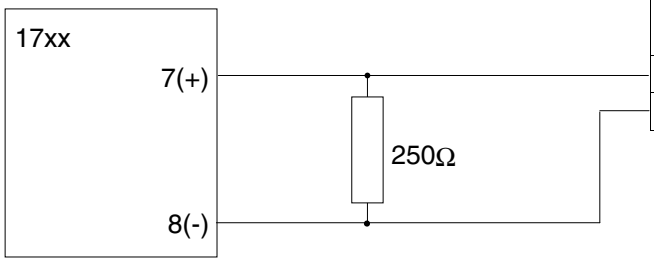
Woodward 17xx accepts voltage signals (+/-5V DC) directly on terminal 7 (+) and 8 (-), so the DEIF controllers can be connected directly:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

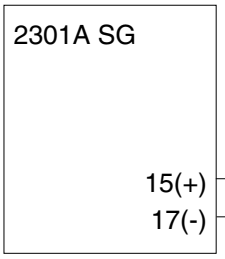
DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Woodward type 2301A speed control governor

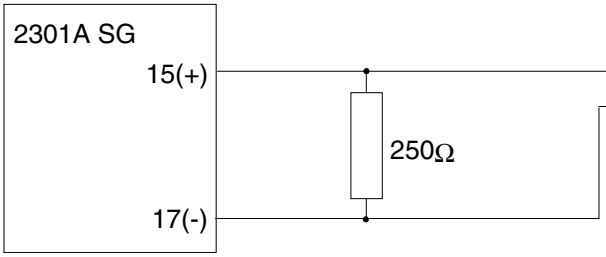
Woodward 2301A speed control voltage signals (0-5V DC) directly on terminal 17 (-) and 15 (+), so the DEIF controllers can be connected directly:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:

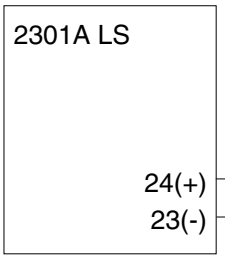


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Woodward type 2301A load sharing

Woodward 2301A load sharing is intended for a 100Ω potentiometer for external speed control.

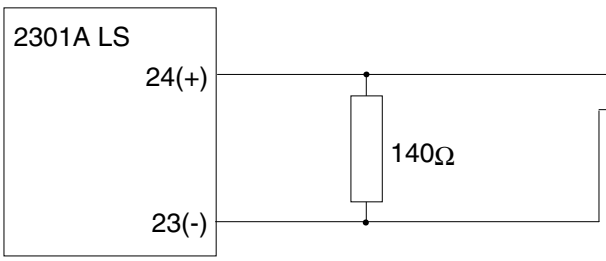
For DEIF equipment with voltage output:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 2.8V DC range:

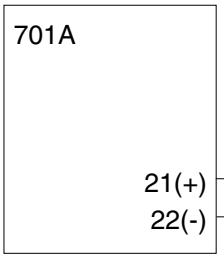


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

Woodward type 701A

The type 701A can accept both analogue or binary signals for speed control.

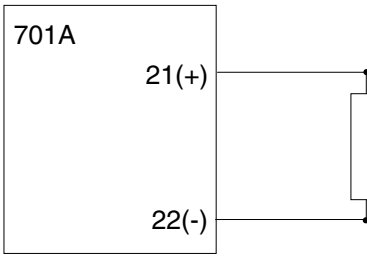
Analogue signals:



DEIF equipment terminals

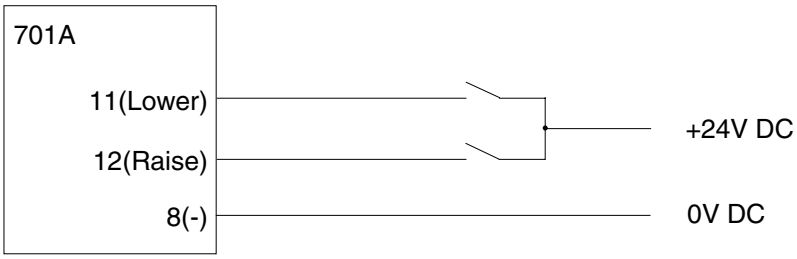
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 2.8V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
29 (+)	66 (+)	66 (+)
30 (⊥)	67 (⊥)	65 (⊥)

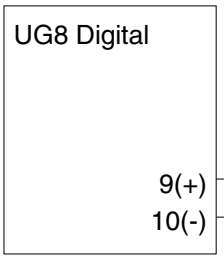
Binary signals:



Woodward UG8 digital control

The UG8 digital control accepts 4…20mA input for speed control. This means that a standard electronic potentiometer cannot be used directly as it is giving a voltage output.

The electronic potentiometers can be changed into giving 0-20mA outputs, but this is a special version that has to be asked for. The delomatic/PPU/GPC/AGC/BGC can connect directly:



SPECIAL EP-Q96	SPECIAL EPN-110DN	DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
10 (+)	23 (+)	29 (+)	66 (+)	66 (+)
9 (⊥)	24 (⊥)	30 (⊥)	67 (⊥)	65 (⊥)

NOTE: The EP-Q/EPN are to be modified for current output.

Woodward generator load sensor

The Woodward generator load sensor (using a Pulse Width Modulated signal for the governor) is intended for a 3-pole potentiometer.

Due to the internal circuits, the standard DEIF way of doing the connections cannot be used. Instead of connecting the outputs from the DEIF units to one side of the potentiometer and the wiper input, connections must be made for ground and wiper. Because of this the usual way of initial setting by switching off the DEIF unit during initial governor adjustment cannot be used. The DEIF unit must be switched ON and the output adjusted to 0V DC when adjusting the governor. After this normal procedure can be carried out. Note also that the output is "inverted", connect the + output from the DEIF unit to the gnd on the load sensor. This is possible due to the fact that the DEIF unit's output is galvanically separated from the rest of the unit.

	DEIF equipment terminals	
Load sensor	EP-Q96	EPN-110DN
21 (Gnd)	10	23
27 (Wiper)	9	24

The Woodward load sensor has not yet been tried with a Delomatic/PPU/GPC/AGC/BGC system, so the needed connections cannot be given at this stage.

Woodward proact digital speed control system type I and II

Even though the unit accepts analogue signals we recommend using the binary input terminal 18 (lower speed) and 19 (raise speed). The inputs are activated when connected to terminal 24 (+).

Woodward 721 digital speed control

Even though the unit accepts analogue signals we recommend using the binary input terminal 27 (lower speed) and 28 (raise speed). The inputs are activated when connected to terminal 1 (+).

Woodward PEAK^{TM} 150 digital control for steam turbines

The unit accepts relay (discrete) inputs. Binary input 12 (lower speed) and 13 (raise speed). Internally powered (jumper 15 set, see manual), the inputs are activated when connecting terminal 33 (+24V DC internal source) to the input in question (12 or 13). Externally powered (jumper 16 set, see manual) the external negative (-) is to be connected to terminal 20 and the inputs (12 or 13) are then activated when the external +24V DC is connected to them.

AVR interfaces

AVK COSIMAT AVR

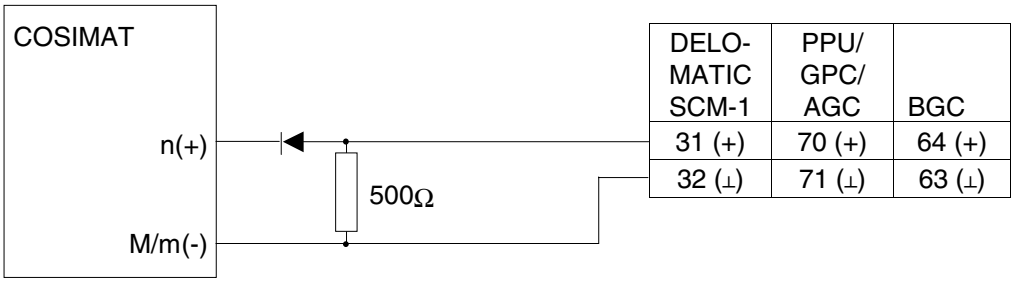
This applies for all types of the AVK COSIMAT:

The COSIMAT has an aux. input for external equipment which accepts 0…10V DC signals. As the input only accepts positive signals, a diode is needed to prevent negative signals:

DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 10V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
31 (+)	70 (+)	64 (+)
32 (⊥)	71 (⊥)	63 (⊥)

Adjustment:

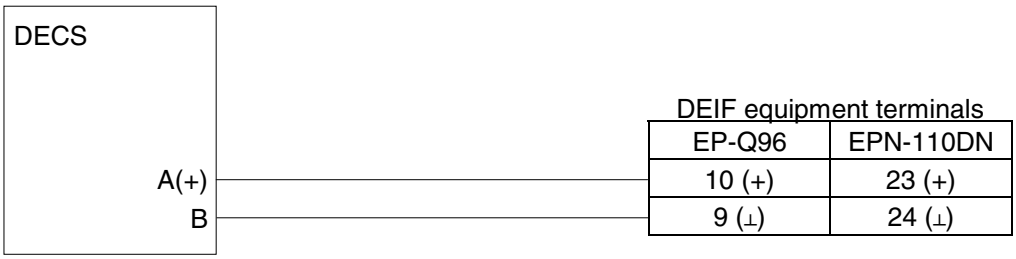
- The R4 potmeter in the COSIMAT (18-turn) must be adjusted to "min."
- Use manual control to raise the DEIF equipment to +10V DC
- Start the generator and use R4 to set the max. allowable voltage
- Adjust the integration time of the DEIF equipment if needed

Basler electric digital excitation control system (DECS)

The DECS accepts binary inputs directly on terminals 6D (lower voltage), 7 (common) and 6U (increase voltage).

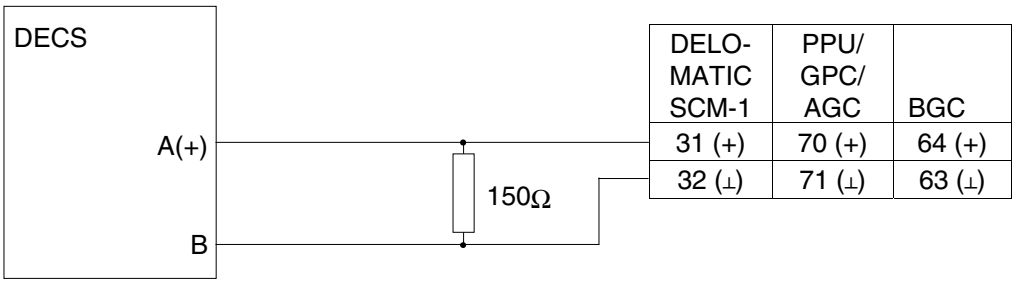
To increase voltage: Connect 6U to 7.
To decrease voltage: Connect 6D to 7.

Also analogue signals can be used (+/-3V DC range):



DEIF equipment terminals	
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 3V DC range:

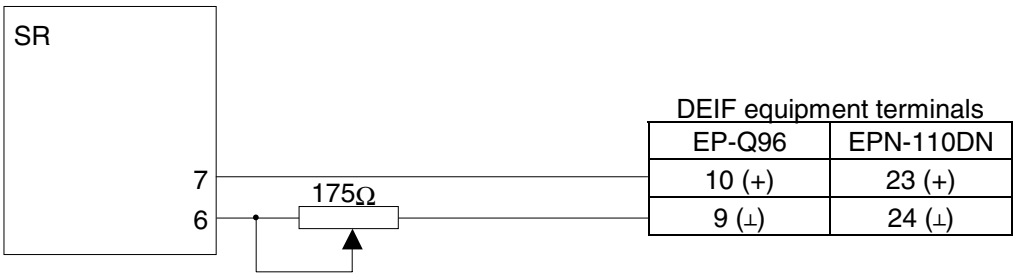


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
31 (+)	70 (+)	64 (+)
32 (⊥)	71 (⊥)	63 (⊥)

Basler electric SR 4A/6A/8A/9A/32A AVR

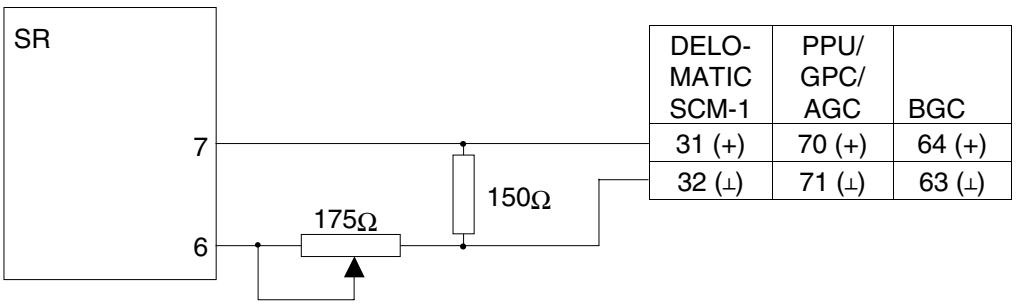
The Basler SR series is intended for a 2-wire 175Ω potentiometer input.

The connection to DEIF equipment is as follows:



DEIF equipment terminals	
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 3V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
31 (+)	70 (+)	64 (+)
32 (⊥)	71 (⊥)	63 (⊥)

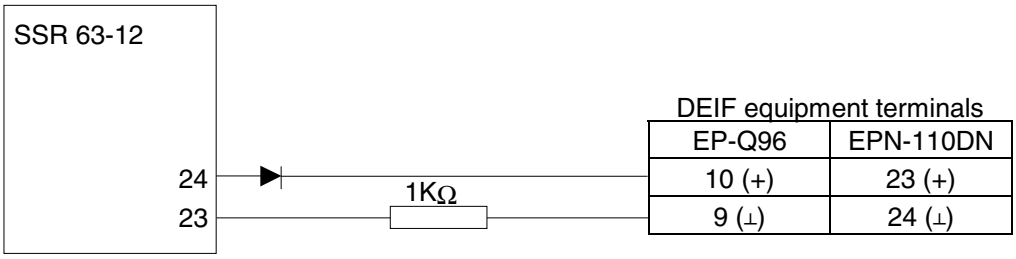
Basler electric SSR 32-12, 63-12, 125-12 AVR

The SSR series works in an "inversed" way, meaning that the standard DEIF way cannot be used.

The input used is the "ext. adj.".

The diode mounted in the connection prevents positive voltages to be sent to the SSR unit. As both EP-Q/EPN and delomatic/PPU/GPC/AGC/BGC are using bipolar galvanically separated outputs, this is not a problem.

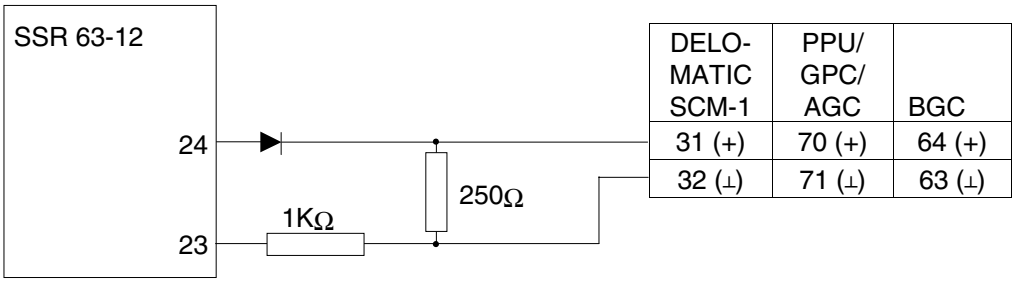
When adjusting the generator voltage initially, adjust the (internal) idle voltage to 25% above nominal. The DEIF units will then bring the voltage down to nominal level when activated:



DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:

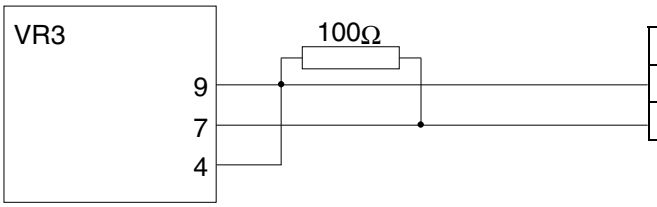


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
31 (+)	70 (+)	64 (+)
32 (⊥)	71 (⊥)	63 (⊥)

Caterpillar® VR3

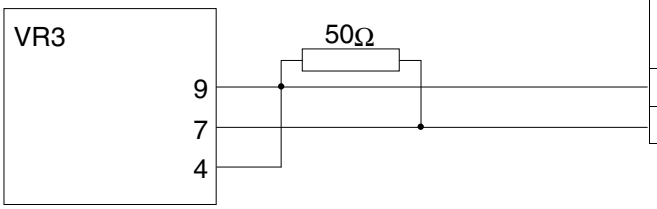
Set the EP-Q/EPN output to +/-5V DC.

The 100Ω resistor is there to dampen the signal.



DEIF equipment terminals	
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 1V DC range:

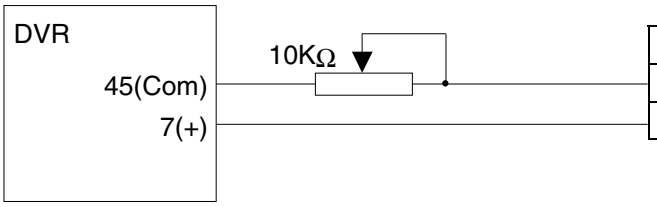


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
31 (+)	70 (+)	64 (+)
32 (⊥)	71 (⊥)	63 (⊥)

Caterpillar® DVR

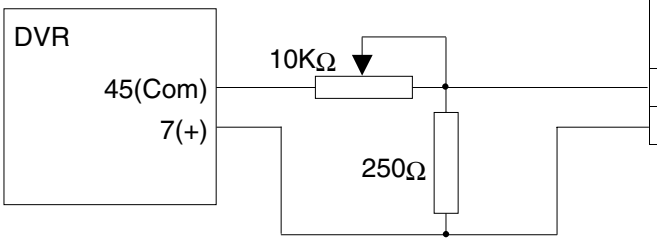
The DVR 2-wire input gives an increasing generator voltage with increasing resistance.

Set the EP-Q/EPN output to +/-5V DC.



DEIF equipment terminals	
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



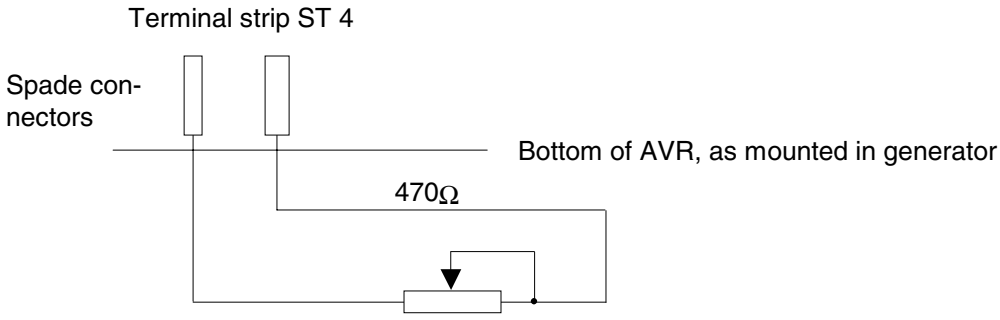
DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
31 (+)	70 (+)	64 (+)
32 (⊥)	71 (⊥)	63 (⊥)

Leroy Somer type R448 LS/C or D AVR

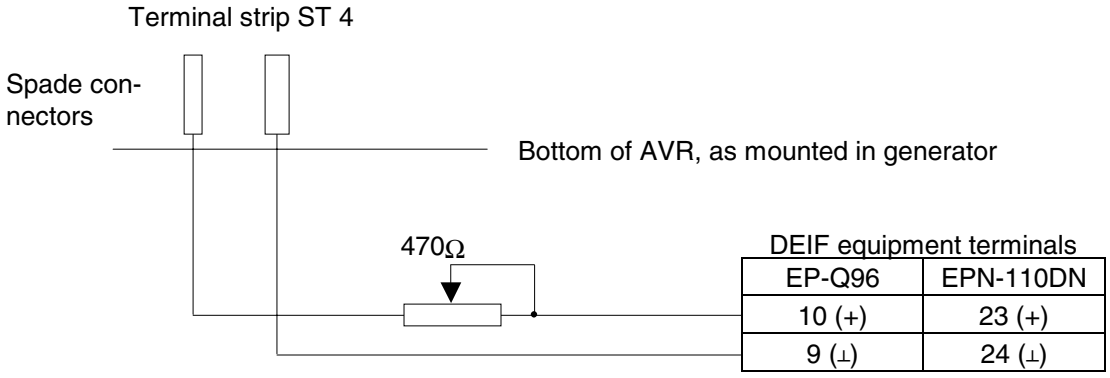
The type R448 does not have a terminal strip but uses automotive spade connectors.

As the external control is 2-wire potentiometer, the following circuit must be used:

Circuit as described by Leroy Somer:



Using DEIF equipment:

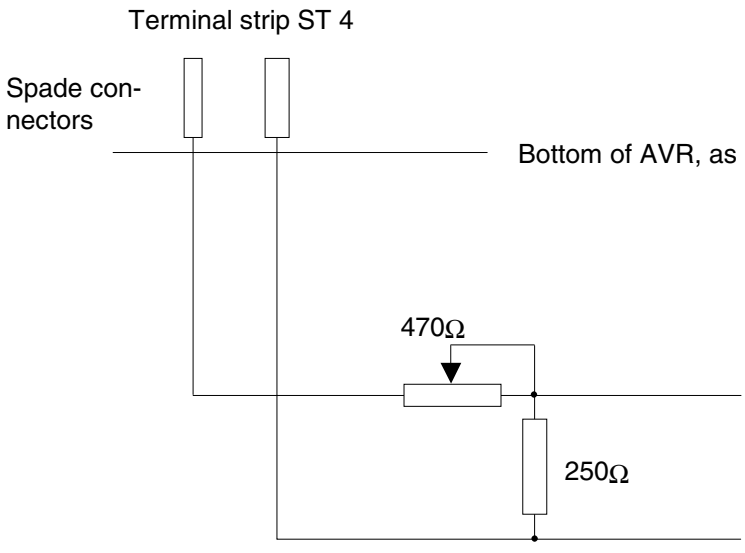


DEIF equipment terminals

EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

The output from the electronic potentiometer is set to 5V DC.

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:

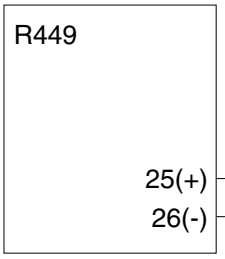


DEIF equipment terminals

DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
10 (+)	23 (+)	64 (+)
9 (⊥)	24 (⊥)	63 (⊥)

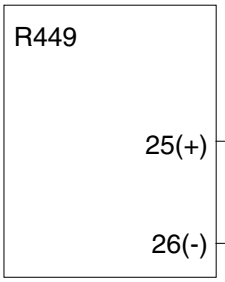
Leroy Somer type R449 AVR

R449 has a potentiometer input (terminal 25 and 26). Therefore the DEIF equipment can usually be connected directly:



	DEIF equipment terminals	
	EP-Q96	EPN-110DN
25(+)	10 (+)	23 (+)
26(-)	9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:

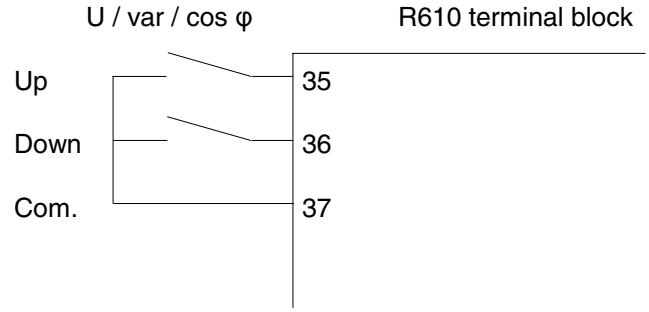


DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
31 (+)	70 (+)	64 (+)
32 (⊥)	71 (⊥)	63 (⊥)

Leroy Somer type R610 AVR

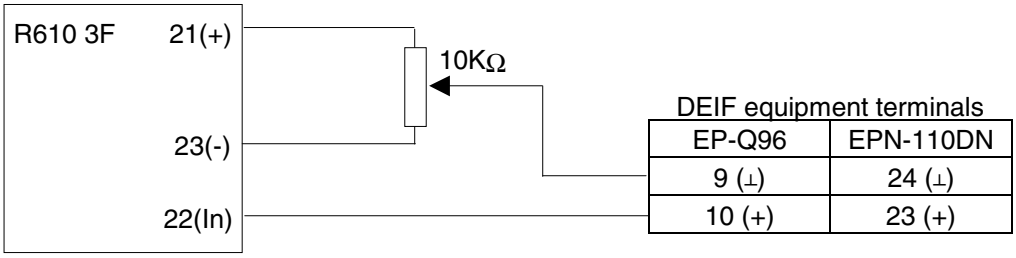
As a standard R610 is not equipped with external control possibilities. There is, however, an option for both potentiometer and binary control of voltage/reactive power/cos φ control.

We recommend using "Digital pot U/P.F. Optional Card". When this card is fitted terminals 35, 36 and 37 are used as follows:



Leroy Somer type R610 3F AVR

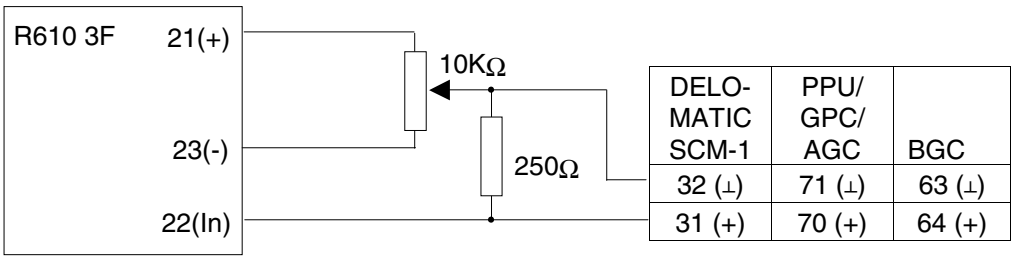
The R610 3F external voltage control is intended for a 3-wire 10KΩ potentiometer. Terminals used are 21, 22 and 23. The DEIF equipment is connected like this:



DEIF equipment terminals

EP-Q96	EPN-110DN
9 (⊥)	24 (⊥)
10 (+)	23 (+)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
32 (⊥)	71 (⊥)	63 (⊥)
31 (+)	70 (+)	64 (+)

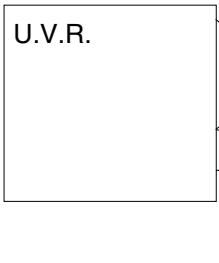
Marathon Magnamax AVR

The Magnamax accepts binary inputs directly on terminals 6D (lower voltage), 7 (common) and 6U (increase voltage).

To increase voltage: Connect 6U to 7.
To decrease voltage: Connect 6D to 7.

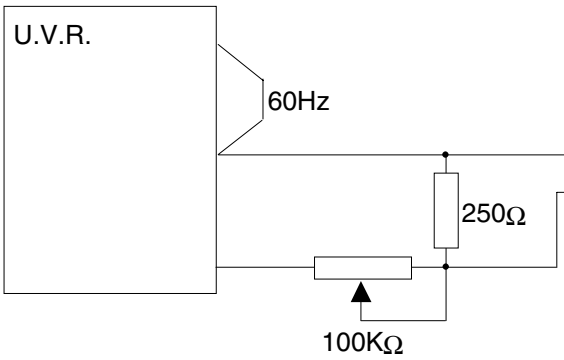
Mecc-Alte type U.V.R. AVR

The Mecc-Alte U.V.R. has no terminal numbers, but the connection for external voltage control is placed next to the 50/60Hz selection connection:



DEIF equipment terminals	
EP-Q96	EPN-110DN
9 (⊥)	24 (⊥)
10 (+)	23 (+)

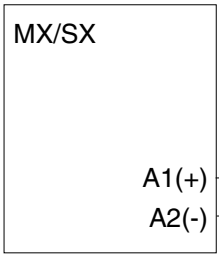
DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
32 (⊥)	71 (⊥)	63 (⊥)
31 (+)	70 (+)	64 (+)

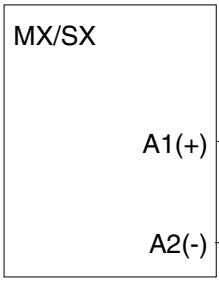
Stamford Newage type MA325, MA327, MX321, MX341, SR465, SX421 and SX440

These AVRs have an aux. input (terminal A1 and A2) which accepts voltage signals (+/-5V). Therefore the DEIF equipment can usually be connected directly:



DEIF equipment terminals	
EP-Q96	EPN-110DN
10 (+)	23 (+)
9 (⊥)	24 (⊥)

DELOMATIC/PPU/GPC/AGC/BGC output is +/-20mA, so a resistor is needed to convert into 5V DC range:



DELO-MATIC SCM-1	PPU/ GPC/ AGC	BGC
31 (+)	70 (+)	64 (+)
32 (⊥)	71 (⊥)	63 (⊥)

NOTE: Stamford Newage type SX460 has no A1 and A2 terminals and cannot be controlled.

Troubleshooting

Problem indication	**Problem cause**	**Remedy**
Loadsharing or parallel with mains power control unstable. Synchronisation OK. Single generator running frequency control OK.	No speed droop on generators.	Apply 3-4% speed droop on prime mover governor.
Loadsharing or parallel with mains voltage (var) control unstable. Synchronisation OK. Single generator running voltage control OK.	No voltage droop on generators.	Apply 3-4% voltage droop on generator AVR.
Uni-line active power loadsharing units only: Loadsharing or parallel with mains power control unstable. Synchronisation OK. Single generator running frequency control OK. Speed droop OK.	Faulty connection of measuring voltage and/ or current transformer input.	Correct connections. Voltage on L1 and L2, current transformer in L1.
Uni-line active power loadsharing units only: Loadsharing stable but not equal. Synchronisation OK. Single generator running frequency control OK. Speed droop OK.	Loadsharers have been mounted to control the wrong size generators (can happen in systems with different size of generators).	Re-mount the loadsharers to match the generators. The loadsharers are pre-configured for a specific generator.
Uni-line reactive power loadsharing units only: Loadsharing or parallel with mains var control unstable. Synchronisation OK. Single generator running voltage control OK. Voltage droop OK.	Faulty connection of measuring voltage and/ or current transformer input and/or voltage transducer.	Correct connections. Voltage on L1 and L2, current transformer in L1, voltage transducer to US-line (term. 38 (+) and 39 (-)).
Uni-line reactive power loadsharing units only: var loadsharing stable but not equal. Synchronisation OK. Single generator running voltage control OK. Voltage droop OK.	var loadsharers have been mounted to control the wrong size generators (can happen in systems with different size of generators).	Re-mount the var loadsharers to match the generators. The var loadsharers are pre-configured for a specific generator.
Generator not able to take load to 100%.	Initial setting of speed governor not correct.	See "Initial setting of speed governor/AVR".
Generator not able to take load to 100%.	Analogue output from DEIF equipment has too low output range.	Increase the full scale value. This is mostly a case when using electronic potentiometers.
Speed decreases when increase was expected (relay outputs).	Relay outputs "up" and "down" reversed.	Swap connections.
Speed decreases when increase was expected (analogue output).	Outputs "+" and "-" reversed.	Swap connections.

Errors and changes excepted