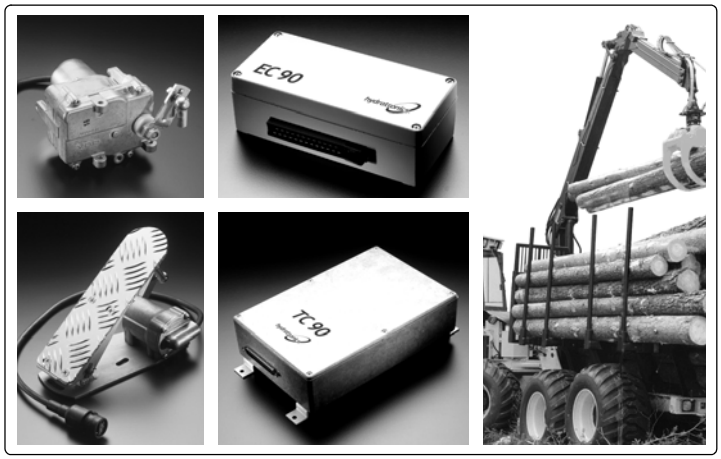
hydratronics

TC90-EC90 System

Control Systems for Hydrostatic Transmissions



User Guide

System description
Installation
Technical data

Part No. 81081350

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1

TC90 control unit

General description

The TC90 is an electrical control amplifier designed primarily to control LINDE hydrostatic transmissions, equipped with variable hydraulic pumps and hydraulic motors, that are used in different types of applications, both mobile and stationary.
The most frequently encountered application comprises transmission control for mobile equipment such as forestry machines and other types of wheeled vehicles powered, for the most part, by diesel engines.
The TC90 can be connected to provide automatic or manual control of current flowing to the hydrostatic transmission. When the basic connection is used, current flowing to the transmission is controlled automatically in such a way that it is proportional to the diesel engine rpm. Moreover, the TC90 can also be used as a control amplifier in other situations where you need to control one or two proportional valves either automatically or using a manual control lever. See also the connection examples presented in Chapter 2, headed *Installation*.

Adjustment

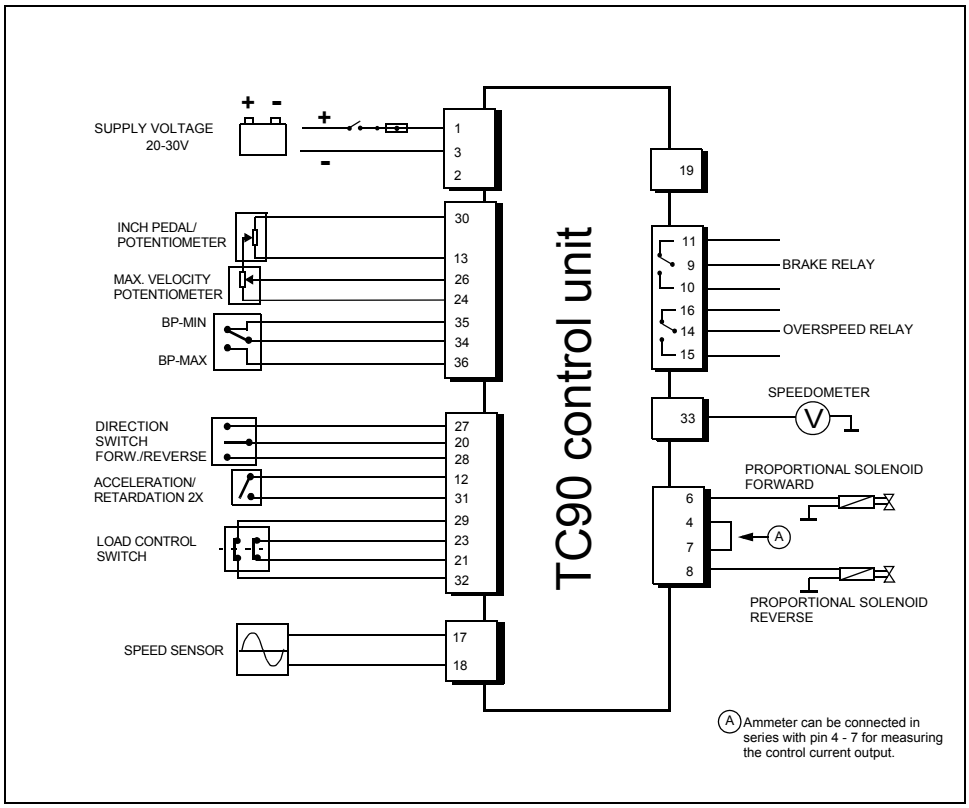
This chapter explains how to trim and adjust the TC90 control unit. A TC90 testunit (test simulator) can be used to provide simple, fast adjustment, but the unit can also be adjusted while mounted in the machine. Since the TC90 can be connected in many different ways, the trimming/adjustment description in this chapter will be limited to the basic connection shown on the connection diagram on the next page.

Chapter 2 of this manual, headed *Installation*, presents some of the ways in which the TC90 can be connected for different applications.

Adjusting the TC90 control unit

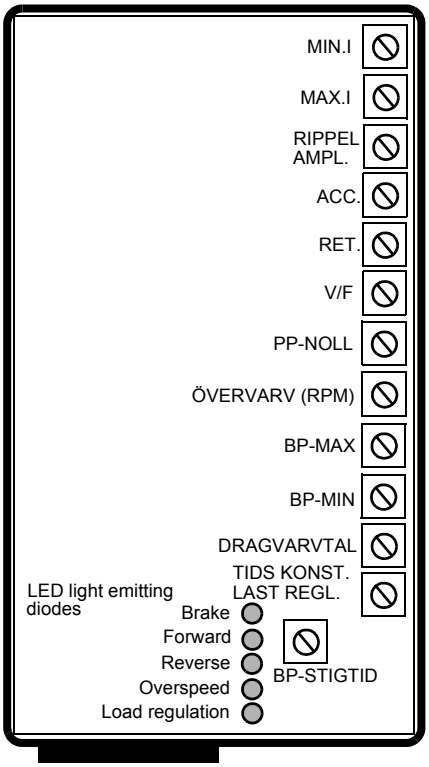
Connection diagram

The connection diagram shown below is referred to in the adjustment instructions set forth in this chapter. Since the TC90 control unit can be used in many different applications, the connection arrangement may differ somewhat from what is set forth below. If so, you may have to adapt the setting procedure accordingly. This adaptation should be relatively simple, however, based on the following description. Before starting to make your settings, check to see that the supply voltage is within 20 - 30 Volt DC. The ripple in the supply voltage must not exceed 3 Volt, peak-to-peak.

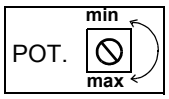


TC90 control unit potentiometers

TC90 control unit
with cover removed



MIN.I	Min. control current
MAX.I	Max. control current
RIPPEL AMPL.	Ripple amplitude for control current
ACC.	Acceleration ramp for control current
RET.	Retardation ramp for control current
V/F	V/F, used to adjust the rpm instrument
PP-NOLL	Electrical neutral point for inching pedal
ÖVERVARV (RPM)	Set point for overspeed indicator
BP-MAX	Set point for upper start-off rpm
BP-MIN	Set point for load-regulation rpm limit
DRAGVARVTAL	Set point for low start-off rpm
TIDS KONST. LAST REGL.	Time constant for load regulation
BP-STIGTID	BP-min/BP-max, time delay



1. Adjustment of the current generator in TC90

Trimming starts with basic adjustment of the current generator. Minimum and Maximum currents; MIN-I and MAX-I potentiometers

1. **Turn off the load control function** by opening the **LOAD CONTOL SWITCH**. (Pins 21/23 and 29/32, open contacts).When the automatic load control function has been disabled, automatic regulation of current flowing to the proportional valves via the diesel engine rpm sensor is also disabled.

2. Connect an ammeter (built into the TC90 testunit) in series with connector pins 4 -7 on the TC90, see figure page 1-2 and use the 1 A range.

3. Set the **DIRECTION SWITCH** to the forward position.

4. Turn the **MAX. VELOCITY POTENTIOMETER** to the position at which the light-emitting diode marked **FORWARD** lights up. (PP on the TC90 testunit).

5. Turn up the **RIPPLE AMPL** trimmer pot. to about 60%.

6. Turn down the **ACC** and **RET** trimmer pots. to their minimum positions.

7. Using the **MIN I** trimmer pot., adjust until the desired ***minimum current*** is obtained. Approx.: **160 mA** for LINDE transmission.

8. Turn up the **MAX. VELOCITY POTENTIOMETER** to its maximum position.

9. Using the **MAX I** trimmer pot. adjust until the desired ***maximum current*** is obtained.
   Approx.: **500 mA** for LINDE transmission incl. variable hydraulic motor.
   Approx.: **360 mA** for LINDE transmission incl. fixed displacement hydraulic motor.

10. If you're using an **INCH PEDAL/POTENTIOMETER** proceed as follows:
    Press the INCH PEDAL down all the way and adjust the trimmer pot. marked **PP ZERO** until the ***same minimum current*** is obtained as adjusted in paragraph 7 above.

NOTE! The adjustments in steps 1-10 above provide initial values that may need fine adjustment while the machine is running to compensate for minor differences in the proportional solenoids. When steps 1-10 are completed, ACC and RET can be set.

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11. Turn up the **MAX. VELOCITY POTENTIOMETER** to its maximum position and make certain that the **ACC/RET x 2** switch is open.

12. Set the **DIRECTION SWITCH** to its neutral position.

13. Wait until the output current reaches zero.

14. Set the **DIRECTION SWITCH** to the forward position and observe the following:
Output current rises rapidly to the preset minimum current and then increases more slowly to the preset maximum current. If **ACC** is set to its minimum position this will take place quite rapidly.

15. By shifting the **DIRECTION SWITCH** from its neutral position to its forward position and simultaneously adjusting the **ACC** trimmer pot., you can set the desired acceleration. This corresponds to the time it takes for the output current to rise from the preset minimum value to the preset maximum value.

16. You can set the desired retardation by shifting the **DIRECTION SWITCH** from its forward position to its neutral position and adjusting the **RET** trimmer pot. correspondingly.

17. Close the **ACC/RET x 2** switch.

18. Shift the **DIRECTION SWITCH** back and forth between the neutral position and forward position a number of times while checking to see that the acceleration and retardation times have both increased to approximately twice their previous values.

19. Disconnect the ammeter that was connected in step 2 and reconnect the wire between pins 4 -7 (does not apply if the TC90 testunit was used).

You have finished making the current generator settings.

Now proceed to adjust the load control function.

2. Adjusting the load control function

The current generator must have been trimmed (adjusted) before you start to adjust load control. Adjusting the speedometer is explained on page 9 in this chapter.

1. Start the engine.

2. Using a voltmeter, measure the voltage across the speedometer between pins 33+ and 3–. It must be 1000 mV (1.0 Volt) when the engine runs at 1000 rpm. If it is not, you must adjust it. Run the engine at a known speed (measured using an external tachometer).
   Adjust the **V/F trimmer potentiometer** until the output voltage corresponds to 1000 mV at 1000 rpm.This will mean that:
   500 mV = 500 RPM
   1000 mV = 1000 RPM
   1500 mV = 1500 RPM
   2000 mV = 2000 RPM
   When the engine is shut down, a residual voltage may remain at the output, but since it is less than 50 mV it has no effect on functionality.

3. Set the **TIME CONST. LOAD CONTR**. trimmer potentiometer to its minimum position.

4. Set the **BP-RISE TIME** trimmer potentiometer to its minimum position.

5. Close the **LOAD CONTROL SWITCH**. (Pins 21/23 and 29/32, closed contacts).

6. Turn up the **MAX. VELOCITY POTENTIOMETER** to its maximum position.

7. Set the **BP-MIN/BP-MAX** switch to **BP-MIN position**, thereby making contact between pins **34 and 35**. (On the TC90 testunit, set the switch to the BP-MIN position.) This will enable you to trim the ***speed limit-loadcontrol*** and the ***low start-off speed.***

8. Run the engine at the speed that corresponds to the ***speed limit-load control***.
   This is the speed beneath which the load control will reduce the output current, 1800 rpm as an example. (Normally in the range 1900-2300 rpm).

9. Using the **BP MIN** trimmer potentiometer adjust until the light-emitting diode marked **LOAD CONTR** lights up. (If the speed is increased somewhat, this light-emitting diode shall go out.).

10. **Disconnect the forward proportional solenoid so that the machine does not have to be running when the following steps are performed:**

11. Set the **DIRECTION SWITCH** to the forward position.

12. Turn the **MAX. VELOCITY POTENTIOMETER** to its maximum position.

13. Run the engine at the speed which corresponds to the ***low start-off speed***, 1000 rpm as an example.

14. Adjust the **START-OFF SPEED** trimmer pot.until the **FORWARD** light-emitting diode goes out.

15. Adjusting ***the upper start-off speed:***
Set **BP-MIN/BP-MAX** switch to **BP-MAX position**, thereby making contact between pins **34 and 36** (on the TC90 testunit, set the switch to the BP-MAX position).

16. Run the engine at its ***upper start-off speed***, 1500 rpm as an example, and adjust the **BP-MAX** trimmer pot. until the **FORWARD** light-emitting diode goes out.

17. Adjust the **overspeed indicator** by running the engine at the upper speed limit, 2600 rpm as an example and turning the **OVERSPEED** potentiometer until the light-emitting diode marked **OVERSPEED** lights up.
(Adjusting range corresponds to: 2000 - 3000 rpm).

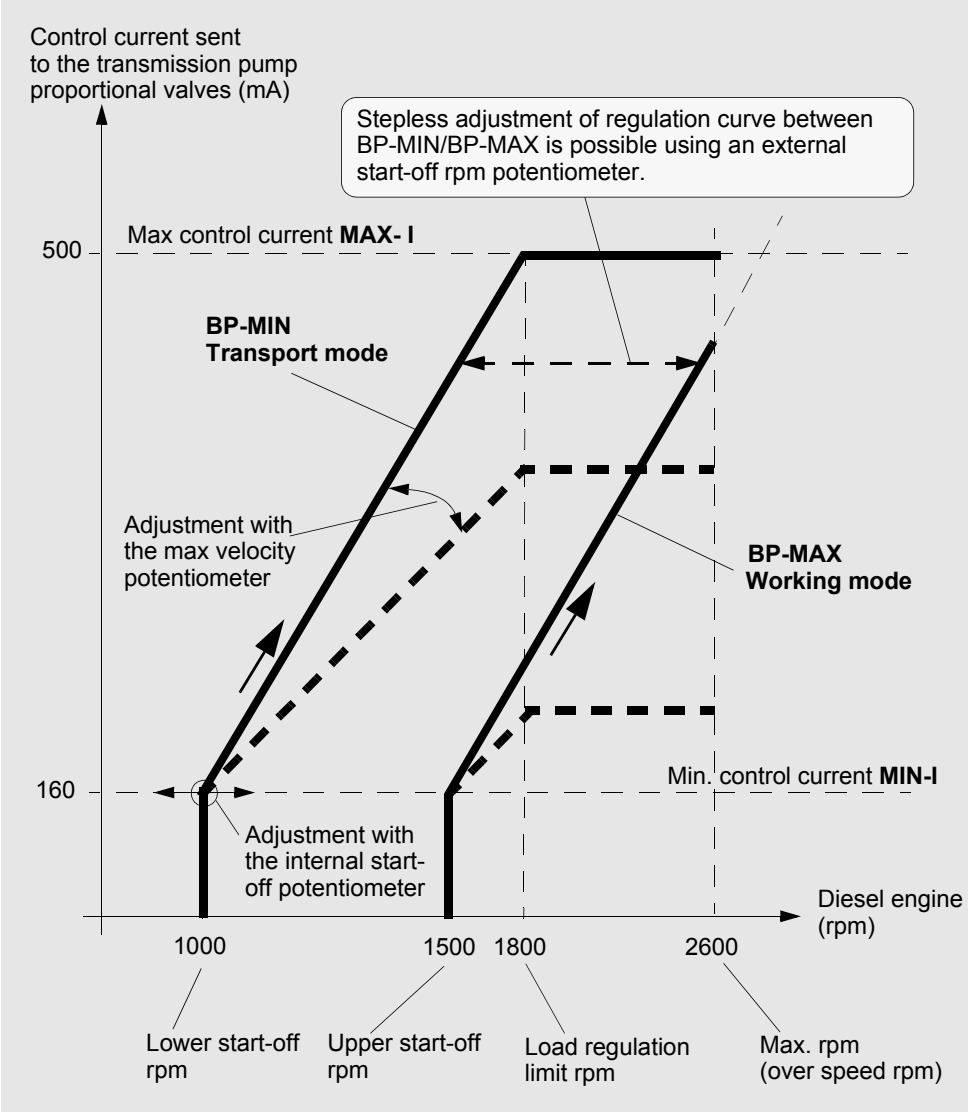
18. **Connect the forward proportional solenoid.**

19. Optimizing the setting of the **TIME CONSTANT LOAD CONTROL** trimmer pot. is only possible while the machine is moving. This is because the time constant must be adapted to the engine time-lag. The time constant must be as short as possible (as close to the minimum position as possible). If the engine/motor speed fluctuate (hunts) up and down, the time constant must be increased: Turn up the **TIME CONSTANT LOAD CONTROL** trimmer potentiometer somewhat and try again. Repeat until the result is satisfactory.

20. The **BP RISE TIME** trimmer pot. is normally set to about 50%. The potentiometer controls the switching time between BP-MIN and BP-MAX regulating curves.

21. After the adjustments are completed, all trimmer potentiometers must be secured with a sealant of the Loctite type.

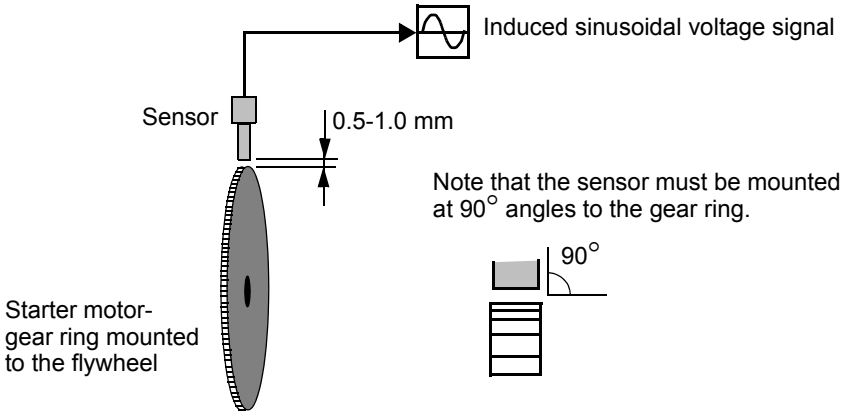
TC90 control curves



The rpm values indicated above are only examples.
They represent typical data for a vehicle driven by
a diesel engine.

Adjusting the speedometer

Speed can be measured by connecting an inductive sensor to the TC90, input pin 17-18. The sensor must be mounted in the engine flywheel housing as close as possible to the starter motor gear ring as illustrated below:



You can use the following formula to calculate the frequency sent out by the sensor:

$$\frac{\text{Number of teeth x RPM}}{60} = \text{Frequency}$$

To adjust the TC90 output for a speedometer using a frequency generator without starting the engine, you can proceed as follows:

1. Ascertain how many teeth there are on the engine's starter motor gear ring (165 for example).

2. Use 1000 rpm as reference rpm (so that 1000 rpm will be equivalent to 1.0 Volt).

3. Insert the appropriate values in the above formula as follows:

$$\frac{165 \times 1000}{60} = 2750\text{Hz}$$

4. Set the frequency generator to 2750 Hz, sine-wave, amplitude about 10 Volt peak-to-peak. Connect the signal to inputs 17 and 18 on the TC90.

5. Connect a voltmeter to output 33 on the TC90.

6. Adjust the V/F trimmer pot. to provide an output of 1.0 Volt at output 33.

7. Set the frequency generator to 5500 Hz and check that the output voltage is now 2.0 Volt.

2

Installation

Responsibility for installation

Hydratronics is responsible for the functionality of the TC90 system components.

The customer is responsible for using the TC90 system properly for the application in question. The customer is also responsible for a) the functionality of the cables/wiring and connectors in the system, b) the functionality of external signal switching devices and c) seeing to it that signals used by the system which arrive from customer-acquired and customer-mounted sensors do not cause faulty machine functions.

Location

The TC90 control unit must be located where the following requirements are fulfilled:

- Protected from rain, dirt and other contaminants.
- Mounted in such a way that it is not exposed to vibration. Rubber anti-vibration mountings are to be used if necessary.
- Mounted where air can flow freely around the casing without obstruction.
- Locations where there is exposure to indirect heating from a cab heater or the like are to be avoided.

Electrical installation

Emergency stop pushbutton

Every system must, without exception, be installed together with an emergency stop pushbutton that can be used to interrupt the power being supplied to the TC90 control unit. The emergency stop pushbutton must be easily accessible to the driver.

Cables/wiring

Power to the TC90 system must be turned off while working with the cables/wiring and units connected to the TC90.

All cables/wiring must be able to withstand weather, oil, salt and wear.
The cables/wiring must be provided with strain-relief clamps that are spaced at regular intervals along the lines. The cables that are used to supply power (+Batt and –Batt) to the TC90 must be connected directly to the battery terminals via only the emergency stop pushbutton and fuses and/or miniature circuit breakers. There must be no other loads connected to the power-supply cables.

NOTE! There must be no other loads connected to the lines that supply power to the TC90.

The following table presents functions that impose special requirements regarding types of cables/wiring:

Function	Cable area	Cable type
Power supply	1.0 mm^2	RKUB or the like
Solenoid valves	0.5 - 0.75 mm^2	RKUB or the like
Input signals	0.5 - 0.75 mm^2	RKUB or the like

Connectors

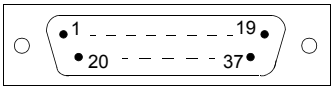
The TC90 system contains the following types of connectors:

Location	Connector	Contact casing	Contact socket	Hand tool
TC90 37 pole D-sub	Art. 164534-4 AMP	Art. 749916-2 AMP	Art. 166291-1 AMP	Art. 58448-2 AMP

Signals to connector pins, see next page.

NOTE! The battery terminals must always be disconnected before starting to weld or to quick-charge the batteries.

TC90 connector, 37 pole D-sub



Pin No.	Signal name
1	Supply voltage, 20-30 Volt
2	Extra capacitor for power supply line
3	Ground (for circuit board)
6	Current output for solenoid, forward
4	Current output
7	Current input
8	Current output for solenoid, reverse
10	Brake relay
9	Brake relay
11	Brake relay
12	Acc/Ret time x 2.
31	Acc/Ret time x 2.
15	Overspeed relay
14	Overspeed relay
16	Overspeed relay
17	Speed sensor
18	Speed sensor
19	Interlock for electric throttle control EC90
21	Load control switch
23	Load control switch
29	Load control switch
32	Load control switch
13	INCH potentiometer
30	Max. velocity/INCH potentiometer
26	Max. velocity potentiometer
24	Max. velocity potentiometer
27	Direction switch
20	Direction switch
28	Direction switch
33	Speedometer
34	BP-MIN/BP-MAX switch/Potentiometer
35	BP-MIN/BP-MAX switch/Potentiometer
36	BP-MIN/BP-MAX switch/Potentiometer

Starting up

NOTE! When starting a mobile system, always make certain that there is an unobstructed area around the machine.

Checking functionality

The system is not adjusted before delivery from Hydratronics, and it should undergo basic adjustment before being started up. The easiest way to do this is to use an TC90 testunit.

1. Turn on power to the system **without** starting the engine.
2. Check to see that there is no output current from the proportional solenoids when the direction switch is at its neutral position.
3. Disable the automatic load control function (speed-related control).
4. Test to see that current flows at the forward and reverse proportional solenoids when the direction switch is actuated in either direction while the throttle potentiometer is at the maximum position.
5. Follow the adjustment instructions set forth in Chapter 1 of this manual.

EMI (Electromagnetic interference)

NOTE! Faulty installation in combination with strong interference fields can cause hydraulic functions to perform erratic movements.

As industrial development proceeds, electrical/electronic devices are proliferating throughout our environment. These devices generate electromagnetic energy that can affect and disturb other systems.
Examples of such devices include communication equipment, voltage converters, relays etc.

How to check for electromagnetic interference

The design/construction of the TC90 system complies with applicable EMI standards. Nonetheless, equipment can be encountered that generates interference which violates applicable standards and can thus affect the functionality of the TC90 system. Each system must thus be checked as follows:

1. Start the machine.
2. Activate the direction switch in one direction or the other so that the hydraulic function in question moves slowly. This is the most sensitive zone of movement.
3. Now start transmitting via the different items of communication equipment that may be causing interference. Watch to see whether or not the hydraulic function is affected.
4. Activate functions that draw high current (searchlight for example).
5. Repeat the above for all hydraulic functions.

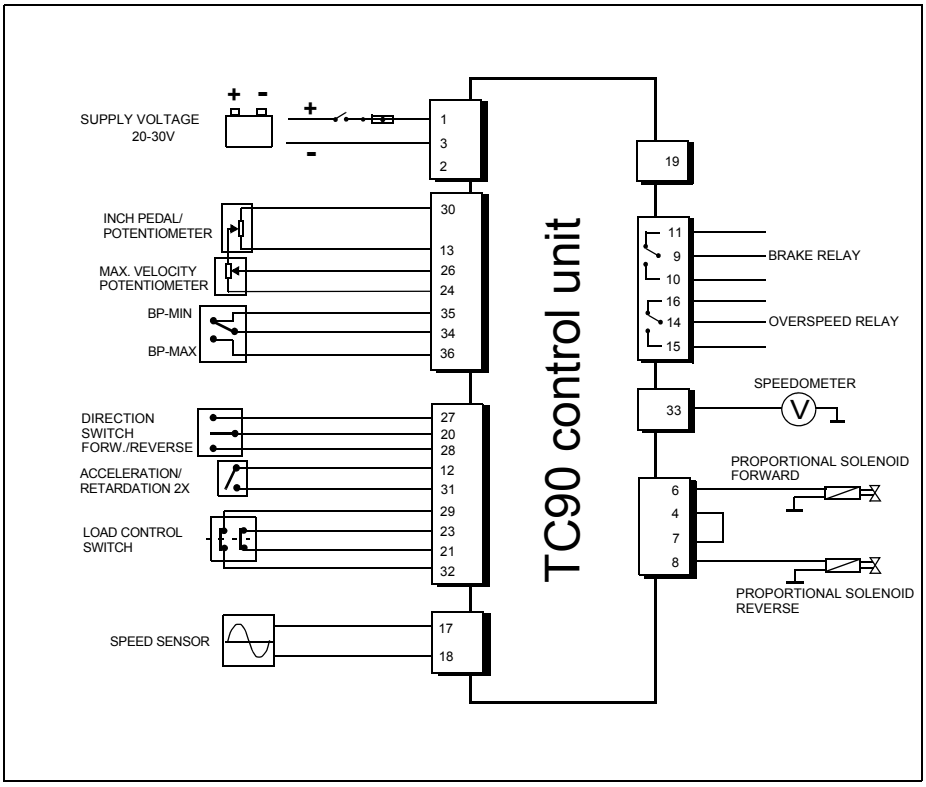
How to remedy magnetic interference

Electromagnetic interference (EMI) can be eliminated, or at least reduced, by taking remedial measures:

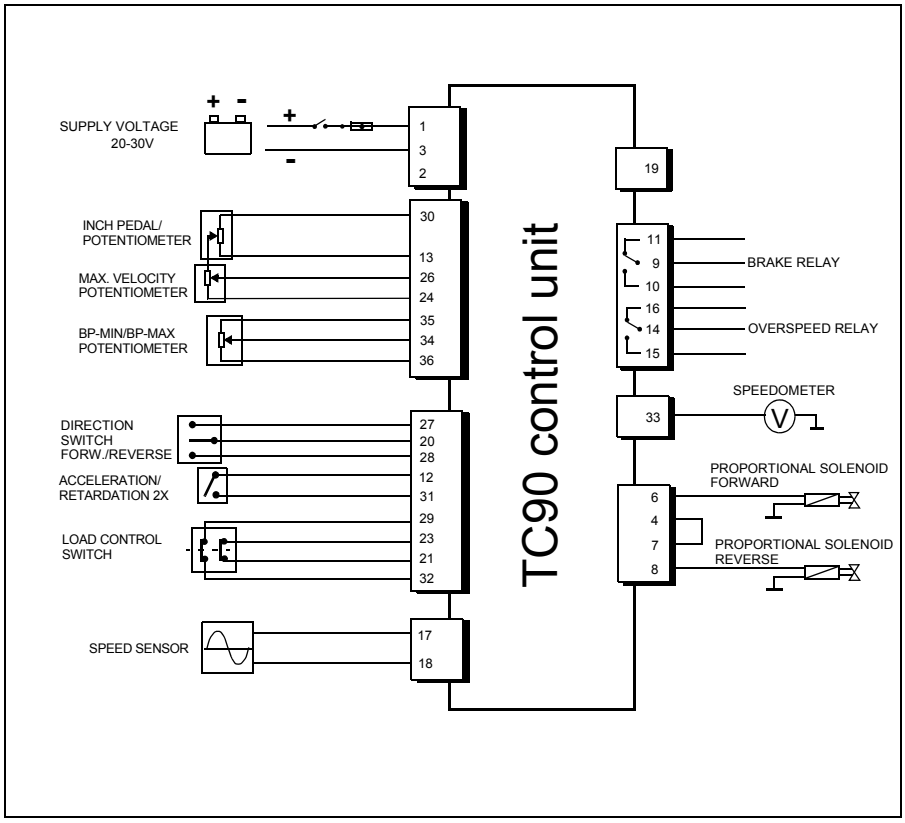
- The best remedy is distance. Position the interfering equipment and its cables/ wiring far away from the TC90 control unit and other components for the system.
- Never run cables/wiring that can cause interference in parallel with cables or wires running to the TC90 control unit.
- Always run cables/wiring close to the chassis or other well-grounded parts.
- Make certain that the communication equipment and antennas are properly grounded via a low-ohmage path.
- Make certain the lines supplying power to the TC90 system are short and connected directly to the battery (via the emergency stop pushbutton and self-holding relay). There most be no other loads connected to these lines.
- Provide shielding for lines that are sensitive or can cause interference (frequency sensor lines for example).

Application examples

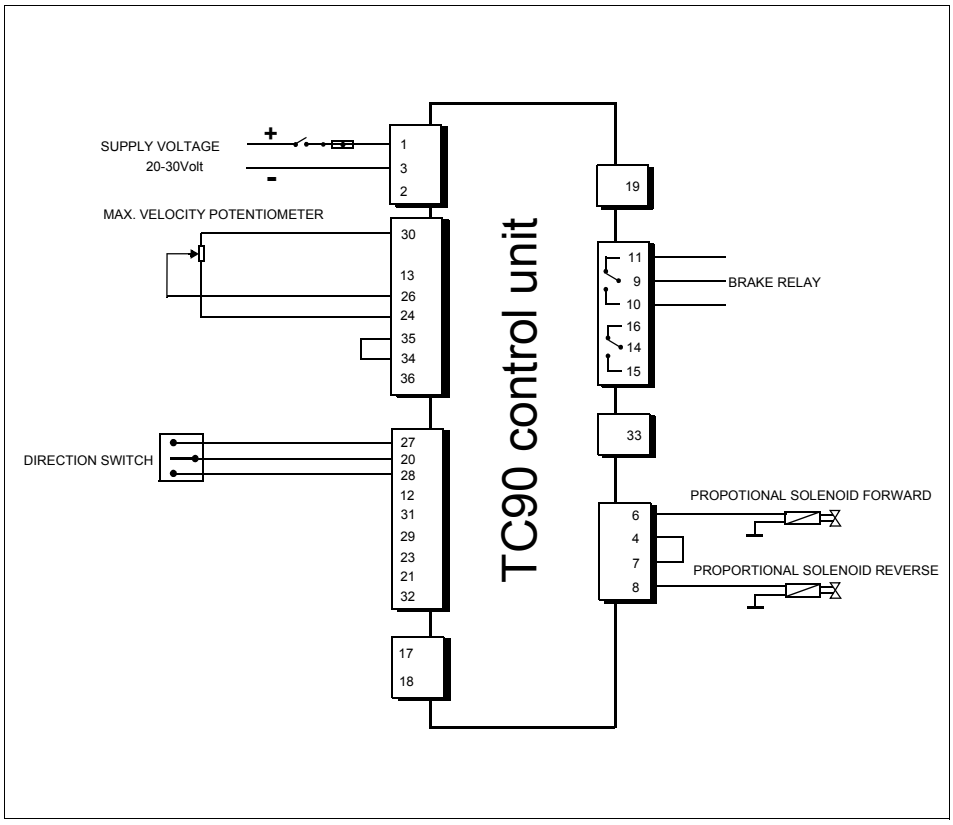
1. Basic connection with single transmission including on/off-switch for two different control curves, BP-min/BP-max, INCH-pedal and Max. velocity potentiometer



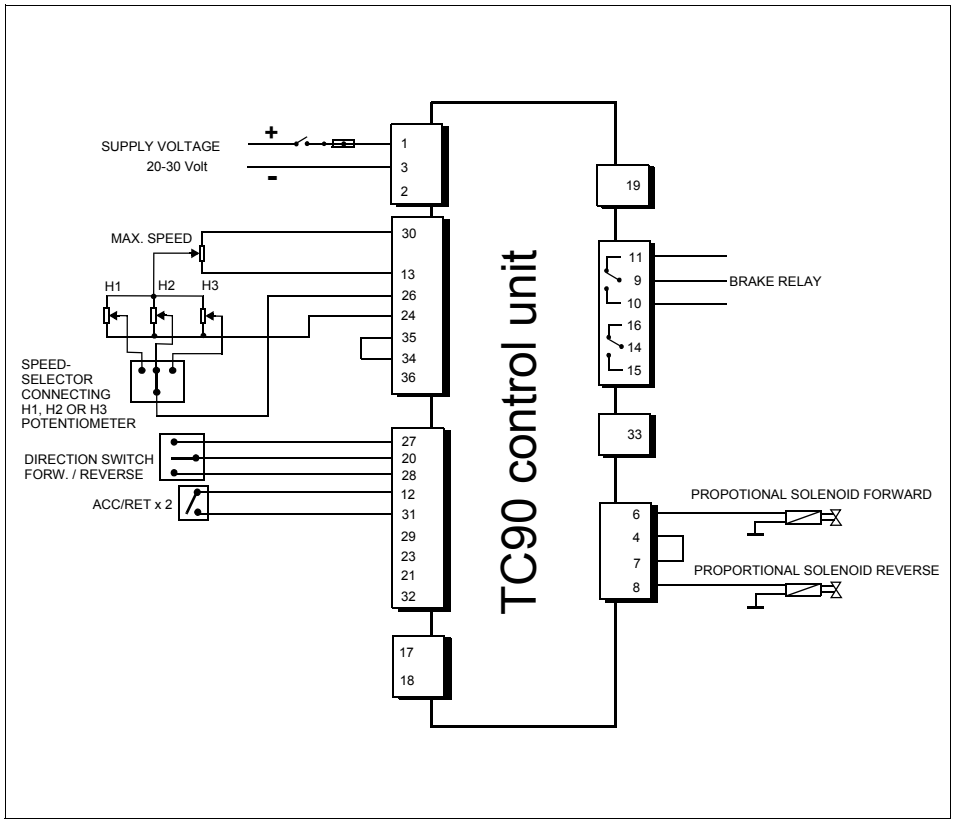
2. Application example with single transmission including potentiometer for adjustable control curve between BP-min/BP-max, Inch pedal and Max. velocity potentiometer



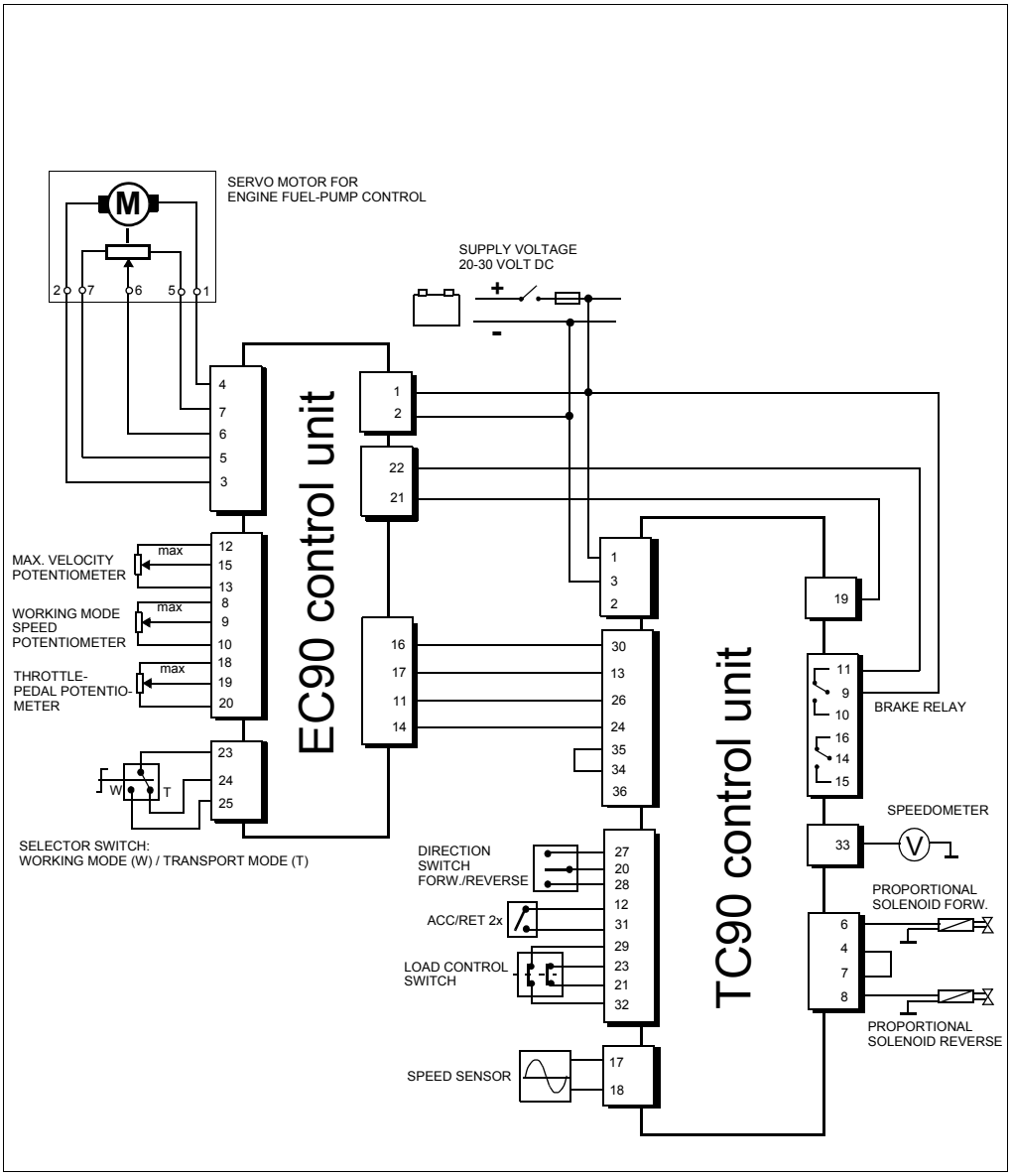
3. Application example: TC90 used as an amplifier module with Max. velocity potentiometer only



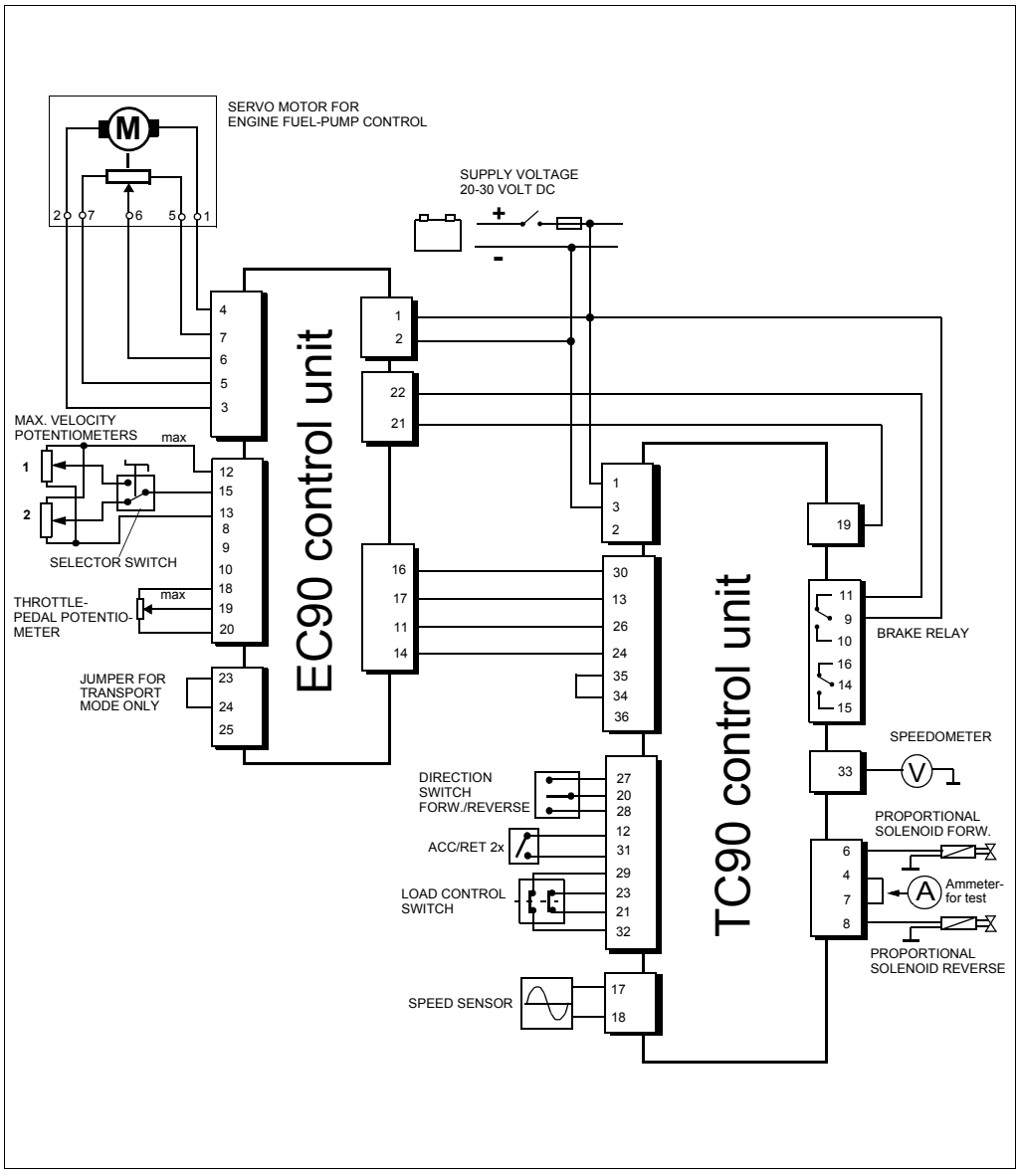
4. Application example with electric motor as prime mover. Transmission having three settable speeds (H1, H2 or H3) and a general maximum speed limit



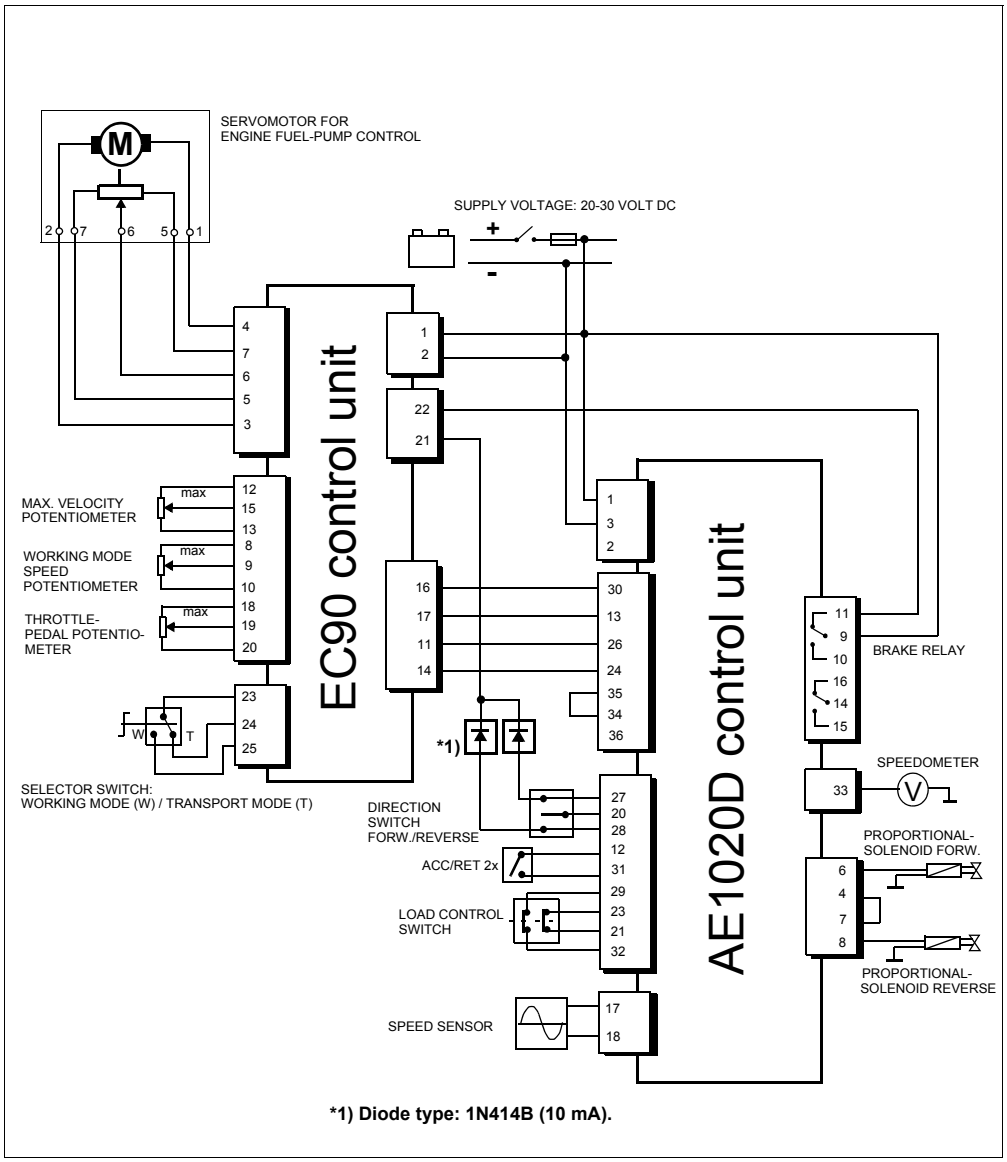
5. Application example: TC90 combined with electric throttle control EC90 (See also Chapter 4)



6. Application example: TC90 combined with electric throttle control EC90. Transport mode only and two separate max. velocity potentiometers



7. AE1020D combined with electric throttle control EC90. (AE1020D not for new projects)



***1) Diode type: 1N414B (10 mA).**

Technical data TC90 control unit

General Data

Weight	0.8 kg
Operating temperature	-25°C to + 60°C
Casing protection class	IP52

Electrical data

Supply voltage:	20 -30 Volt DC
Max supply voltage ripple:	3Vp-p, 50hz - 10kHz
Max current drain:	2A
Speed sensor input frequency range:	2 kHz - 7 kHz

Output current to proportional solenoid for 20-30 ohms and +25°C:

Minimum current adjustable between 75 mA and 225 mA
Maximum current adjustable between 350 mA and 700 mA
Ripple current adjustable between 0 and 200 mA, p-p
Ripple frequency, 40-50 Hz

Temperature drift of output current circuit: 0.1% per °C

Acceleration and retardation of output current adjustable from 0.35 to 3.5 sec.
Can be changed to 0.9 to 9 sec if so desired.

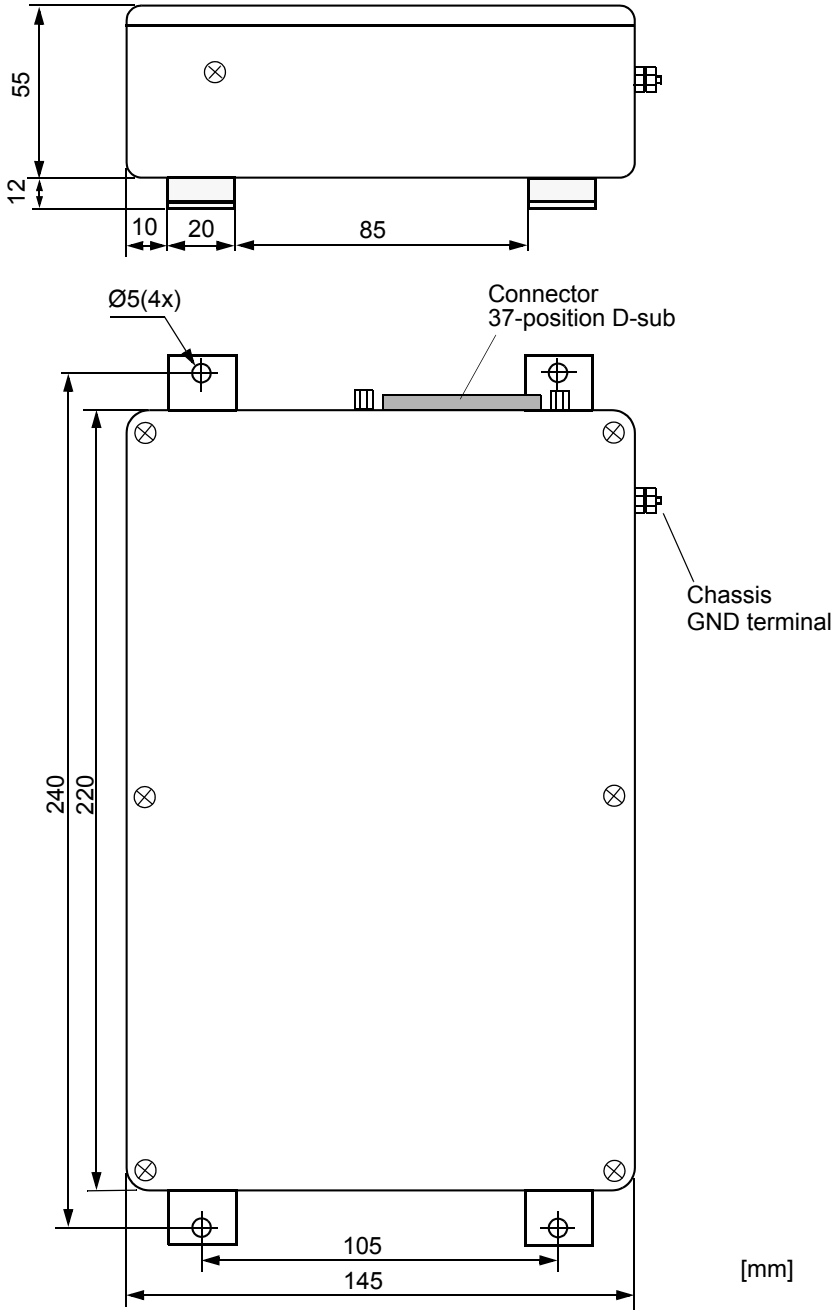
Zero-current (dead) zone: 2% ± 0.5% of max input signal from the Max. velocity potentiometer provides the preset minimum current. A lower input signal provides zero output current after the preset retardation time.

Parking brake relay is activated about 0.5 seconds after the output current becomes zero.
Brake output is active when in the de-energized state. Light-emitting diode in the TC90 lights up to indicate brake released.

Built-in start block disables Max. velocity potentiometer input for about 2 seconds when power is turned on.
Input signal more negative than –2.5 V from the Max. velocity potentiometer reduces the output current to zero.

Resistance of Max. velocity potentiometer: 1-5 kilohms (linear), 0.25 W. Zero-point displacement of the Max. velocity potentiometer is adjustable from 0 to about 27% of the Max. velocity potentiometer supply voltage.

TC90 control unit - Dimensions



3

EC90 control unit

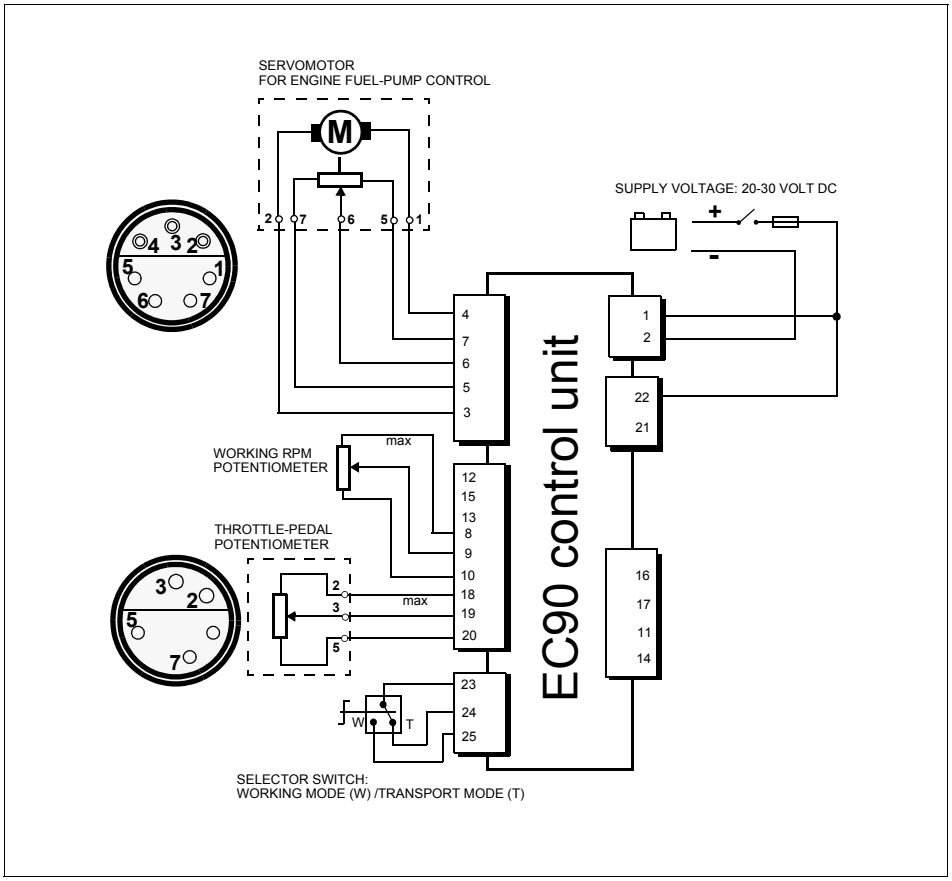
General description

The EC90 is an electrical control amplifier designed to control a servomotor which, in turn, activates the diesel engine fuel-pump control arm. The EC90, in combination with a servomotor and a throttle-pedal potentiometer, can be used as a separate diesel engine rpm control system or it can be used together with a TC90 control unit for controlling hydrostatic transmissions.

Adjusting the EC90

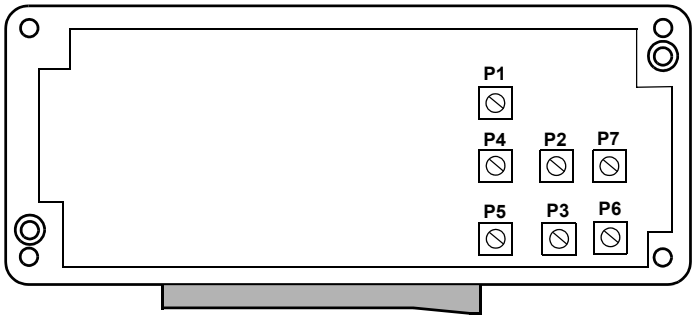
Connection diagram

Refer to the connection diagram shown below while following the adjustment instructions.
The EC90 is usually used in combination with the TC90. If such is the case, follow the adjustment instructions set forth in Chapter 4.
Before making any adjustments, check to see that the voltage supplied to the EC90 lies between 20 and 30 V. The supply voltage ripple must not exceed 3 V, peak-to-peak.



EC90 potentiometers

EC90 control unit with cover removed



Potentiometer function

P1: Max. velocity. Used only in combination with TC90 Control Unit
P2: Min. servomotor setting/Min. rpm for diesel engine in working mode
P3: Max. servomotor setting/Max. rpm for diesel engine in working mode
P4: Min. servomotor setting/Min. rpm for diesel engine in transport mode
P5: Max. servomotor setting/Max. rpm for diesel engine in transport mode
P6: Servomotor dead zone
P7: Amplification (gain)

Notes:

The term "WORKING RPM" means the fixed diesel engine rpm that is set with a separate working rpm potentiometer when the machine attachment (crane for example) is to be used.

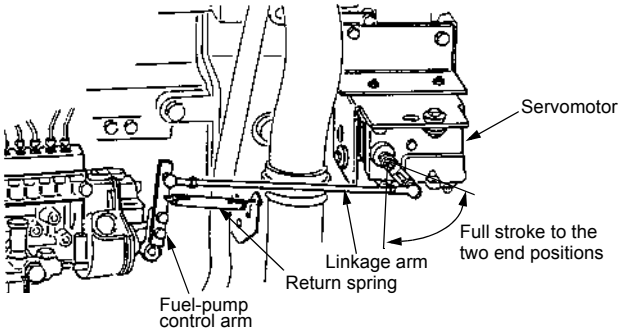
The "TRANSPORT MODE" is invoked when the transmission is engaged and the machine is being moved from place to place. Here, the diesel engine rpm and thus the machine's velocity are controlled directly using the throttle-pedal.

Adjusting the potentiometers

Check to see that the servomotor's angular stroke (see illustration below) matches the stroke of the diesel engine fuel-pump control arm.

1. First check to see that the servomotor makes a full, end-limit to end-limit stroke.

2. Then adjust the linkage arm so that the fuel-pump control arm makes a full stroke without striking any mechanical end limit when the servomotor makes a full stroke. There must be a certain amount of mechanical play at the fuel-pump control arm to prevent the servomotor from remaining activated at either of the two end positions.



Adjust the potentiometers in the following sequence:

1. **P6**: Regulates the servomotor dead zone. Set to minimum position by turning it counter clockwise as far as it will go.

2. **P7**: Amplification. Set to about 50%.

3. **P4**: Servomotor minimum setting for transport. Set the working/transport selector switch to the **transport** position. Completely release the throttle-pedal and use potentiometer **P4** to adjust to the desired ***lowest diesel engine rpm in the transport mode*** (normally 800-850 rpm).

4. **P5**: Servomotor maximum setting for transport. Set the working/transport selector switch to the **transport** position. Press the throttle-pedal all the way down and use potentiometer **P5** to adjust to the desired ***highest diesel engine rpm in transport mode*** (normally 2000-2500 rpm).

5. **P2**: Servomotor minimum position at working rpm. Set the working/transport selector switch to the **working rpm** position. Set the separate WORKING RPM POTENTIOME-

TER to its minimum position and use potentiometer **P2** to adjust to the desired ***lowest diesel engine rpm in working mod***e (normally 1000-1200 rpm).

6. **P3**: Servomotor maximum position at working rpm. Set the working/transport selector switch to the **working rpm** position. Set the separate WORKING RPM POTENTIOMETER to its maximum position and use potentiometer **P3** to adjust to the desired ***highest diesel engine rpm in working mode*** (normally 1800-2000 rpm).

7. P1: Potentiometer P1 functions only in combination with the TC90 control unit. (Before adjusting P1, you must set the max. velocity potentiometer to its maximum position, as explained in Chapter 4).

EC90 Technical data

General data

Weight	0.65 kg
Operating temperature	-25°C till + 60°C
Casing	Cast aluminium
Casing protection class	IP52 when the unit is mounted with the connector at bottom
Dimensions	175 x 80 x 57 mm

Electrical data

Supply voltage	24V DC (20 -30 V)
Max supply voltage ripple	3 V p-p, 50hz - 10kHz
Max current drain	3A

Inputs

Throttle-pedal input compatible with pedal/potentiometer, part No.: 810 41600

Working rpm and max velocity potentiometers: 1 Kohm, part No.: 810 41540

Output

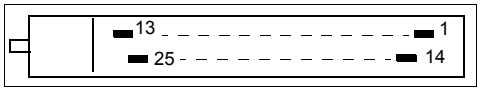
Compatible with servomotor, part No.: 408 403 002 001

Connector

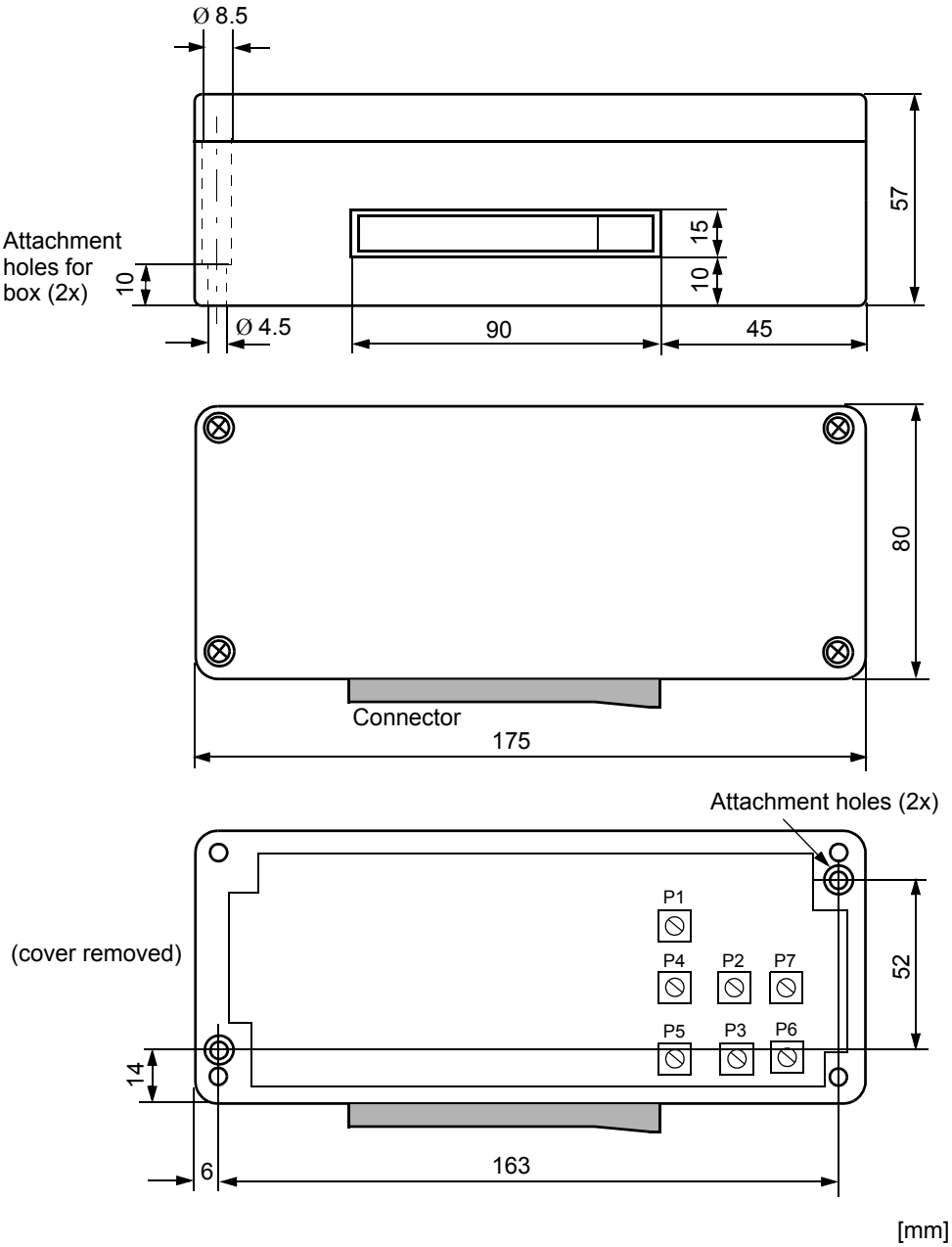
25-pole AMP timer connector, part No.:	827 534-1
AMP timer pin, part No.:	925 596-2
Hand tool, AMP part No.:	825 590-3

25-pole AMP timer connector

Pin No.	Signal name
1	20 - 30V DC supply voltage
2	Ground (for circuit board)
3	Servomotor
4	Servomotor
5	Servomotor
6	Servomotor
7	Servomotor
8	Working rpm potentiometer
9	Working rpm potentiometer
10	Working rpm potentiometer
12	Max. velocity potentiometer comb. with TC90
13	Max. velocity potentiometer comb. with TC90
15	Max. velocity potentiometer comb. with TC90
18	Throttle pedal /potentiometer
19	Throttle pedal /potentiometer
20	Throttle pedal /potentiometer
23	Working/transport mode selector switch
24	Working/transport mode selector switch
25	Working/transport mode selector switch
21	Only in combination with TC90
22	Supply voltage or used via TC90
11	Only in combination with TC90
14	Only in combination with TC90
16	Only in combination with TC90
17	Only in combination with TC90



EC90 control unit - Dimensions



4

TC90 with EC90

General description

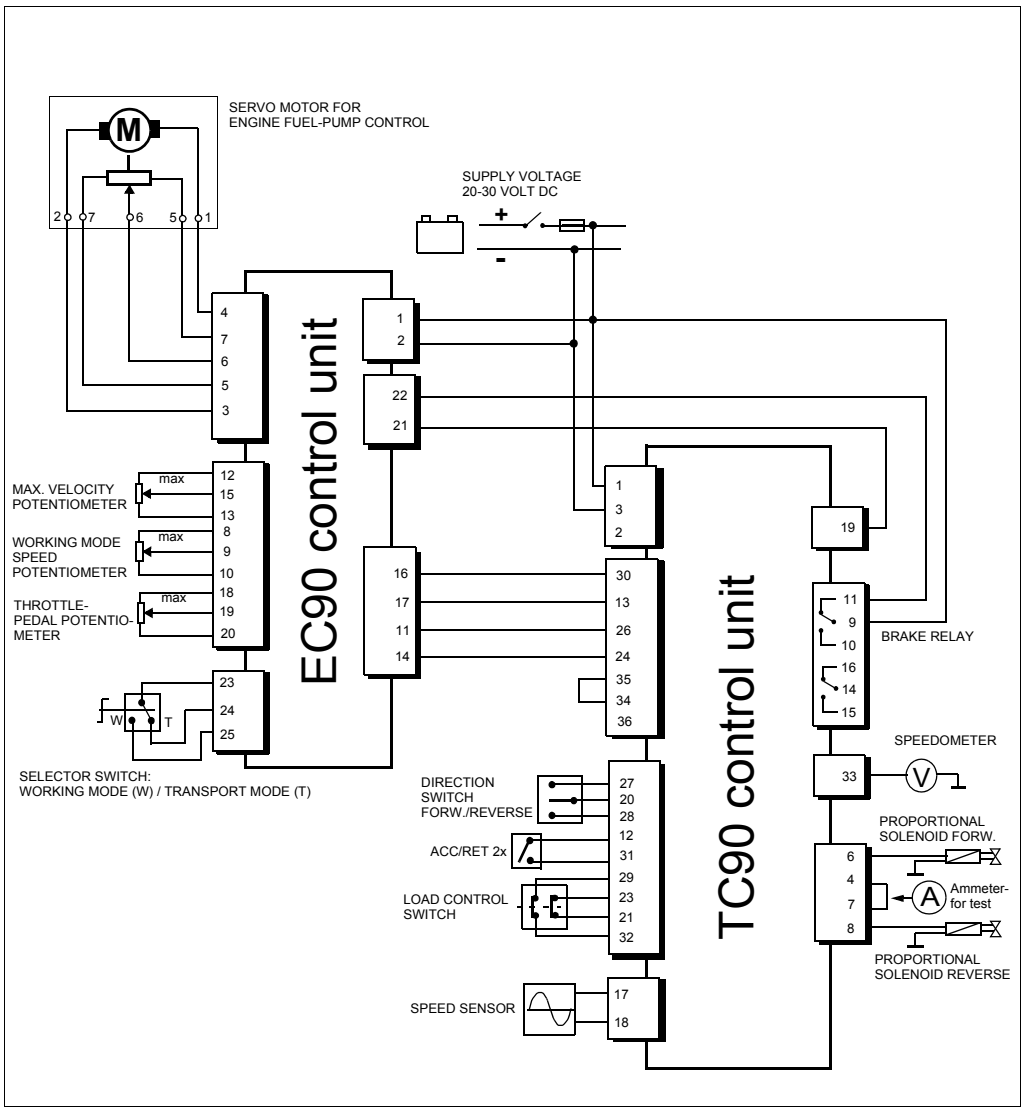
The TC90 control unit, when used in combination with the EC90 control unit, becomes an integrated system intended primarily for controlling LINDE hydrostatic transmissions, equipped with variable hydraulic pumps and hydraulic motors, that are used in different types of mobile equipment.
The most frequently encountered application comprises transmission control of forestry machines and other types of wheeled vehicles powered by diesel engines. When the basic connection is used, current flowing to the transmission is controlled automatically in such a way that it is proportional to the diesel engine rpm.

Normally, there is a selector switch which enables you to change from the ***working mode*** to the ***transport mode*** and vice versa. In the transport mode, the machine velocity and the diesel engine rpm are directly proportional to the position of the throttle within a range extending from the stationary/idling rpm position to the position that provides both maximum modulation of the transmission and maximum diesel engine rpm. In the working mode, a preset diesel engine rpm (called the working rpm) is established at a point where the machine attachment (crane for example) can be used efficiently *while allowing the transmission to be simultaneously controlled*. In the working mode, full throttle-pedal position resolution is obtained vis-à-vis machine velocity, but the lowest possible diesel engine rpm is the preset working rpm.

Adjustment

This chapter explains how to trim and adjust the TC90 combined with EC90.

Since the TC90 can be connected in many different ways, the trimming/adjustment description in this chapter will be limited to the basic connection shown on the connection diagram below:



Adjustment of the TC90-EC90 system

1. Start by carrying out basic adjustment of the EC90 that controls the servomotor for the engine fuel-pump

Turn to Chapter 3 which explains how to adjust potentiometers **P2-P7** in the **EC90** control unit in order to obtain the basic setting for the servomotor range, i.e. the setting that will be used to establish the min/max values for diesel engine rpm in the ***transport mode*** and also in the ***working mode***. (Potentiometer P1 in the EC90 will be adjusted later on). Then proceed to make the adjustments as follows:

2. Adjustment of the current generator in TC90

Trimming starts with basic adjustment of the current generator. Minimum and Maximum currents; MIN-I and MAX-I potentiometers

1. Turn off the load control function by opening the **LOAD CONTOL SWITCH**. (Pins 21/23 and 29/32, open contacts). When the automatic load control function has been disabled, automatic regulation of current flowing to the proportional valves via the diesel engine rpm sensor is also disabled.

2. Connect an ammeter (built into the TC90 testunit) in series with connector pins 4 -7 on the TC90, see figure page 4-2 and use the 1 A range.

3. Set the **WORKING/TRANSPORT** selector switch to the **TRANSPORT** position and the **DIRECTION SWITCH** to the **FORWARD** position.

4. Turn the **MAX. VELOCITY POTENTIOMETER** to the position at which the light-emitting diode marked **FORWARD** lights up.

5. Turn up the **RIPPLE AMPL** trimmer pot. to about 60%.

6. Turn down the **ACC** and **RET** trimmer pots. to their minimum positions.

7. Using the **MIN I** trimmer pot., adjust until the desired ***minimum current*** is obtained. Approx.: **160 mA** for LINDE transmission.

8. Turn up the **MAX. VELOCITY POTENTIOMETER** to its maximum position.

9. Using the **MAX I** trimmer pot. adjust until the desired ***maximum current*** is obtained. Approx.: **500 mA** for LINDE transmission incl. variable displacement hydraulic motor. Approx.: **360 mA** for LINDE transmission incl. fixed displacement hydraulic motor.

10. Set the **DIRECTION SWITCH** to neutral.

11. Set the **WORKING/TRANSPORT** selector switch to the **WORK** position and the **DIRECTION SWITCH** to the **FORWARD** position.

12. Turn up the **MAX. VELOCITY POTENTIOMETER** to its maximum position.

13. Press the **THROTTLE-PEDAL** all the way down and adjust the trimmer pot. marked **P1** in **EC90 (see chapter 3)** until the ***same maximum current*** is obtained as adjusted in paragraph 9 above.

NOTE! The adjustments in steps 1-13 above provide initial values that may need fine adjustment while the machine is running to compensate for minor differences in the proportional solenoids. When steps 1-13 are completed, ACC and RET can be set

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14. Turn up the **MAX. VELOCITY POTENTIOMETER** to its maximum position and make certain that the **ACC/RET x 2** switch is open.

15. Set the **DIRECTION SWITCH** to its neutral position.

16. Wait until the output current reaches zero.

17. Set the **DIRECTION SWITCH** to the forward position and observe the following: Output current rises rapidly to the preset minimum current and then increases more slowly to the preset maximum current. If **ACC** is set to its minimum position this will take place quite rapidly.

18. By shifting the **DIRECTION SWITCH** from its neutral position to its forward position and simultaneously adjusting the **ACC** trimmer pot., you can set the desired acceleration. This corresponds to the time it takes for the output current to rise from the preset minimum value to the preset maximum value. As the rate of rise becomes slower, acceleration decreases.

19. You can set the desired retardation by shifting the **DIRECTION SWITCH** from its forward position to its neutral position and adjusting the **RET** trimmer pot. correspondingly.

20. Close the **ACC/RET x 2** switch.

21. Shift the **DIRECTION SWITCH** back and forth between the neutral position and forward position a number of times while checking to see that the acceleration and retardation times have both increased to approximately twice their previous values.

22. Disconnect the ammeter that was connected in step 2 and reconnect the wire between pins 4 -7 (does not apply if the TC90 testunit was used).

Now proceed to adjust the load control function.

3. Adjusting the load control function

The current generator must have been trimmed (adjusted) before you start to adjust load control. Adjusting the speedometer is explained on page 9 in chapter 1.

1. Start the engine.

2. Using a voltmeter, measure the voltage across the speedometer between pins 33+ and 3–. It must be 1000 mV (1.0 Volt) when the engine runs at 1000 rpm. If it is not, you must adjust it. Run the engine at a known speed (measured using an external tachometer).
   Adjust the **V/F trimmer potentiometer** until the output voltage corresponds to 1000 mV at 1000 rpm. This will mean that:
   500 mV = 500 RPM
   1000 mV = 1000 RPM
   1500 mV = 1500 RPM
   2000 mV = 2000 RPM
   When the engine is shut down, a residual voltage may remain at the output, but since it is less than 50 mV it has no effect on functionality.

3. Set the **TIME CONST. LOAD CONTR**. trimmer potentiometer to its minimum position.

4. Close the **LOAD CONTROL SWITCH**. (Pins 21/23 and 29/32, closed contacts).

5. Turn up the **MAX. VELOCITY POTENTIOMETER** to its maximum position.

6. Set the **WORKING/TRANSPORT** selector switch to the **TRANSPORT** position.

7. Run the engine at the speed that corresponds to the ***speed limit-load control***.
   This is the speed beneath which the load control will reduce the output current, 1800 rpm as an example. (Normally in the range 1900-2300 rpm).

8. Using the **BP MIN** trimmer potentiometer adjust until the light-emitting diode marked **LOAD CONTR** lights up. (If the speed is increased somewhat, this light-emitting diode shall go out).

9. Disconnect the forward proportional solenoid so that the machine does not have to be running when the following steps are performed:

10. Set the **DIRECTION SWITCH** to the forward position.

11. Turn up the **MAX. VELOCITY POTENTIOMETER** to its maximum position.

12. Run the engine at the speed which corresponds to the ***start-off speed***, 1000 rpm as an example.

13. Adjust the **START-OFF SPEED** trimmer pot.until the **FORWARD** light-emitting diode goes out.

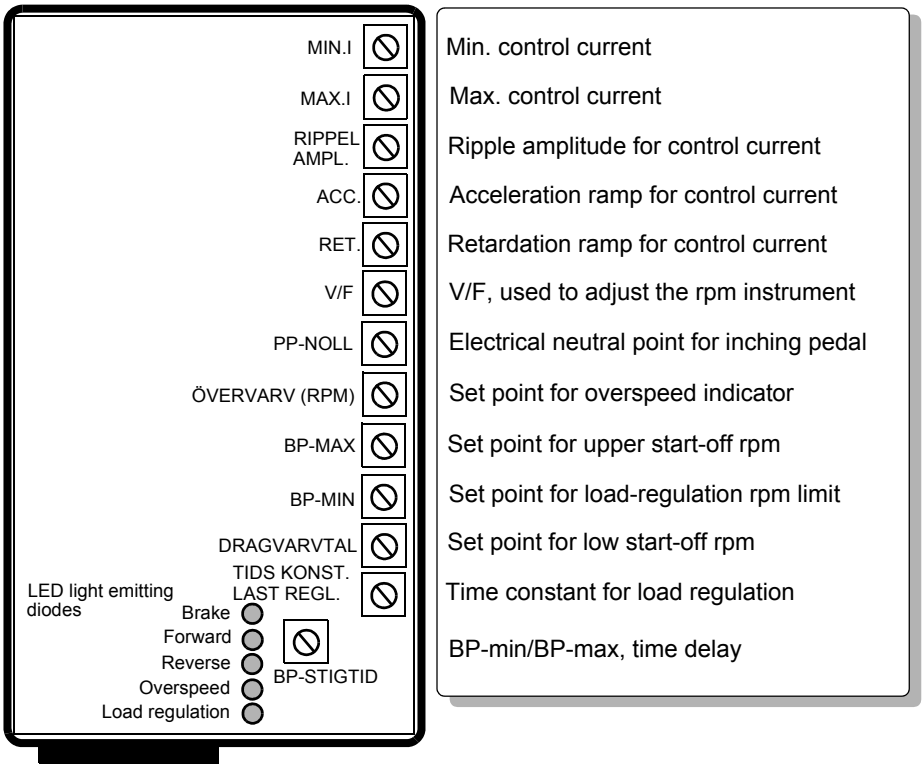
14. Adjust the **overspeed indicator** by running the engine at the upper speed limit, 2600 rpm as an example and turning the **OVERSPEED** potentiometer until the light-emitting diode marked **OVERSPEED** lights up. (Adjusting range corresponds to: 2000 - 3000 rpm).

15. Connect the forward proportional solenoid.

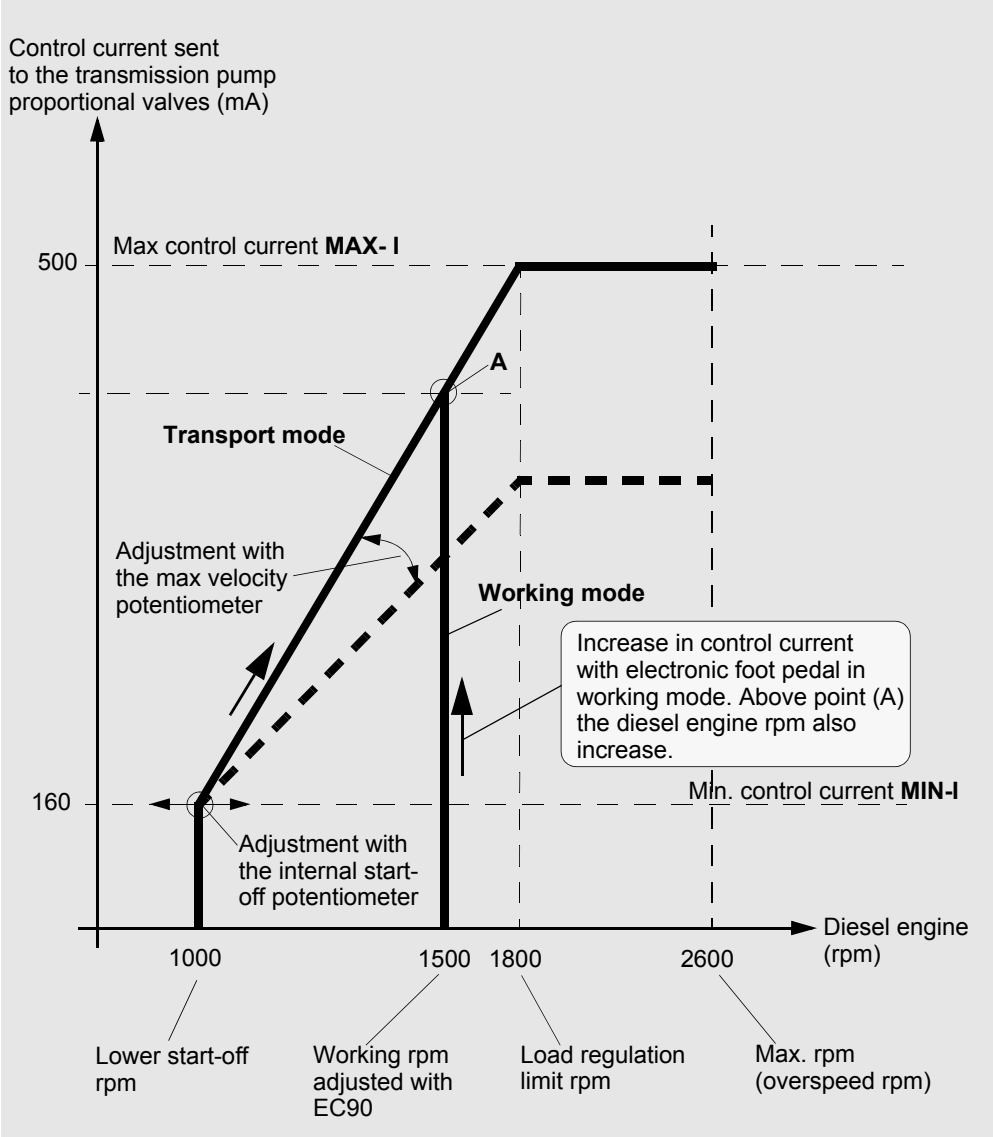
16. Optimizing the setting of the **TIME CONSTANT LOAD CONTROL** trimmer pot. is only possible while the machine is moving. This is because the time constant must be adapted to the engine time-lag. The time constant must be as short as possible (as close to the minimum position as possible). If the engine speed fluctuate (hunts) up and down, the time constant must be increased: Turn up the **TIME CONSTANT LOAD CONTROL** trimmer potentiometer somewhat and try again. Repeat until the result is satisfactory.

17. After the adjustments are completed, all trimmer potentiometers must be secured with a sealant of the Loctite type.

Note: The **BP-RISE TIME**, **BP MAX** and **PP ZERO** trimmer potentiometers do not have to be adjusted when the TC90 is used together with the EC90.



TC90 with EC90; control curves



The rpm values indicated above are only examples. They represent typical data for a vehicle driven by a diesel engine.

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