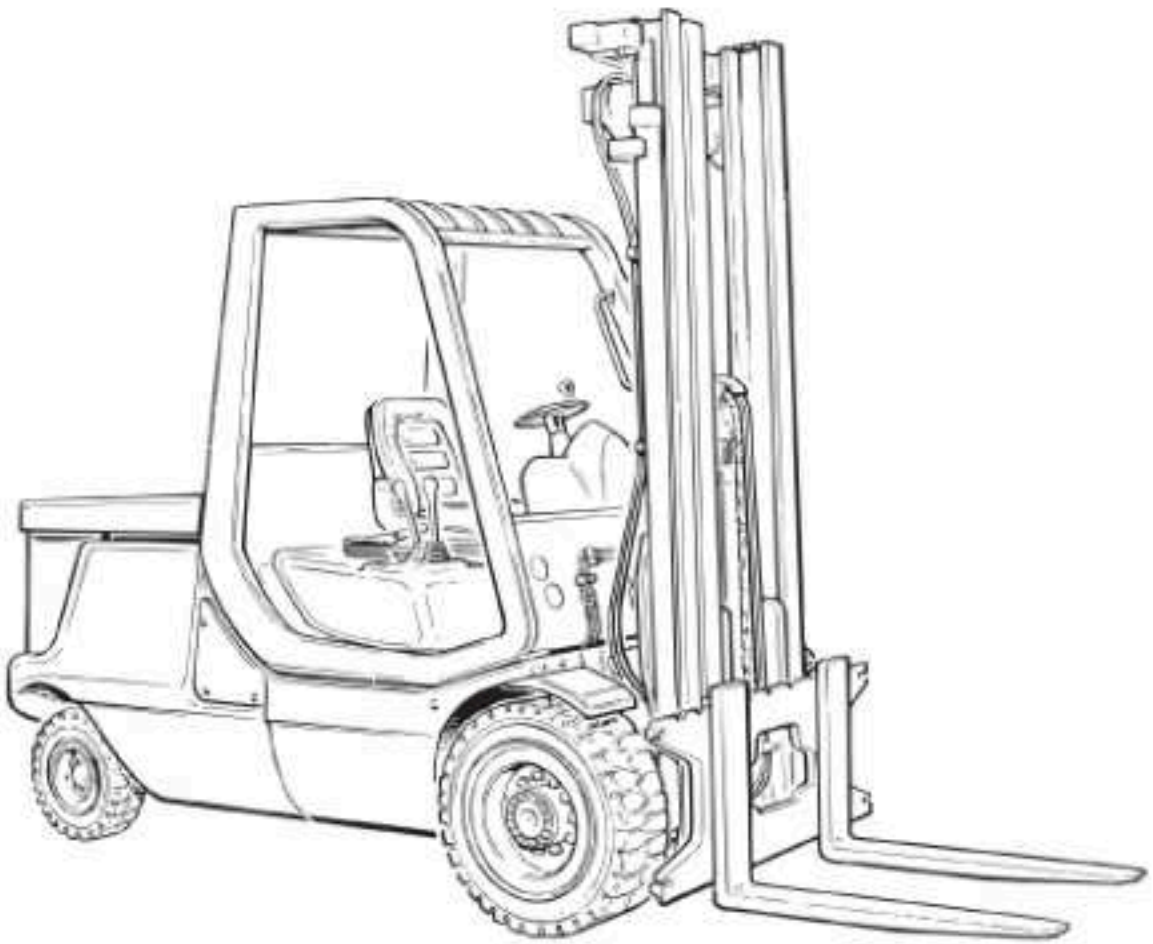
Service Training

Linde Lansing

Lansing Linde Ltd.
Electric Counterbalance Truck
E 35 - E 40 - E 48
Type 337-02 (LDC)



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4.6.1 PRINCIPLE OF THE FIELD EFFECT TRANSISTOR

The transistor modules employed by Linde are of the MOS-FET type.

M Metal
O Oxide
S Semiconductor
F Field
E Effect
T Transistor

Field effect transistors (FET) belong to the category of unipolar transistors. There are various types of FETs. The type we use is an N-channel enhancement-type FET.

The current flow in the field-effect transistor is from the drain to the source

The source terminal is connected to battery negative and the drain to the traction motor. The other terminal side of the motors is connected to positive.

The concept of N-channel denotes that a positive voltage must be applied between the gate and the source to control the transistor. This voltage influences the region between drain and source. In an enhancement-type transistor the drain-source channel has approximately zero conductivity, that is the transistor blocks, when the gate-source voltage is 0 Volts. If the transistor is to become conductive, the gate-source voltage must be increased until the threshold of approximately 4 Volts is exceeded.

Only minimal power is required to control the FETs via the gate-source channel.

4.6.1.1 CONTROL OF FIELD-EFFECT TRANSISTORS

To make a FET conductive, an electric field is required as in the case of a capacitor. The FET principle, has a capacitance between the gate and source terminal that must be charged for switching the FET on and discharged for switching it off.

TURNING ON:

To turn the FET on, positive potential is applied to the gate (+ 15 Volt) via the series resistor and the control circuit. . The gate junction capacitance is charged and the transistor becomes conductive. Voltage is now applied to the traction motors. After the gate junction capacitance is charged only a small current flows through the bleed resistor. The transistor remains conductive.

TURNING OFF:

To turn the FET off a negative potential is applied to the gate via the series resistor . Current now flows from the gate terminal into the control module discharging the gate capacitance. The gate voltage is quickly reduced to zero. This turns the transistor off, cutting off the voltage to the traction motor.

The transistor module is controlled via gate 3 and auxiliary source terminal 1. The drain voltage is monitored by the controller via auxiliary terminal 6

The 15 volt stabilised supply of the control electronics is referenced to negative through the auxiliary source terminal 1.

Both traction and lift compact modules contain a protection diode, freewheel diode two braking diodes a regen braking diode, a Zener diode, voltage snubber diode plus bleed and series resistors. The traction compact module also includes a temperature sensor.

The protection diode is an intrinsic part of the MOSFET structure, it protects the mosfet against negative voltage spikes.

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4.6.14.4 HYDRAULIC THERMAL SWITCH 2B11

There are two thermostats mounted inside the hydraulic motor on the brush box units.

When the hydraulic thermostat (2B5 location 35 on the main circuit diagram) closes at 80°C, the cooling fan mounted on top of the hydraulic motor will start.

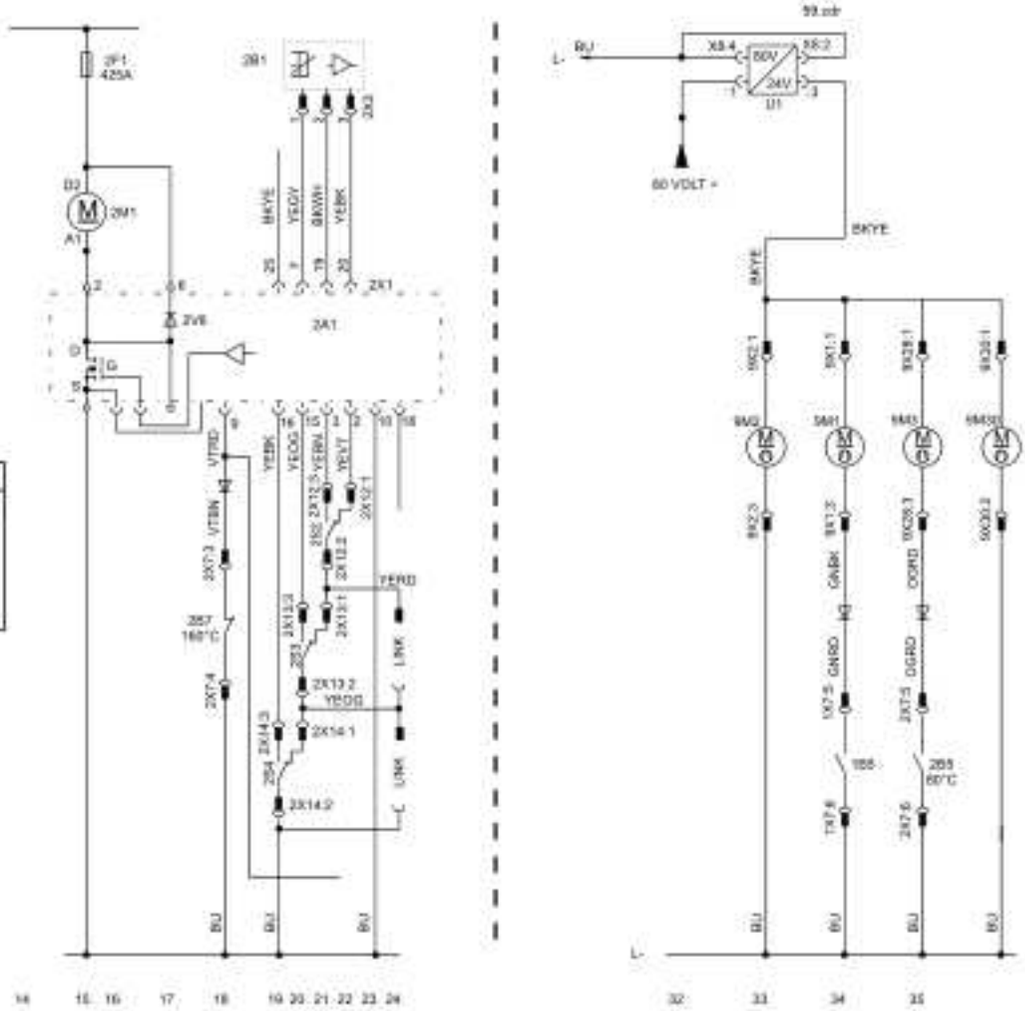
When the hydraulic thermostat (2B7 location 18 on the main circuit diagram) opens at 160°C, hydraulic performance is reduced and the combi instrument indicates a warning.

NOTE: The temperatures quoted above are of brush box temperature, not of motor casing.

Hydraulic 2X7

1 VTGN	6B3	Brush wear sensor
2 GN	6B4	Brush wear sensor
3 VTBN	2B7	Thermal switch 160°C switched negative
4 BU	2B7	Thermal switch 160°C battery negative
5 OGRD	2B5	Thermal switch 80°C switched negative
6 BU	2B5	Thermal switch 80°C battery negative

COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE



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4.6.18.3 INTERMITTENT FAULTS

By its definition an intermittent type of fault is often difficult to locate and rectify as the symptoms are unlikely to be present when circuit tests are carried out. The cause of an intermittent fault is normally not complex, however, since the circuit is working correctly for the majority of the time.

In the first instance question the operator to establish the fault symptoms and refer these to the appropriate sections in the preceding analysis. Ask the following:-

Frequency of faults	-	how often per day, per week, and at what time in the shift?
Nature of fault	-	fail to drive, and in one direction only: fail to brake electrically:
Operation at time of fault	-	Accelerating: braking: multiple operation of controls: sounding the horn: using handbrake interlock?
Environment	-	Smooth or rough surfaces: on a gradient: indoors or outdoors: extreme heat or cold: in the rain: in dusty conditions?
Maintenance	-	When was last service work carried out: what was done?

The following features can be the cause of intermittent faults

- Switches

  Check the actuation and overtravel of:- Handbrake switch, accelerator switch, MS1. Check all connections.

- Connections

  Check the cleanliness and soundness of every bolted connections, crimped and soldered joint and module connectors. Inspect the battery connectors.

- Damaged insulation

  Inspect the condition of all cables, wires and looms, particularly the battery cables and flexible motor cables. Check earth leakage resistance between truck chassis and all terminals.

- Motors

  Inspect the condition of brushes and commutators.

- Contactors

  Check contactor characteristics.

- Additional Equipment

  Ensure that no unauthorised modifications or additions have been made to the wiring, circuit layout or components.

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TRACTION DIAGNOSTIC WINDOW MENU MAP

```
(1+)Linde DC-Control
Vers:   1.0/1.0
Type:   LDC20C03
Truck: BR337 1P
```

```
(2) 3   2
```

```
(3+)   30:1
```

```
(4+)    1S13:000
1S12:0   1S4:1 1S5:1
1S50:1   x06:0 x20:0
 1B7:1   x38:1 x05:1
```

```
(5+)         1K27:0
1K26:0/0     1K28:0
----:0/0     1K11:0
 7K1:0       1K12:0
```

```
(6+)          U:   78V
Te:    22C    X:   0%
Up:-0.13V     I:   0A
U+:14.74V     v:0.0
```

```
(7+)
Vmax:   ->
Vinp:   ->
Opt.:    0
```

```
(11)
C80V:10
CLAN:1
```

```
(31+) 30:1/
```

```
(41)
ena2: 11
1S13: 00 00
1S50: 11
```

```
(51)         1K27:0
1K26:0/0     1K28:0
----:0       1K11:00 00
 7K1:0       1K12:00 00
```

```
(61+)        Ve:  10
vCo:  20     Er:   0
Vp1: 494     X1:   0%
Vp2: 492     X2:   0%
```

```
(71+)
Default   (7):1

   (Default=<CE>)
```

```
(32)


(clear errors=<CE>)
```

```
(62) Xc0     R050
X10     Re0     Wa0
Xs0     Ic23    Up7364
Xa0     Im1     Fq0
```

```
(72+)
Imax:450A  Amax: 60%
IIbc:180A  Vmin:10.0
Ibrk:370A
```

```
(73+)
Default   (7) :1
Default   (72):1
(Default=<CE>)
```

```
(74)
Vlim:  ->
Weak:   0
Boos:   0
```

= STANDARD WINDOWS (DIAGNOSTIC ACCESS)

= PROTECTED WINDOWS (MASTER ACCESS)

= PROTECTED WINDOWS (CAN BE VIEWED WITH DIAGNOSTIC ACCESS)

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