MEDETEC

Metal Detector QSDM 111L

User´s Guide

M111L MENG

www.medetec.se

Use of **DANGER**, **WARNING**, **CAUTION**, and **NOTE**

This publication includes, **DANGER**, **WARNING**, **CAUTION** and **NOTE** information where appropriate to point out safety related or other important information.

DANGER Hazards which could result in severe personal injury or death

WARNING Hazards which could result in personal injury

CAUTION Hazards which could result in equipment or property damage

NOTE Alerts user to pertinent facts and conditions

Although **DANGER** and **WARNING** hazards are related to personal injury, and **CAUTION** hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all **DANGER**, **WARNING**, and **CAUTION** notices.

TRADEMARKS

NOTICE

The information in this document is subject to change without notice and should not be construed as a commitment by MeDetec AB. MeDetec AB assumes no responsibility for any errors that may appear in this document.

In no event shall MeDetec AB be liable for direct, indirect, special, incidental or consequential damages of any nature or kind arising from the use of this document, nor shall MeDetec AB be liable for incidental or consequential damages arising from use of any software or hardware described in this document.

This document and parts thereof must not be reproduced or copied without MeDetec AB's written permission, and the contents thereof must not be imparted to a third party nor be used for any unauthorized purpose.

The software described in this document is furnished under a license and may be used, copied, or disclosed only in accordance with the terms of such license.

CE-MARKING

The Metal detector QSDM 111L fulfills the requirements as stated in the EMC Directive 89/336/EEC and the Low Voltage Directive 73/23/EEC, provided that the installation is carried out in accordance with the installation instructions given in chapter 4 Installation, included in this User´s Guide.

Copyright © MeDetec AB, 2006.

TABLE OF CONTENTS

CONTENTS (continued)

Chapter 4 - Installation

Chapter 5 - Commissioning

CONTENTS (continued)

Chapter 6 - Operation

Chapter 7 - Maintenance

Chapter 8 - Fault-tracing

CONTENTS (continued)

Appendix A - Changing signal processing method

Appendix B - Drawings

Chapter 1 Introduction

1.1 Function and design

The metal detector QSDM 111 is intended for fixed installation in an industrial environment. Its purpose is to detect metal objects in a flow of non-metallic material. Typical applications are detecting nails in timber and protecting planing machines, saw mills and mills in the recycling industry.

The metal detector consists of electronic unit QSDM 111L, search coil QSDM 110S and a signal cable.

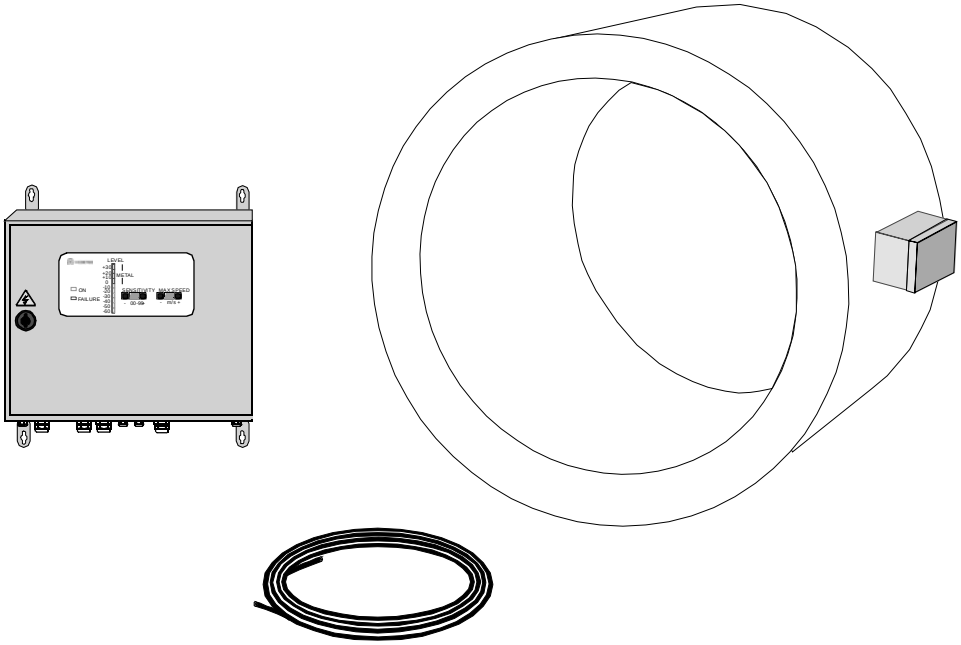


Figure 1-1. Metal detector QSDM 111

All metals can be detected using metal detector QSDM 111. Iron and common steel give maximum sensitivity. Copper, aluminum and stainless steel give lower sensitivity. Non-metallic objects with high iron contents or good electric conductivity can also be detected.

The flow of material passes through the search coil. The magnetic field in the coil is affected by the presence of metal.

Under favorable conditions, the metal detector is sensitive enough to detect, for example, a steel ball with a diameter of 0.5% of the inside diameter of the search coil.

The metal detector has two normally activated relay outputs. When metal is detected, the relay outputs are deactivated. The level of detection (sensitivity) can be set individually for both relay outputs. The relay outputs can be connected to activate an alarm, send a stop impulse to a conveyor, send a signal to a scraping device, etc. The relays are also deactivated if the mains supply voltage is cut or if a failure occurs, e.g. a cable failure. This increases the reliability of the equipment.

1.2 Purpose and contents

This User´s Guide describes metal detector QSDM 111.

The purpose of the User´s Guide is to describe general function and design of the equipment and also to be referred to during installation, commissioning, operation, maintenance and fault-tracing. Some of the equipment spare parts are also listed.

The User´s Guide is structured as follows:

Chapter 1	Chapter 2	Chapter 3	Chapter 4	Chapter 5	Chapter 6	Chapter 7	Chapter 8
Introduction	**Technical description**	**Functional description**	**Installation**	**Commiss-ioning**	**Operation**	**Maintenance**	**Fault-tracing**
Function and design	General	General	General	General	General	General	General
Purpose and contents	Electronics unit	Sensitivity	Search coil	Necessary equipment	Safety	Search coil	Vibrations
	Search coil	Maximum material travel speed	Conveyor requirements	Actions before the mains supply is switched on	Marking	Electronics unit	Poor contact
	Connections	Direct panel functions	Metal-free zones	Switching on the mains supply	Starting the metal detector	Spare parts	Moving metal objects
	Connection diagram	Indirect panel functions	Poor contact between metal parts	Automatic adjustment of the work point	Metal alarm		Electro-magnetic interference
	Technical data	Alternative methods for signal processing	Mounting the electronics unit and the signal cable	Setting parameters			Mechanical damage
			Connecting cables	Adjusting the sensitivity setting			Electrical faults
							False alarm
							Loss of metal alarm
							Error codes

Chapter 2 Technical description

2.1 General

Metal detector QSDM 111 consists of:

- one electronics unit QSDM 111L
- one signal cable (3-100 m)
- one search coil QSDM 110S, available in different sizes.

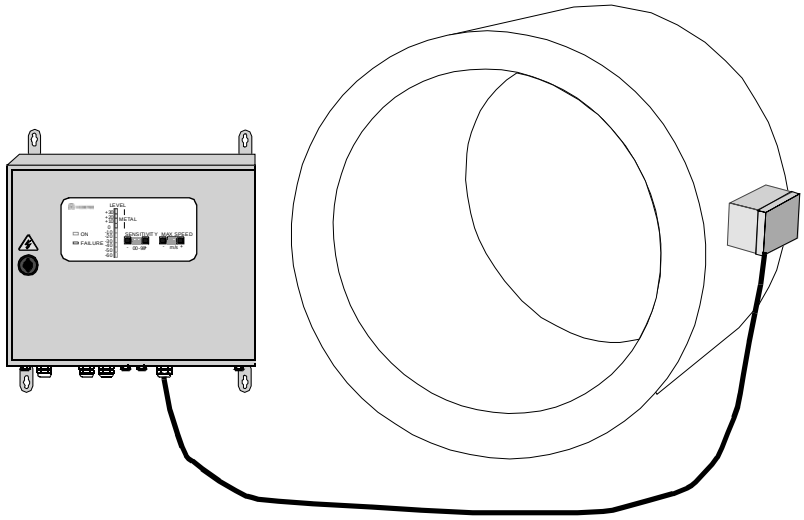


Figure 2-1. Metal detector QSDM 111

The electronics unit performs the following functions:

- Detection of metal at one or two levels
- Automatic adjustment of correct work point
- Self-monitoring with fault alarm
- Filtering radio interference
- Signal filtering with respect to conveyor speed

The search coil is reinforced with glass fibre, has three encapsulated windings, and is screened. A connection box with a signal amplifier is mounted on the outside.

The size of the search coil determines the main operating parameters of the metal detector. These are:

- the sensitivity of the metal detector
- the size of the metal-free zone around the search coil
- the maximum conveyor speed through the search coil

2.2 Electronics unit QSDM 111L

The electronics unit QSDM 111L is housed in a sheet metal cabinet. On the underside of the cabinet there are cable glands for supply voltage, alarm outputs, search coil and reset signal (if required).

All components in the electronics unit are mounted on a plate. These are:

- Terminal group X1 for incoming supply voltage
- Transformer T1
- Power supply and power amplifier board QSDM 111B2
- Signal processing board QSDM 111P2 with panel.

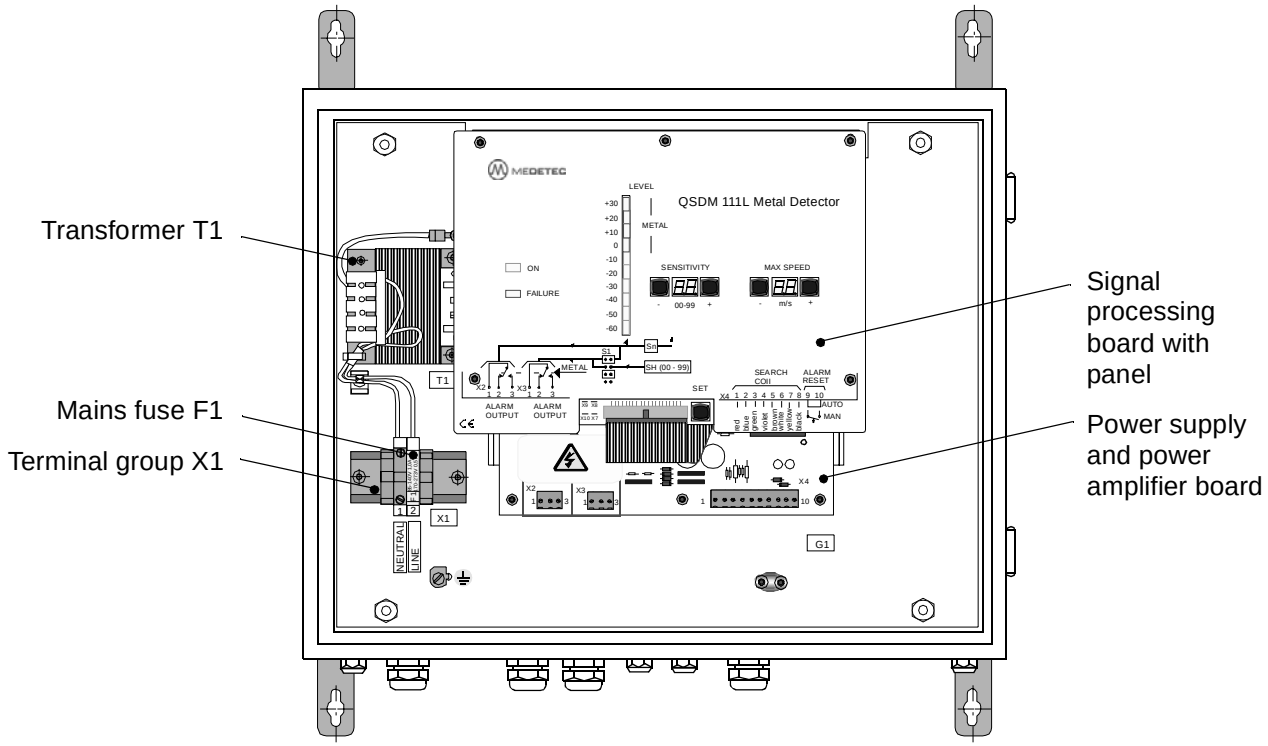


Figure 2-2. The electronics unit QSDM 111L with open door

2.2.1 Terminal group X1

Mains fuse F1 for the metal detector is located in terminal group X1.

2.2.2 Transformer T1

Selection of mains voltage supply is made on terminal group at transformer T1.

2.2.3 Power supply and power amplifier board QSDM 111B2

The power supply unit is located on board QSDM 111B2, located at the bottom of the cabinet. This board also contains a power amplifier, which supplies the transmitting winding of the search coil.

Terminals to connect alarm outputs (2 pcs.), search coil and reset signal are located at the lower part of the board.

2.2.4 Signal processing board QSDM 111P2 with panel

The signal processing board is located below the panel unit. The board is connected to the power supply unit via a ribbon cable.

The signal processing board has functions for:

- indicating and adjusting sensitivity
- indicating and adjusting maximum material travel speed
- display signal level and metal detection
- indicating power on/off.
- indicating faults
- setting the supply voltage to the search coil
- filtering and processing the signal from the search coil
- fault-tracing
- setting installation parameters
- one or two separate detecting levels

2.3 Search coil QSDM 110S and QSDM 111/S112

The search coil has three encapsulated windings, and is screened and reinforced with glass fiber. A connection box with signal amplifier QSDM 111R is mounted at the search coil.

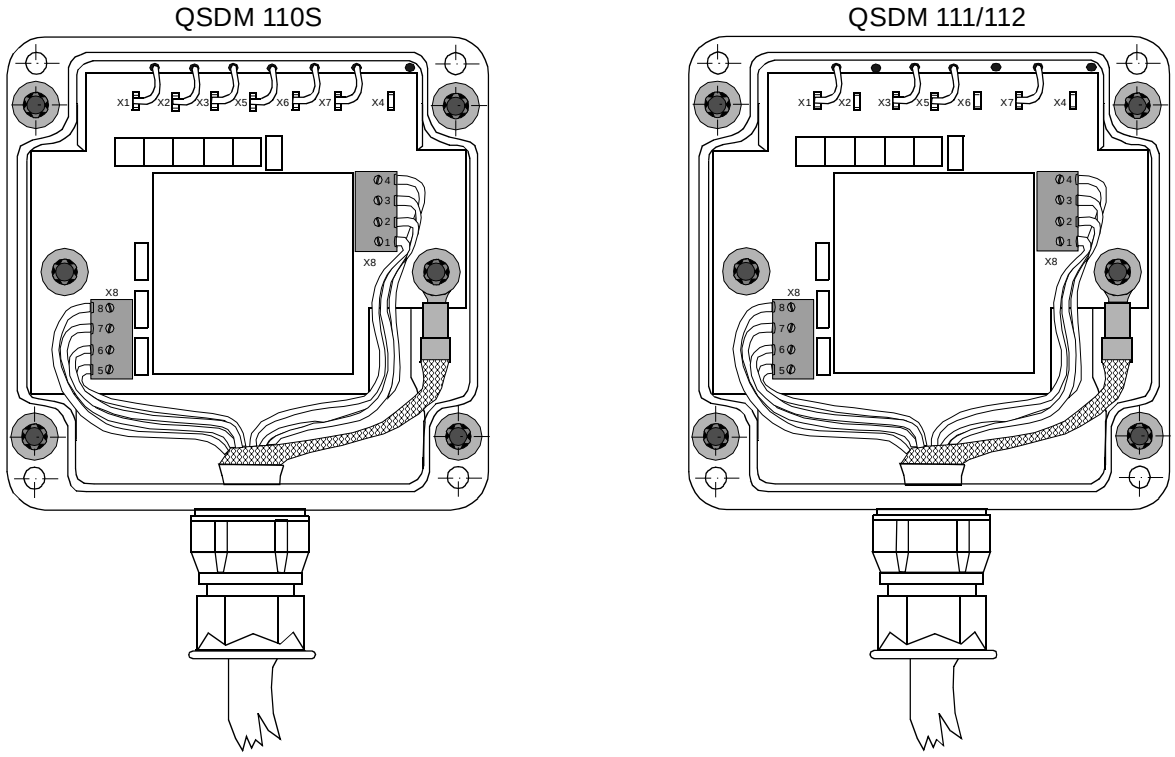


Figure 2-3. Signal amplifier QSDM 111R mounted on the search coil QSDM 110S and QSDM 111/112

2.4 Connections

The electronics unit has the following connections:

- Alarm outputs
- Reset input

2.4.1 Alarm outputs

The electronics unit has two alarm outputs with adjustable alarm levels.

The output relay is activated during normal running. Metal alarm (METAL), fault alarm (FAILURE) or loss of power supply (POWER OFF), deactivate the relay.

Each relay has a switching contact, protected by varistors. The alarm outputs are shown in Figure 2-4.

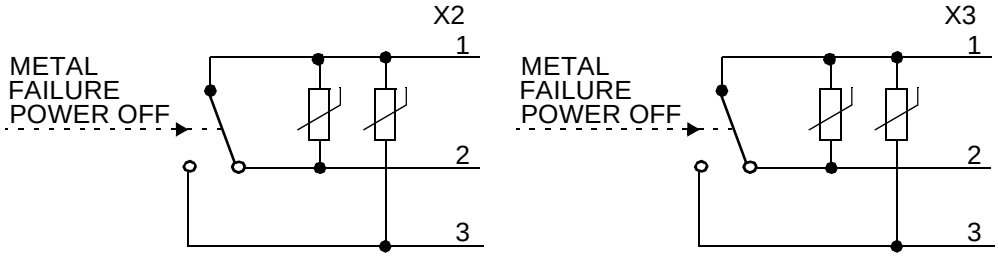


Figure 2-4. Alarm outputs with varistors

2.4.2 Reset input

The electronics unit has an uninsulated reset input. The input is used for resetting the alarm outputs. The reset input is shown in Figure 2-5.

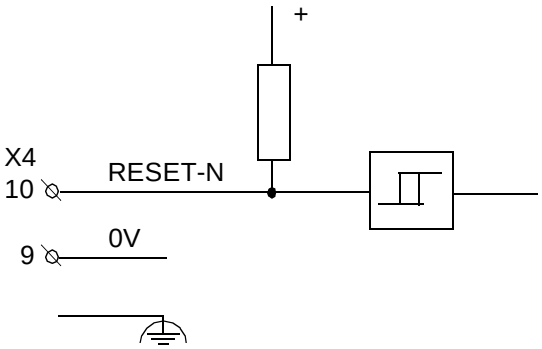


Figure 2-5. Reset input

The reset input is supplied from the electronics unit.

- Manual reset is obtained by momentary connection of terminal X4:10 and X4:9 (0 V).
- Automatic reset is obtained by permanent connection of terminal X4:10 and X4:9.

2.5 Connection diagram

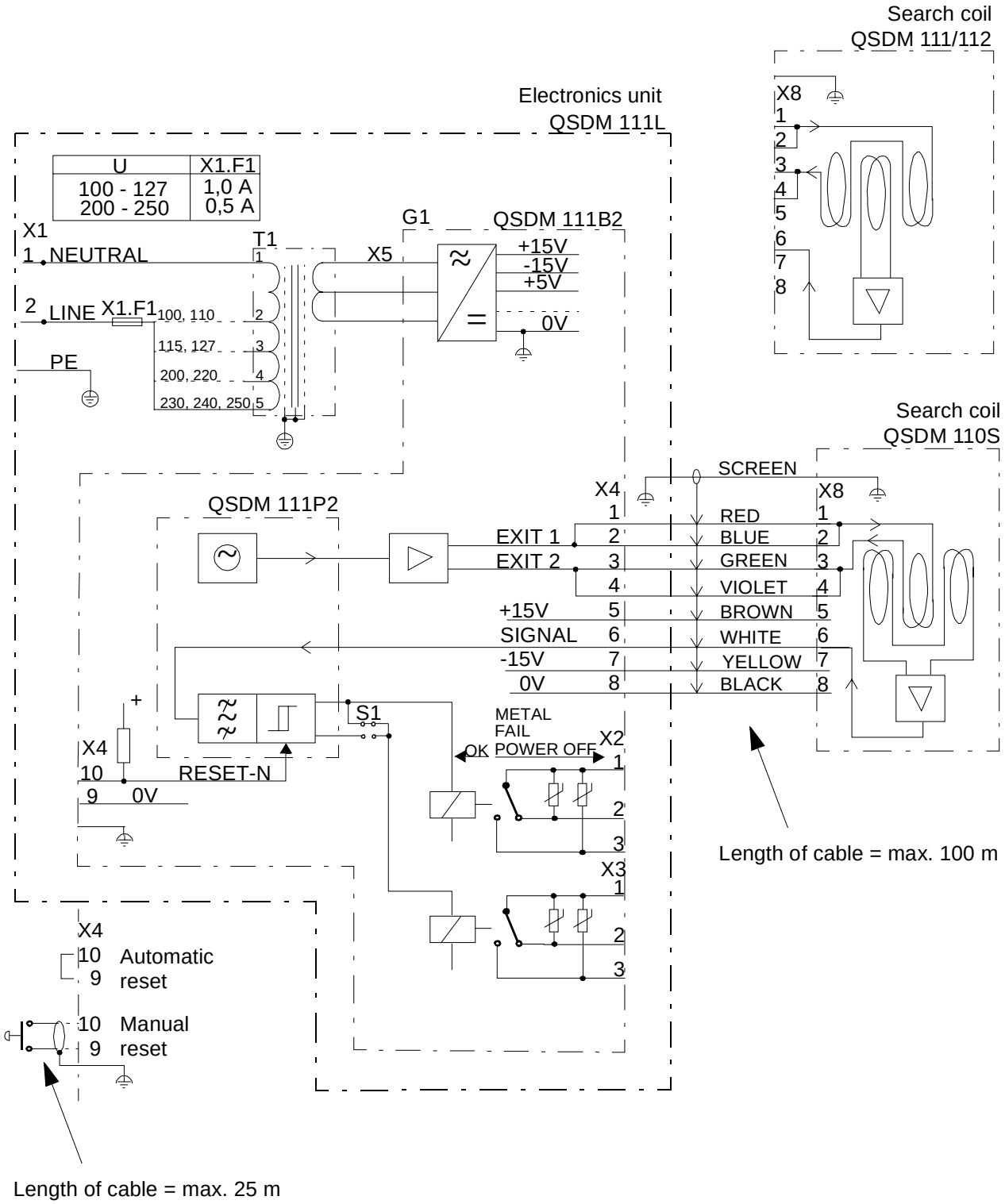


Figure 2-6. Connection diagram for metal detector QSDM 111

2.6 Technical data

Table 2-1. General data

Type	Data
Mains voltage	100 - 127 V / 200 - 250 V, –15% - +10%
Frequency variation	50 / 60 Hz ± 5%
Power consumption	55 VA
Sensitivity, ball of steel(1)	Max. 0.5% of the inside diameter of the search coil
Transportation velocity for objects: full sensitivity is obtained at reduced sensitivity is obtained at	 0.2 - 8 times the length of the search coil per second 0.1 - 0.2 and 8 - 12 times the length of the search coil per second

(1) A ball of steel is especially suitable to use as a reference object, as the extension in the magnetic field always is the same.

Table 2-2. Alarm outputs (X2, X3)

Type	Data
Rated insulation voltage	250 V
Max. continuous load	4 A
Max. current at breaking/closing	4 A at 250 V AC cos Φ > 0.4 0.3 A at 110, 127 V DC 0.2 A at 220, 240 V DC
Contact resistance	0.1 ohm at 0.1 A/24 V/50 Hz (see also IEC 255-0-20)
Protection of contacts, varistor	250 V, 70 J (2 ms)

Table 2-3. Environmental data

Type	Data
Working temperature Electronics unit Search coil	 0 - +40 °C during operation –40 - +55 °C during operation
Degree of protection	S54 according to SEN 2121, dust and rose proof, IP 65 according to IEC 144
Electromagnetic compatibility	Fulfills the EMC Directive 89/336/EEC
Electrical safety	Fulfills the Low Voltage Directive 73/23/EEC

Table 2-4. Dimensions and weight of the electronics unit

Type	Data	Unit
Dimensions (l × w)	500 x 400	mm
Weight	approx. 18	kg

Table 2-5. Dimensions and weight of the circular search coil

Type	Inside diameter (mm)	Outside diameter (mm)	Length (mm)	Weight (kg)
QSDM 110S03	300	420	400	approx. 25
QSDM 110S06	600	800	600	approx. 55
QSDM 110S08	800	1000	800	approx. 70
QSDM 111S10	1000	1200	1000	approx. 110
QSDM 112S10	1000	1460	1200	approx. 315
QSDM 110S12	1200	1500	1200	approx. 150
QSDM 110S14	1400	1700	1400	approx. 260

Table 2-6. Dimensions and weight of the rectangular search coil

Type	Inside diameter (mm)	Outside diameter (mm)	Length (mm)	Weight (kg)
QSDM112S10	1000	1360	1200	approx. 315
QSDMS1010	1000 x 1000	1500 x 1500	1020	approx. 340
QSDMS1210	1200 x 1000	1700 x 1500	1020	approx. 370
QSDMS1410	1400 x 1000	1900 x 1500	1020	approx. 400
QSDMS1610	1600 x 1000	2100 x 1500	1020	approx. 425
QSDMS1810	1800 x 1000	2300 x 1500	1020	approx. 450

Chapter 3 Functional description

3.1 General

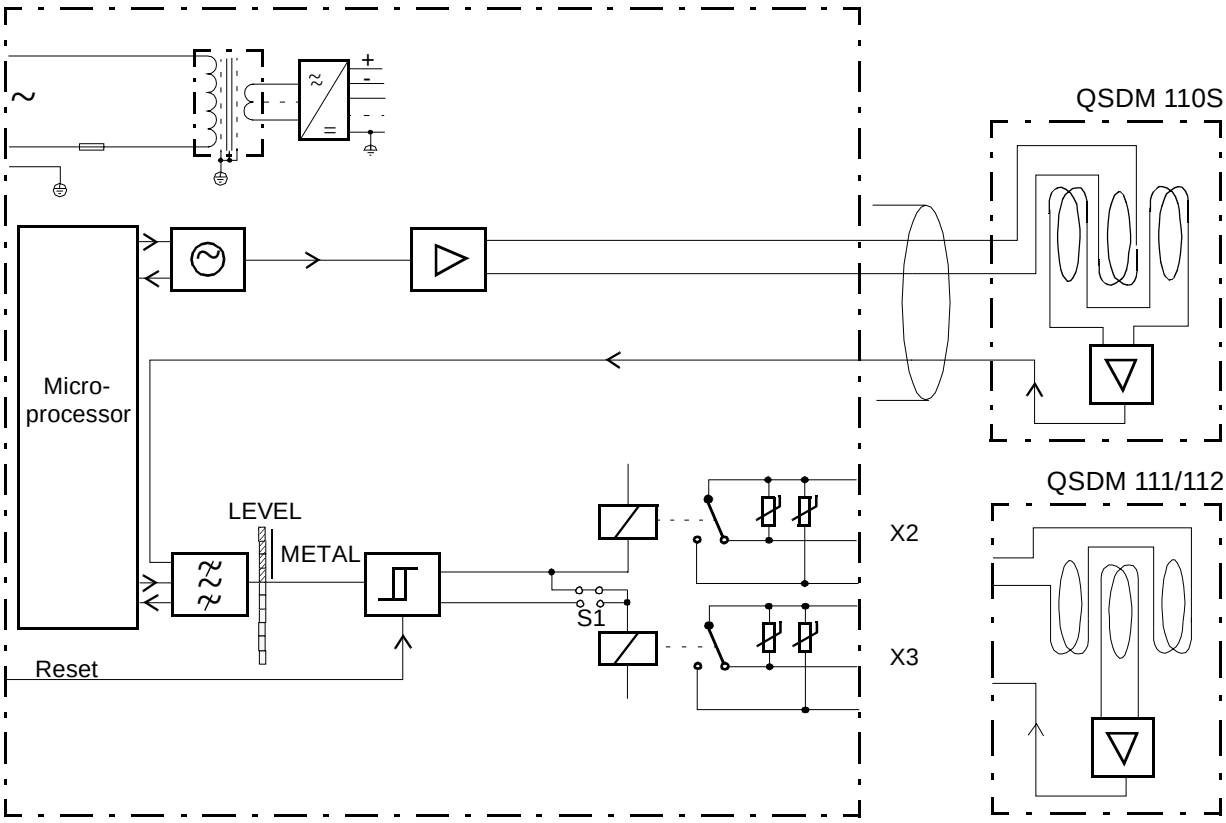


Figure 3-1. Block diagram for metal detector QSDM 111

The electronics unit supplies the transmitter windings in the search coil with sinus shaped current. This current creates a magnetic field in the search coil. The magnetic field is affected when a metal object passes through the search coil.

The receiver windings in the search coil detect the change in the magnetic field. The resulting signal is amplified in a pre-amplifier on the search coil and fed to the electronics unit. The signal is filtered and A/D-converted in the electronics unit. Then it is processed in the micro-processor.

The signal level is shown on a level indicator. When a metal object is detected, the alarm outputs are deactivated. One of the relays (output X3) can be connected to switch at another signal level than the one shown on “LEVEL”.

Metal indication remains until the reset input is activated. If the reset input is permanently activated, metal indication will last for a minimum of 0.3 seconds.

When the built-in fault indication system detects a fault, the alarm outputs are deactivated.

The metal detector is supplied from the mains via a terminal group with a built-in mains fuse.

The sensitivity and function of the metal detector can be changed with push-buttons located on the panel.

3.2 Sensitivity of the metal detector

Sensitivity means the ability of the metal detector to detect small metal objects.

The following characteristics improve the metal detector sensitivity:

- A small search coil

  A small search coil gives a larger signal from a given metal object than a larger search coil. It also picks up less interference than a larger coil. The size of the search coil is chosen based on the size of the material or the conveyor belt that is going to pass through it.

- No vibrations in the search coil

  The larger the vibrations in the search coil are, the greater the disturbance will be. Vibrations can be avoided with a separate stand for the search coil and by ensuring that the material conveyor and the material itself never touche the search coil.

- Low mechanical load on the search coil's mounting.

  The search coil is slightly deformed when it lies on its foundation. The foundation's contact surface against the search coil should be as large as possible to give as little interference as possible with, e.g. gusting winds. The fastener holding the search coil should only be loosely tensioned. The foundation should be as long as the search coil.

- Low electromagnetic interference level

  Electromagnetic interference is effectively avoided in the search coil by the built-in screen. The electronics unit contains signal processing circuits, to suppress electromagnetic interference.

- Low electrical and magnetic conductivity in the transported material

  The sensitivity can be reduced if the transported material is electrically or magnetically conductive. Functions in the electronics unit allow for the selection of suitable detecting modes that take the properties of the transported material into consideration.

- Large metal-free zone

  A metal-free zone is required in the direction of material travel. Even though the search coil is screened, metal structures close to the search coil must be taken into consideration. Large metal structures outside the search coil do not interfere unless they are moving relative to the search coil.

  Poor contact between metal objects may cause severe interference. Interference is avoided if the poor contact is eliminated, for example, by welding the metal parts together.

3.2.1 Smallest detectable metal object

Table 3-1 show the sensitivity (i.e. the smallest detectable metal object), that can normally be achieved in an industrial environment.

Table 3-1. The sensitivity of the metal detectors QSDM 110 / QSDM 111/112

QSDM 110 (Circular)				QSDM 111/112 (Rectangular)	
Search coil size	**Steel ball**	**Nail at favorable angle**	**Nail at unfavorable angle (1)**	**Search coil size**	**Steel ball**
inside diameter	diameter	length	length	inside diameter	diameter
300 mm	2 mm	4 mm	12 mm	1000 x 1000 mm	12 mm
600 mm	4 mm	10 mm	30 mm	1200 x 1000 mm	13 mm
800 mm	5 mm	13 mm	40 mm	1400 x 1000 mm	14 mm
1000 mm	7 mm	15 mm	50 mm	1600 x 1000 mm	15 mm
1200 mm	8 mm	20 mm	60 mm	1800 x 1000 mm	16 mm
1400 mm	10 mm	25 mm	75 mm		

(1) "Unfavorable angle" means that the nail passes through the center of the search coil at right angles to the direction of travel. Even small angular deviations give considerably higher sensitivity.

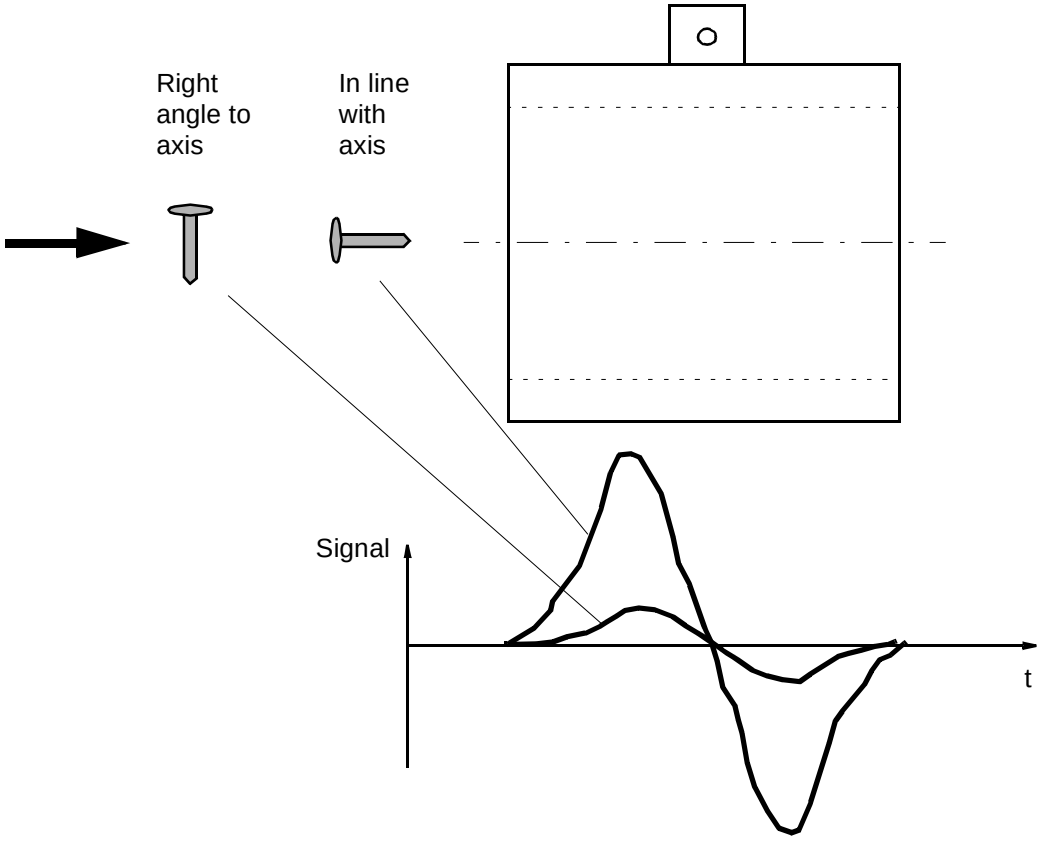


Figure 3-2. Metal objects and their dependence on angle of travel

3.3 Maximum material travel speed

A metal object gives a signal while it is passing through the search coil.

A short and narrow search coil gives the signal a shorter duration than a wide and long search coil. The duration of the signal also depends on the material travel speed through the search coil.

A low pass filter in the electronics unit allows signals with longer duration than a certain limit value. This value depends on the value for maximum material travel speed (MAX SPEED), and it also depends on the actual coil size.

The level of the signal decreases with increased coil size because the metal object becomes smaller compared to the coil size (see Figure 3-3).

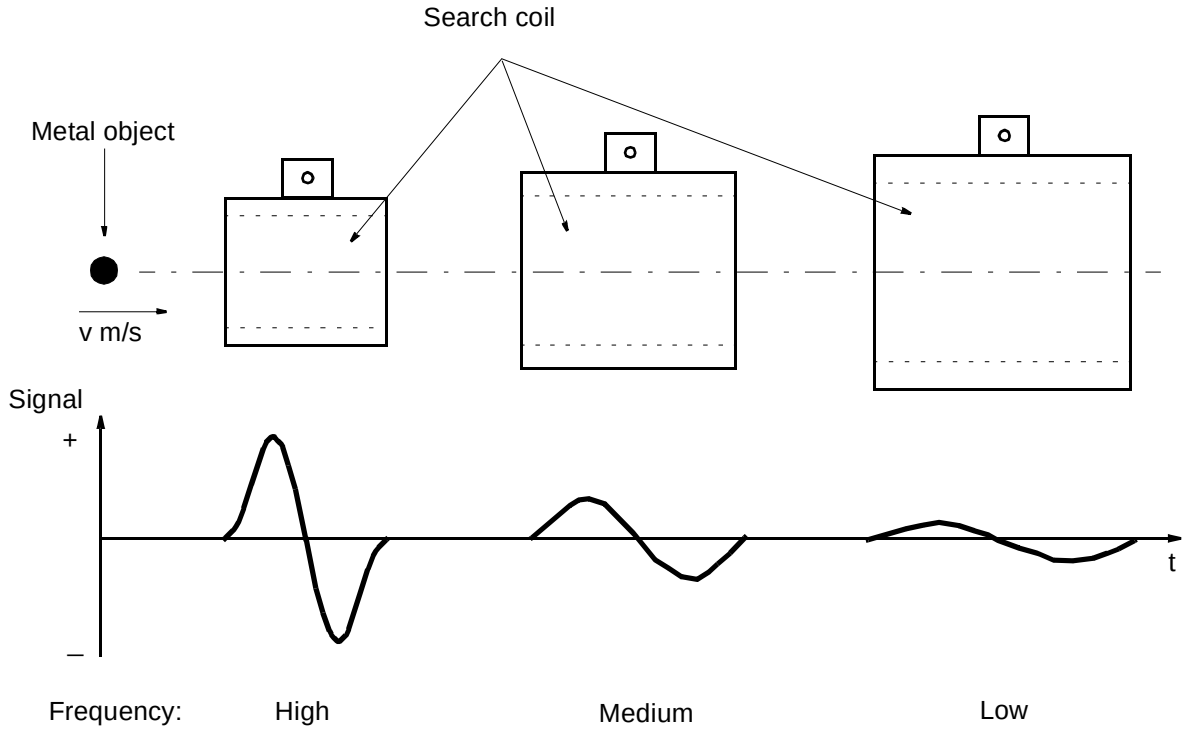


Figure 3-3. Comparison between signals from coils of different sizes for a given metal object

3.4 Direct panel functions

The functions in the metal detector are set on the panel of the electronics unit. These functions are set during commissioning and are normally changed afterwards.

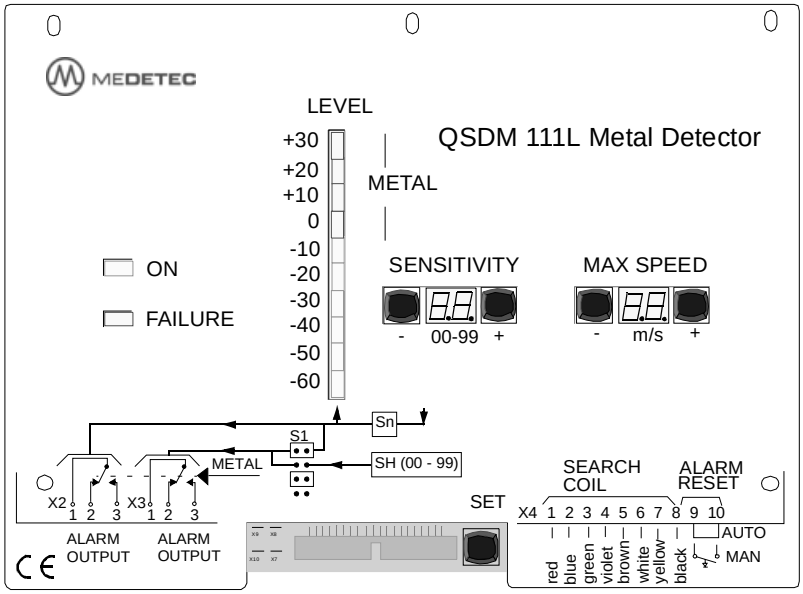


Figure 3-4. Panel

The functions of the indicators and the push-buttons are explained in Table 3-2.

Table 3-2. Indicators and push-buttons on the panel

Indicators	
ON	Indicates that the metal detector has power and is on.
FAILURE	Indicates that the built-in fault indication system has detected a fault in the metal detector.
LEVEL	Displays actual signal level and appearance of metal (METAL). (1)
SENSITIVITY	Displays the set sensitivity. (1)
MAX SPEED	Displays the set maximum travel speed.
Push-buttons	
SENSITIVITY +	Used to increase the sensitivity setting of the detector. (1)
SENSITIVITY –	Used to decrease the sensitivity setting of the detector. (1)
MAX SPEED +	Used to increase the max. travel speed setting through the detector.
MAX SPEED –	Used to decrease the max. travel speed setting through the detector.
SET	Used during input of parameter values, when a parameter value is to be changed.

(1) Alarm output X2 is always connected. X3 is connected if S1 is strapped in position 1-2.

The push-buttons and the indicators for sensitivity (SENSITIVITY) and maximum travel speed (MAX SPEED) are also used to set other parameters that affect the operation of the metal detector. They are also used during fault-tracing to acknowledge fault alarms and to read test values.

3.4.1 ON

The green LED ON indicates that the metal detector is in operation. In the event of power failure or fuse failure, the LED ON goes off.

3.4.2 LEVEL

The LEVEL indicator shows the present signal and noise levels. When the signal reaches up to any of the red LEDs, the metal alarm is activated at alarm output X2 (and X3 if S1:1-2 is strapped). The green LEDs indicate signal levels below the alarm limit. Normally, the level moves up and down in the line of the green LEDs according to the rate of interference.

3.4.3 METAL

The red LEDs at the top of the level indicator (LEVEL) light up when the metal detector indicates metal. When any of the red LEDs is lit, the output relay for X2 (and X3, if S1:1-2 is strapped) is deactivated.

If manual reset is used, one or more of the red LEDs remains lit until the reset input RESET_N is momentarily activated. With autoreset in use, one or more of the red LEDs flash each time metal is detected.

3.4.4 SENSITIVITY

The sensitivity setting is shown with SENSITIVITY. It is shown with the same scale factor as the level indicator.

Adjusting the sensitivity for output X2 (and X3 if S1:1-2 is strapped) is performed with the push-buttons marked + and –. Increased sensitivity makes the metal detector more sensitive to metal. The maximum useful sensitivity depends on the actual installation.

Adjustment of the sensitivity of output X3 is made from the parameter setting (parameter SH). Note that S1:3-4 must be strapped in order for X3 to be controlled by SH.

3.4.5 MAX SPEED

The maximum travel speed is shown with MAX SPEED. The digits show the setting of maximum travel speed in meters per second (m/s).

Adjusting the maximum travel speed is performed with push-buttons marked + and –. Maximum travel speed can only be set within a certain range, which depends on the size of the actual search coil.

The metal detector can be used at higher travel speed with reduced sensitivity.

3.4.6 FAILURE

The function of the metal detector is supervised by a fault indication system. A fault (FAILURE) results in a continuous (non-resetable) alarm at the output relays. The panel shows actual error code. If the fault is temporary, the fault indication (FAILURE) will stop when the fault has passed. The metal detector will then return to normal operation and the output relays are activated. The error code remains until it is acknowledged.

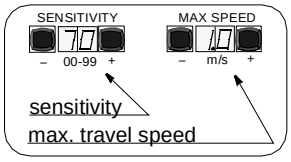
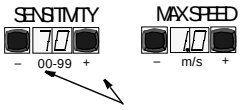
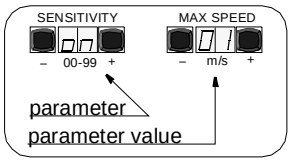
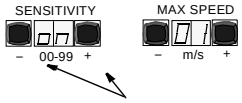
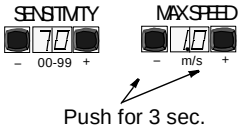
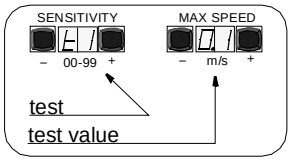
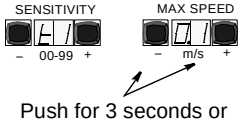
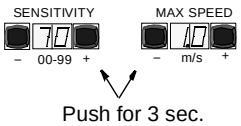
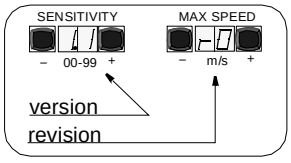
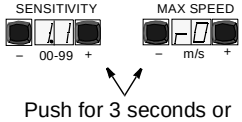
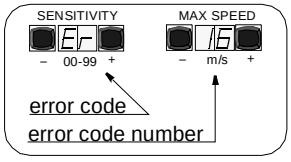
If the mains supply of the metal detector fails, the output relays give an alarm. However, FAILURE is not lit if the mains supply fails.

3.5 Indirect panel functions

The push-buttons and the indicators for sensitivity (SENSITIVITY) and maximum travel speed (MAX SPEED) are also used for setting parameters that adjust the operation of the metal detector. During fault-tracing and commissioning, they can also be used for reading error codes, internal test values and software release.

Different combinations of push-buttons change the types of readings that can be performed. This is illustrated in Table 3-3.

Table 3-3. Alternative use of push-buttons SENSITIVITY and MAX SPEED

Normal mode	Push ...	to go to...	Push ... to go back to normal mode[1)]
		**Setting parameters** 	 Push for 3 seconds or the display returns to normal mode after 10 min.
		**Test value** 	 Push for 3 seconds or the display returns to normal mode after 2 min.
		**Software version** 	 Push for 3 seconds or the display returns to normal mode after 2 min.
	The system automatically displays an error code when a fault occurs.	**Error code** 	The display returns to normal mode after acknowledgment of the fault, see Section 3.5.4 Error codes.

1) It is possible to go directly to the desired function, without returning to normal mode.
The same combinations of push-buttons can be used regardless of which function is in use.

3.5.1 Normal mode

Use of SENSITIVITY and MAX SPEED in normal mode is described in Section 3.4 Direct panel functions.

3.5.2 Setting parameters

- Go to setting parameters by:
  simultaneously pushing SENSITIVITY + and SENSITIVITY – for 3 seconds.

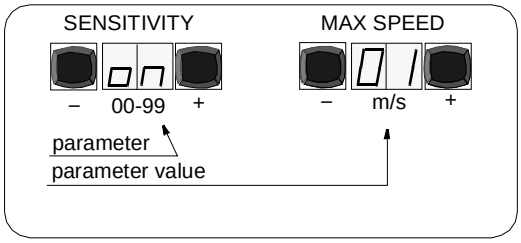


Figure 3-5. Setting parameters at the panel

- SENSITIVITY shows the parameter designation.
  Step through the list of parameters by
  pushing SENSITIVITY + or SENSITIVITY –.
- MAX SPEED shows the parameter value.
  Change the setting of a parameter value by
  simultaneously pushing SET and MAX SPEED + or SET and MAX SPEED –.
  - Increase the value by simultaneously pushing SET and MAX SPEED +
  - Decrease the value by simultaneously pushing SET and MAX SPEED –
- Leave parameter setting by:
  simultaneously pushing SENSITIVITY + and SENSITIVITY – for 3 seconds.
  The system will also leave the function automatically after 10 minutes.

Table 3-4 shows the parameters which normally need setting or changing. Other parameters must not be changed.

Table 3-4. Available parameters with their explanation and default value

Indication on SENSITIVITY	Parameter	Explanation	Default value
on	EXCITATION ON	00 = No current fed to transmitter coil 01 = Current fed to transmitter coil	01
Sn	SENSITIVITY	Set sensitivity for X2 (X3). (1)	70
SP	MAX SPEED	Maximum travel speed (m/s).	1.0
CS	COIL SIZE	Inside diameter of the search coil (m).	1.0
CL	CABLE LENGTH	Cable length between the electronics unit and the search coil (m).	25
AS	ALARM SIGNALING	Maximum number of metal pulses after a metal indication.	01
SH	SENSITIVITY H	Set sensitivity for X3.(2)	70
SE	SIGNAL EVALUATION	The signal processing method used in the metal detector (readable only).	01
dE	DEFAULT SIGNAL EVALUATION	Setting the signal processing method to be used after next start with change of signal processing method.	01
.....		These parameters are normally not displayed. If the open signal processing method is used (SE = 00), more parameters will be displayed.	

(1) Alarm output X2 is always connected. X3 is connected, if S1 is strapped in position 1-2.
(2) Alarm output X3 is controlled by SH, if S1 is strapped in position 3-4.

Example: At commissioning, both the size of the search coil (parameter **CS**) and the length of the cable (parameter **CL**) must be set. Change the parameters according to the following:

1. Push SENSITIVITY + and SENSITIVITY – simultaneously for 3 seconds.
2. SENSITIVITY shows the first parameter, **on**, and MAX SPEED shows the value 01.
3. Push SENSITIVITY + three times to step forward to the parameter for coil size. SENSITIVITY shows **CS** and MAX SPEED shows the set coil size.
4. Push MAX SPEED + or MAX SPEED – to change the coil size. Note that SET must be pushed at the same time.
5. Push SENSITIVITY + once to step forward to the parameter for cable length. SENSITIVITY shows **CL** and MAX SPEED shows set cable length.
6. Push MAX SPEED + or MAX SPEED – to change the cable length. Note that SET must be pushed at the same time.
7. Leave the parameter setting mode by pushing SENSITIVITY + and SENSITIVITY – simultaneously for 3 seconds.

   Note: The parameter SH must be set if two separate detection levels are used to control the alarm outputs X2 and X3, see Section 5.6.7 Setting of sensitivity for alarm output X3 (SH).

3.5.3 Test values

The metal detector contains extensive supervision of faults. A part of this supervision is based on measured internal signals, which can be compared with reference values. With this function, the measured signals can be read, which is often very useful at fault-tracing.

- Read the test values by pushing MAX SPEED + and MAX SPEED – simultaneously for 3 seconds.
  - SENSITIVITY shows a **t** and the symbol for the test value.
  - MAX SPEED shows the difference between the measured value and the reference value.
- Step between the test values by pushing SENSITIVITY + or SENSITIVITY –.

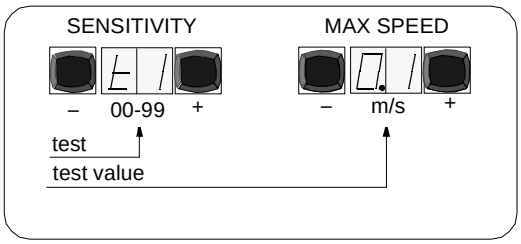


Figure 3-6. Displaying test values at the panel

- The indicator for MAX SPEED shows the deviation from the reference value.
  - The maximum positive deviation, that can be shown is 99. If the deviation is larger, a flashing “99” will be shown.
  - The maximum negative deviation, that can be shown is -19. If the deviation is larger, a flashing “-19” will be shown.
- Leave the reading of test values by pushing MAX SPEED + and MAX SPEED – simultaneously for 3 seconds. The system will also leave the function automatically after 2 minutes.

Table 3-5 shows the internal test signals that can be read.

Table 3-5. Internal test signals

Test	Designation	Reference-value	Allowed interval
t 0	A/D-converter 0V	0 V	-.2 - 0.2
t 1	+5V for electronics in the electronics unit	5 V	-.2 - 0.2
t 2	+5V for filter in the electronics unit	5 V	-.5 - 0.5
t 3	-5V for filter in the electronics unit	-5 V	-.5 - 0.5
t 4	+12V for A/D-converter in the electronics unit	12 V	-1.2 - 1.2
t 5	-12V for A/D-converter in the electronics unit	-12 V	-1.2 - 1.2
t 6	+15V for electronics in the electronics unit	15 V	-1.5 - 1.5
t 7	-15V for electronics in the electronics unit	-15 V	-1.5 - 1.5
t 8	+25V for the power amplifier generating the supply voltage to the search coil	25 V	-8 - 11
t 9	+30V unregulated voltage in the supply unit in the electronics unit	0 V	17 - 36
t A	Supply level to the transmitter winding of the search coil	0 V	11 - 16
t b	The level of the unbalance signal from the search coil	0 V	-1 - 3.5
t r	Detected resistive part of the signal from the search coil	0 V	--
t i	Detected inductive part of the signal from the search coil	0 V	--
t d	Calculated zero level of the resistive part of the signal from the search coil	0 V	--
t c	Calculated zero level of the inductive part of the signal from the search coil	0 V	--
t L	Calculated time for background program in steps of 10 ms	0 step	10 - 25

3.5.4 Error codes

Error codes are shown automatically if there is an unacknowledged fault in the metal detector. If the fault is of temporary nature, the metal detector will operate normally again when the fault ceases. The error code is displayed until it is acknowledged.

An error code is displayed when:
SENSITIVITY shows **Er**.
MAX SPEED shows the number of the error code.

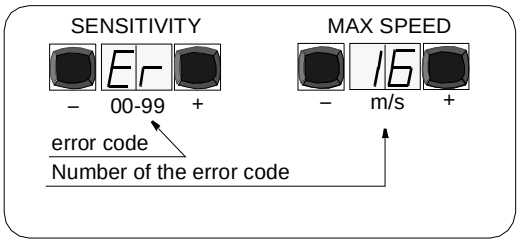


Figure 3-7. Displaying an error code at the panel unit

Table 3-6 lists the error codes. A more detailed explanation and recommended actions are given in Chapter 8 Fault-tracing.

- Acknowledge an error code by pushing MAX SPEED + or MAX SPEED –.
- If there are more unacknowledged faults, the next error code is shown.
- When all the faults have been acknowledged "--" is shown at MAX SPEED for a short time. Then the first remaining fault is shown again.
- If there are no remaining faults, SENSITIVITY and MAX SPEED are shown on the indicators again.

Table 3-6. Error codes

Error code	Designation
Er 01	Fault in the program memory (FLASH) of the electronics unit
Er 02	Fault in the parameter memory (FLASH) of the electronics unit
Er 03	Fault in the read and write memory (RWM) of the electronics unit
Er 04	0V-measurement faulty in the electronics unit
Er 05	Unbalance voltage from the search coil too high
Er 06	+5V to the filter is faulty in the electronics unit
Er 07	-5V to the filter is faulty in the electronics unit
Er 08	+12V to the A/D-converter is faulty in the electronics unit
Er 09	-12V to the A/D-converter is faulty in the electronics unit
Er 10	The supply to the transmitter winding of the search coil is faulty
Er 11	+30V-supply is faulty in the electronics unit
Er 12	+25V-supply is faulty in the electronics unit
Er 13	+15V-supply is faulty in the electronics unit
Er 14	-15V-supply is faulty in the electronics unit
Er 15	+5V-supply is faulty in the electronics unit
Er 16	The current limit is exceeded for the supply to the signal amplifier on the search coil
Er 17	The current limit is exceeded for the power amplifier to the search coil
Er 18	A parameter has been changed due to a new setting of another parameter
Er 19	Fault has occurred during start of the memory of the electronics unit (FLASH)
Er 20	Fault when reading in program memory of the electronics unit (FLASH)
Er 21	Fault when erasing in the program memory of the electronics unit (FLASH)
Er 22	Fault when writing to the program memory of the electronics unit (FLASH)
Er 23	Fault when reading in the parameter memory of the electronics unit (FLASH)
Er 24	Fault when writing to the parameter memory of the electronics unit (FLASH)
Er 25	Fault when re-reading into the parameter memory of the electronics unit (FLASH)
Er 26	Fault when erasing in the parameter memory of the electronics unit (FLASH)
Er 27	The memory of the electronics unit (FLASH) has been used incorrectly
Er 28	The microprocessor in the electronics unit has been overloaded
Er 29	Internal fault in the program
Er 30	Insufficient compensation
Er 31	Unstable compensation

3.5.5 Software release

This function shows the software release of the metal detector.

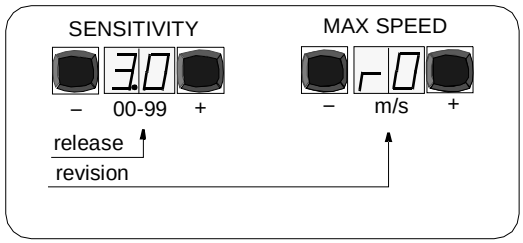


Figure 3-8. Displaying the software release at the panel (example)

- Show the software release by
  pushing SENSITIVITY + and MAX SPEED –
  simultaneously for 3 seconds.
- Leave the function by
  pushing SENSITIVITY + and MAX SPEED –
  simultaneously for 3 seconds.
  The system will also leave the function automatically after 2 minutes.
- The values shown on SENSITIVITY and MAX SPEED
  are interpreted according to Table 3-7.

Table 3-7. Reading displayed values for software release

Value	SENSITIVITY	MAX SPEED	Interpretation
Software release (1)	3.0	r0	Software release 3.0/0

(1) The software release for QSDM 111L is 3.0/0 or later.

3.6 Alternative methods for signal processing

The signal processing in the metal detector is controlled by a large number of parameters in the program of the microprocessor. Only a few of these parameters need to be set by the user at commissioning, see Section 3.5.2 Setting parameters. The other parameters are predefined in the default setting of the metal detector.

The default setting gives the best possible function for most applications, such as saw mills, and paper, pulp and recycling industries. All kinds of metals can be detected with high sensitivity, magnetic as well as non-magnetic.

The metal detector has two predefined settings, in addition to the default setting. These two settings are adjusted for material flows which are either electrically or magnetically conductive.

The different methods for signal processing and how to change the methods are described in Appendix A.

Chapter 4 Installation

4.1 General

Careful selection of the location and careful installation of the search coil and other parts are of great importance for the performance of the metal detector. Follow the installation instructions carefully and take into account the metal-free zones.

The detector only indicates objects of metal or other electrically or magnetically conducting material that move relative to the search coil. Non-moving objects do not cause any indication. However, a large metal object close to the coil can affect the magnetic field, even if the movement is very small.

The following can cause interference:

- If the search coil is subjected to blows or vibrations, this can cause interference and in the worst case damage to the coil.
- Moveable metal parts in the vicinity of the coil may be a source of interference, especially if they are large or very close to the coil.

- **Undefined electrical connections between metal parts in the vicinity of the coil can be a source of severe interference.**

NOTE

Check for welding cracks, loose rivets or screws, rust and damaged paint work.

- Electric cables are usually emitters of disturbance and when run past the coil they must be routed in iron pipes or tubes. This is especially important if a thyristor control or frequency converter is connected to the cable running past the coil.
- Magnetic fields emanating from an electric motor may represent a powerful source of interference, especially if the motor is connected to thyristor equipment or has a rapid pulsating load (powering a hydraulic pump). Sparks in the motor brushes may be another source of disturbance.
- Unless provided with spark suppression, contactors and contacts may cause interference.
- Electric welding may occasionally be a source of interference. During electric welding in the immediate vicinity of the search coil, the earth clamp shall be connected close to the welding spot. The welding cables must not be routed around the search coil.

4.2 Mounting the search coil

Consider the following when mounting the search coil, see Figure 4-1:

- The search coil must be mounted on its own **vibration-free** foundation in order to prevent movements in the surroundings from being transferred to the search coil.
- To make the search coil as vibration-free as possible, the foundation can be divided into two parts. The search coil rests on the upper part, which is mounted on the lower part of the foundation via four vibration dampers.
  - Each of the four vibration dampers must be dimensioned to take 1/4 of the total weight of the load, i.e. the search coil and the upper part of the foundation. The dampers must be intended for the actual ambient temperature.
  - To minimize vibrations, it is important that the load resting on the vibration dampers is heavy. This can be arranged by designing the upper part of the foundation as a case, that can be filled on-site with heavy materials such as sand, gravel, metal pieces, rocks etc.
- Place pieces of rubber mat at both ends between the search coil and the foundation. The rest of search coil should not be supported. Supporting the search coil only at the ends decreases the risk of search coil deformation caused by the installation. The search coil will also be more resistant to vibrations and gusts of wind.
- Strap the search coil loosely to the foundation with reinforced plastic straps.
- Mount the wooden stopping devices at both ends of the search coil to prevent the coil from moving in the direction of transportation and falling down from the foundation.
- Protect the search coil from heavy material striking against it. The coil can be protected by, for example, providing a protective arch of wood or plastic upstream of the search coil. The protective arch can also be arranged to operate an emergency stop switch to stop the conveyor.
- Protect the search coil from rain, ice and snow, e.g., by providing a roof.

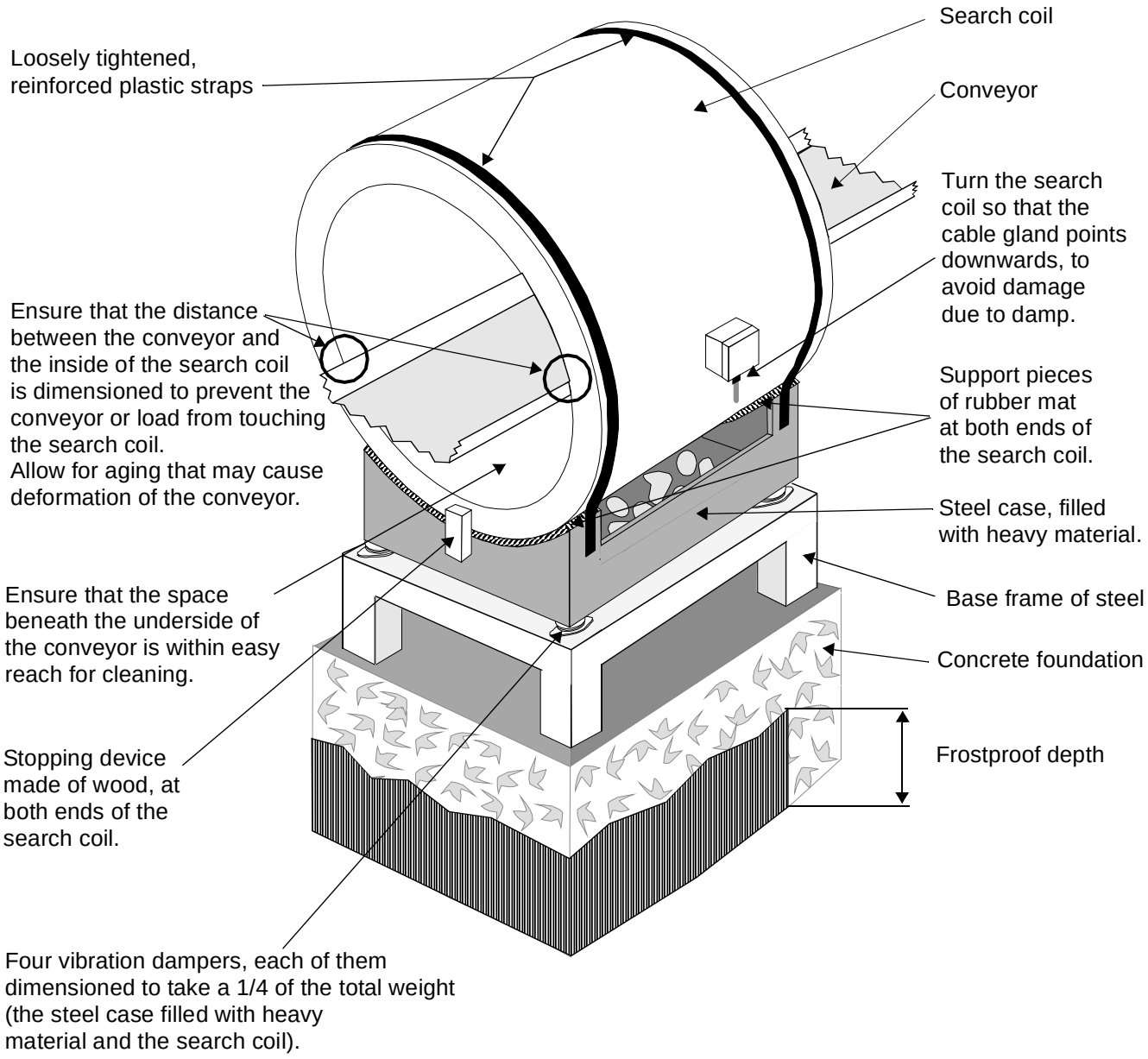


Figure 4-1. The search coil mounted on a foundation

4.3 Conveyor requirements

The conveyor is normally a belt running in a runway through the search coil.

Consider the following during installation (see Figure 4-2):

1. The runway must not touch the inside of the search coil.
2. The part of the runway inside the metal-free zone of the metal detector must not be made of metal.
3. The belt must not be made of metal or any other conductive material.
4. The belt must not be reinforced with metal cords.
5. The joints in the belt must not contain metal or any other conductive material (e.g. metal chips from grinding).

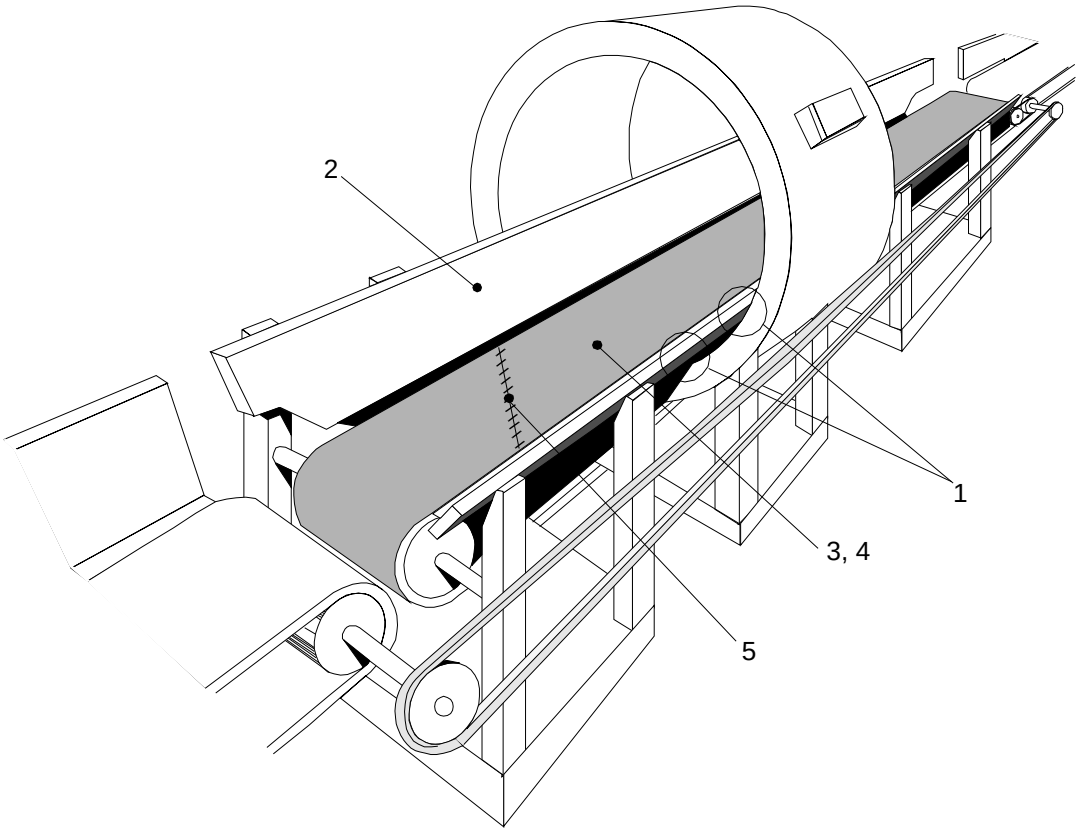


Figure 4-2. Conveyor requirements

4.4 Metal-free zones

4.4.1 Maximum sensitivity

Maximum sensitivity can only be achieved if the following requirements of metal-free zones are considered:

- The surroundings of the search coil are divided into three spherical zones:
  - Zone 0 must be totally metal-free.
  - Zone I is allowed to contain small non-moving metal objects.
  - Zon II is allowed to contain small moving metal objects.

  The definition and the extension of the zones are given in Figure 4-3 respectively Figure 4-3 and Table 4-1 respectively Table 4-1.
- Metal objects in the longitudinal direction of the conveyor should be avoided. However, the search coil can be mounted on a stand of metal, if the stand is not longer than the search coil.

4.4.1.1 Circular search coil

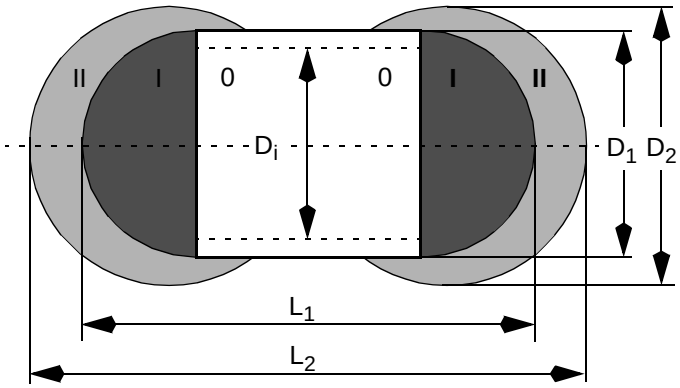


Figure 4-3. Metal-free zones

Table 4-1. Dimensions of metal-free zones

	Zone 0 (1)	Zone I (1)		Zone II (1)	
	D_i (mm)	D_1 (mm)	L_1 (mm)	D_2 (mm)	L_2 (mm)
Circular searc coil	300	420	550	450	750
	600	800	1000	900	1500
	800	1000	1300	1200	2000
	1000	1200	1600	1500	2500
	1200	1500	2000	1800	3000
	1400	1700	2200	2100	3500

(1) Note that in practice, the limits between the zones are floating.

4.4.1.2 Rectangular search coil

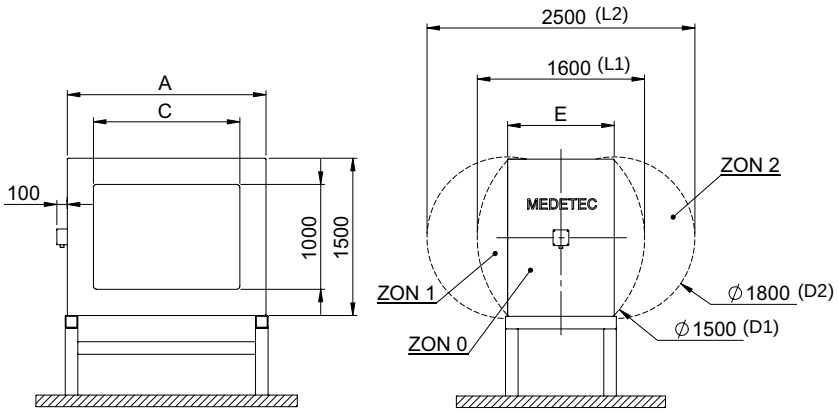


Figure 4-4. Metal-free zones

Table 4-2. Dimensions of metal-free zones

Type	Dimensions (mm)			Recommended Metal-free zones(1)			
				Zon 1		Zon 2	
	Inside diameter	Outside diameter	Length	D1	L1	D2	L2
QSDM112S10	1000	1360	1200	1500	1600	1500	2500
QSDMS1010	1000 x 1000	1500 x 1500	1020	1500	1600	1800	2500
QSDMS1210	1200 x 1000	1700 x 1500	1020	1500	1600	1800	2500
QSDMS1410	1400 x 1000	1900 x 1500	1020	1500	1600	1800	2500
QSDMS1610	1600 x 1000	2100 x 1500	1020	1500	1600	1800	2500
QSDMS1810	1800 x 1000	2300 x 1500	1020	1500	1600	1800	2500

(1) Note that in practice, the limits between the zones are floating.

4.4.2 Reduced sensitivity

If a lower sensitivity can be accepted, metal objects can be allowed closer to the search coil than stated in Table 4-1. Bolts of stainless steel or non-magnetic steel can then be used for joining the conveyor.

NOTE

Metal objects inside the search coil (zone 0) must be avoided, since this can give rise to interference if such object is moving. Vibration of a large metal object can cause interference. A metal object moving forwards and backwards in the direction of transportation causes the largest interference.

4.5 Poor contact between metal parts

Poor contact between metal parts can be difficult to detect, since very small movements of material far away from the search coil can generate interference signals.

NOTE

All joints near the search coil where poor contact can be suspected, for example bolted joints, must be welded. See Figure 4-5.

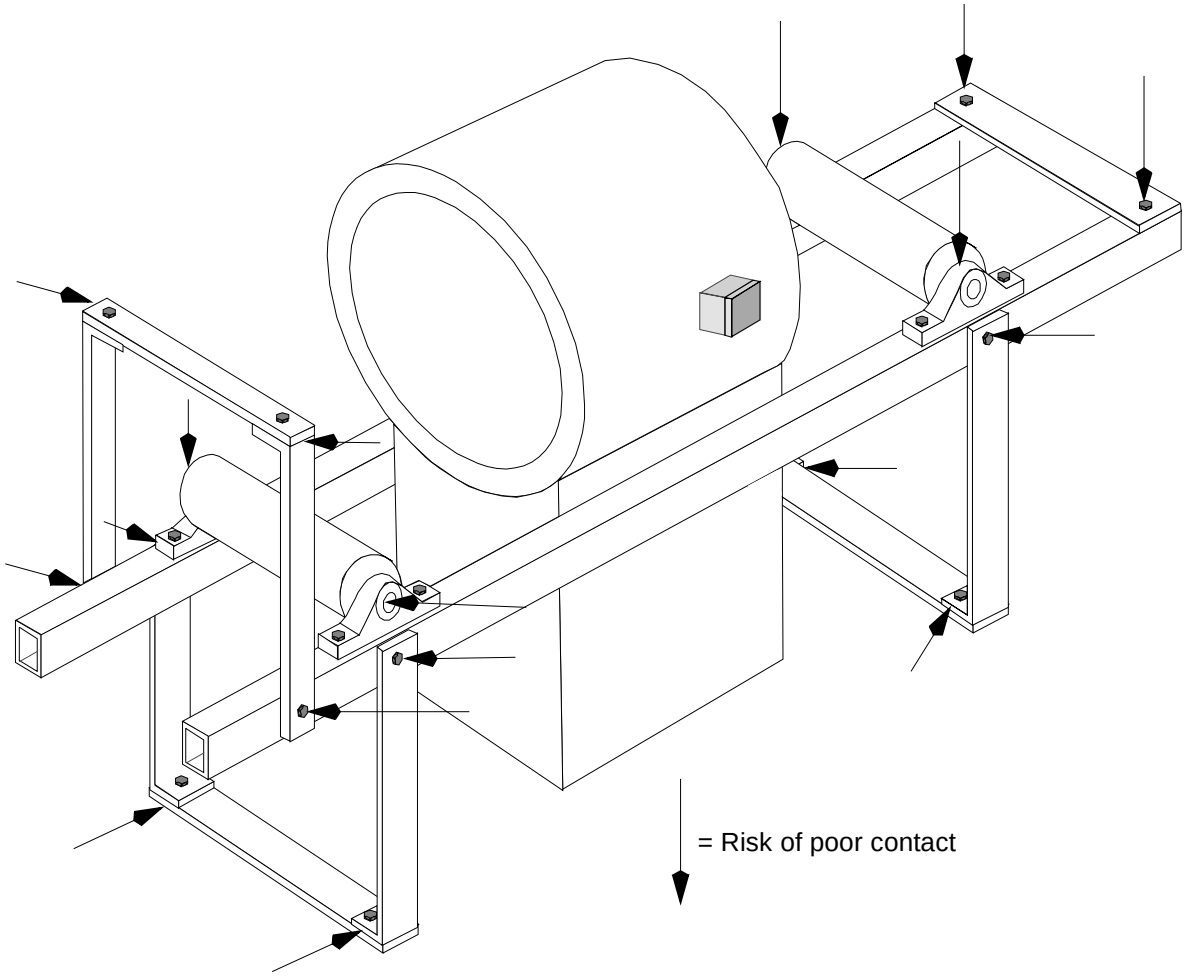


Figure 4-5. Typical points where poor contact can be expected

4.5.1 Suppressing interference from roll supports

The idler rolls and the longitudinal beams of the conveyor form a short-circuited loop around the search coil if the search coil is mounted half way between two idler rolls. Short-circuited loops such as this can cause interference if the loop resistance varies. Poor contact in bolted joints or bearings may also cause variation in the resistance.

Such a short-circuited loop can be broken, but often the problem is then moved to the next possible transverse connection between the longitudinal beams.

A method that is usually effective is to ensure that the resistance in the circuit thus formed does not vary. This can be done by bypassing rolls and roll supports by welding screen plates between the beams as close as possible to the sides of the rolls supports facing the search coil.

NOTE

Screen plates are a simple form of insurance against possible future interference problems and stoppages. Always install the plates from the start, even if they are not considered necessary at installation.

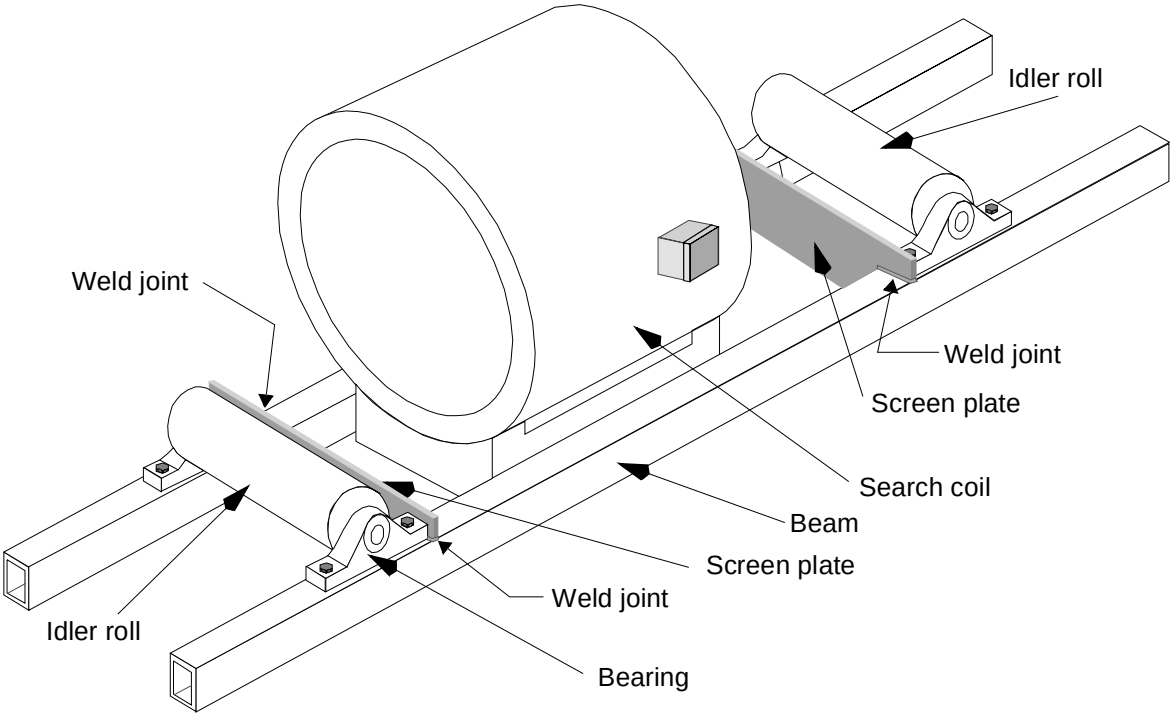


Figure 4-6. Interference suppression of roll supports

4.5.2 Interference suppression of other types of metal constructions

Metal brackets supporting, e.g. dust protecting devices or the conveyor, may form a part of a short-circuited loop. Weld all bolted connections.

4.6 Mounting the electronics unit and the signal cable

1. Install the electronics unit **indoors** at an ambient temperature of 0 - +40 °C. The maximum cable length between the electronics unit and the search coil is 100 m.

   The distance from power equipment that can cause interference, such as small transformers and contactors, must be at least 1 m.

2. Mount the electronics unit on a **vibration-free** wall, with the cable entries downwards. Make the holes in the wall according to Figure 4-7.

3. Any unused cable entries must be sealed to prevent dust, insects, etc. entering.

4. Mount the signal cable carefully, so that vibrations do not cause false indications or failure of the cable.

NOTE

The signal cable must not be routed with other cables, especially not power cables. The distance to the nearest cable must be at least 30 cm.

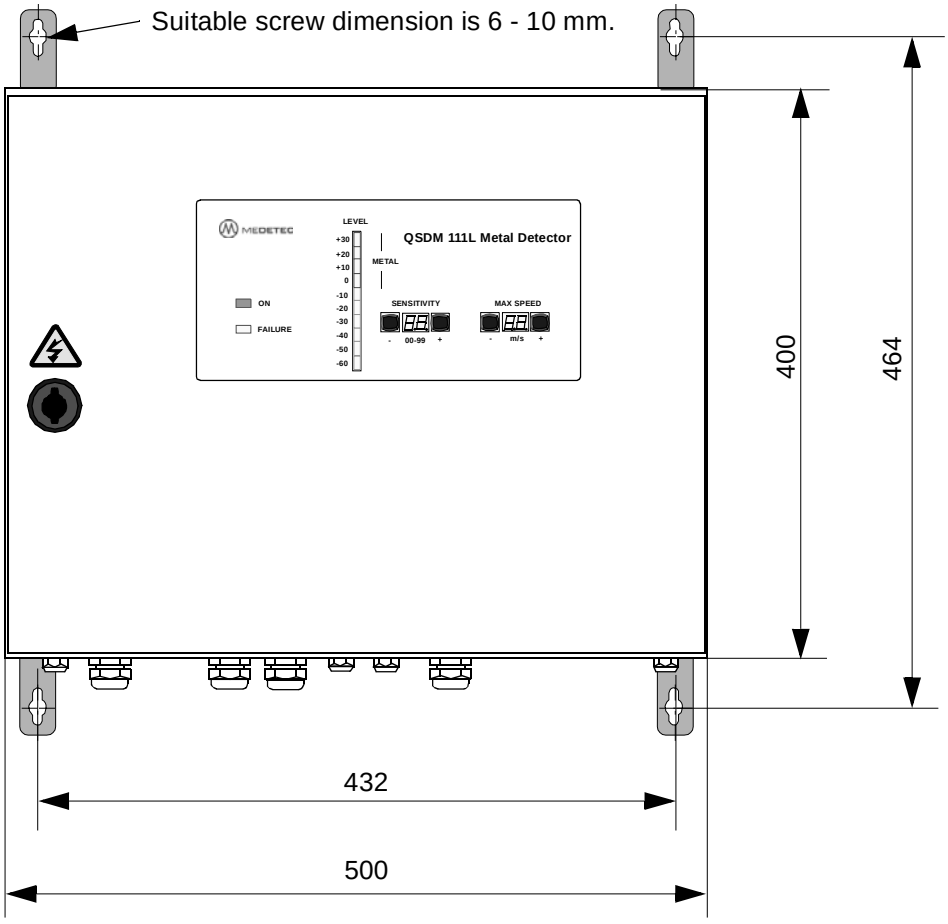


Figure 4-7. Space requirements and cut-out dimensions for the electronics unit

4.7 Connecting cables

Cables connected to terminal groups must not be twisted, since there is a risk of the cable cores cutting each other off when the terminal is tightened. This is also relevant if end sleeves are used.

4.7.1 Signal cable

The signal cable between the electronics unit and the search coil must be an eight wire cable with braided and robust copper screen. Normally, a cable of type MKFR 8 x 0.5 mm^2 is used. It is important to maintain this cable design, if another type is to be used (see Figure 4-8).

NOTE!
The figures within brackets are wire No:s in the cable, not terminal No:s in X4/X8.

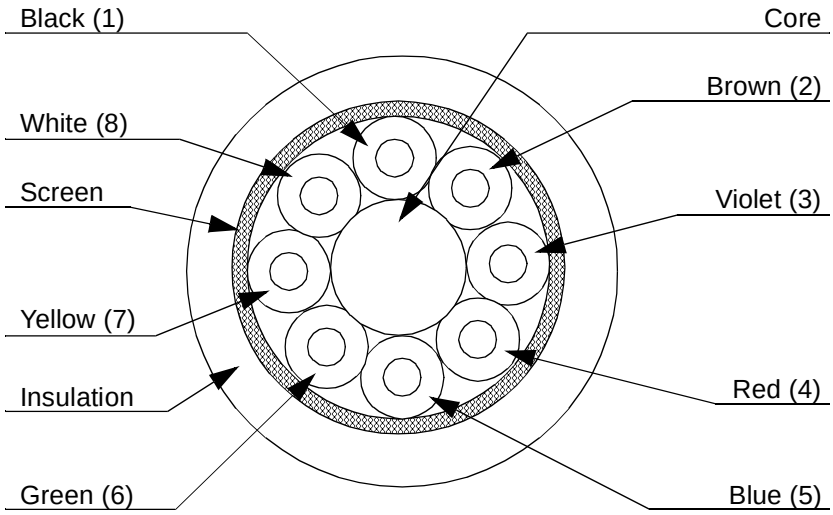


Figure 4-8. Signal cable: screened 8-wire, MKFR 8 x 0.5 mm^2

NOTE

The permitted max. length of the cable between the electronics unit and the search coil is 100 m.

4.7.2 Connecting the signal cable to the connection box

1. Insert the cable through the cable entry in the connection box on the search coil.
2. Connect the cable to the divided terminal block X8 according to Figure 4-9 and Table 4-3. **Keep the wires in the connection box as short as possible.**

NOTE

The order of the wires is very important. Pay attention to the numbers if the cable used has other colors.

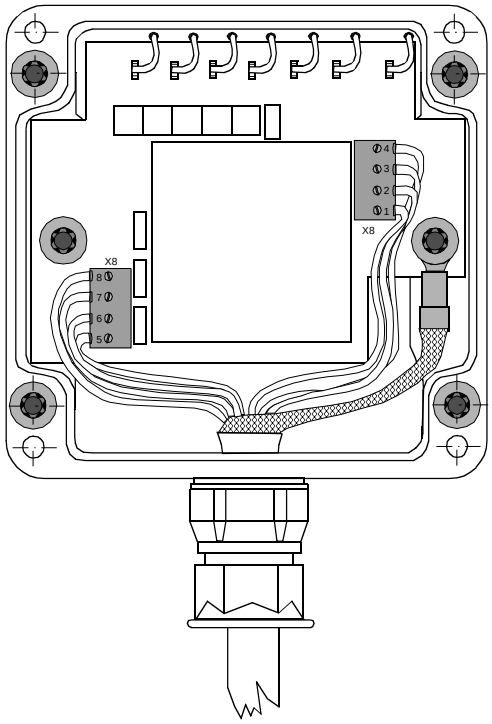


Figure 4-9. Connecting the signal cable in the connection box on the search coil

Table 4-3. Connecting the signal cable in the connection box, terminal X8

Terminal No.	Function	Wire color	(Wire No. in the cable)
X8:1	SUPPLY 1	Red	(4)
X8:2	SUPPLY 1	Blue	(5)
X8:3	SUPPLY 2	Green	(6)
X8:4	SUPPLY 2	Violet	(3)
X8:5	+15V	Brown	(2)
X8:6	SIGNAL	White	(8)
X8:7	-15V	Yellow	(7)
X8:8	0V	Black	(1)
Screen connection	Screen	Screen	Screen

4.7.3 Connecting the signal cable in the electronics unit

1. Connect the signal cable to screw terminal X4 on the supply and power amplifier board (QSDM 111B2) at the bottom of the cabinet. The wire colors and numbers are the same as for the connection in the connection box on the search coil. **Keep the wires as short as possible.**
2. Connect the cable screen to the earth screw on the mounting plate.

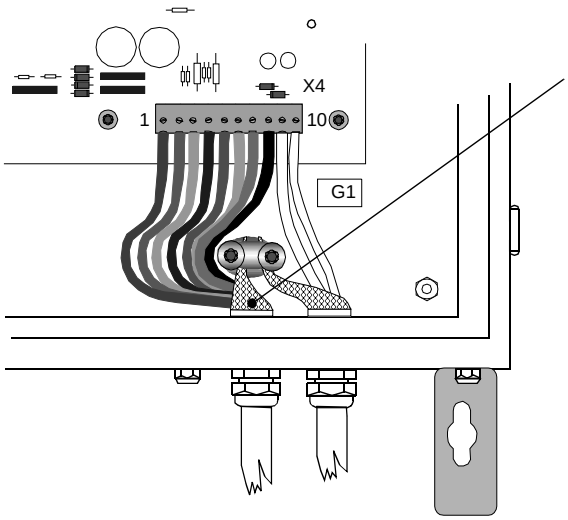


Figure 4-10. Connecting the signal cable in the electronics unit

Table 4-4. Connecting the signal cable in the electronics unit, terminal X4

Terminal No.	Function	Wire color	(Wire No. in the cable)
X4:1	SUPPLY 1	Red	(4)
X4:2	SUPPLY 1	Blue	(5)
X4:3	SUPPLY 2	Green	(6)
X4:4	SUPPLY 2	Violet	(3)
X4:5	+15V	Brown	(2)
X4:6	SIGNAL	White	(8)
X4:7	-15V	Yellow	(7)
X4:8	0V	Black	(1)
X4:9 (1)	0V	-	-
X4:10 (1)	RESET	-	-
Screen connection	Screen	Screen	Screen

(1) Terminal X4:9 and X4:10 are used for the reset function, see Section 4.7.4 Connecting a RESET-button to the electronics unit.

4.7.4 Connecting a RESET-button to the electronics unit

A manual reset function can be used if a spring-loaded closing switch is connected between terminals X4:10 and X4:9. Use screened cable.

If the manual reset function is not to be used, connect X4:10 and X4:9 permanently. This provides automatic reset, which results in metal detection providing a short pulse on the relay output.

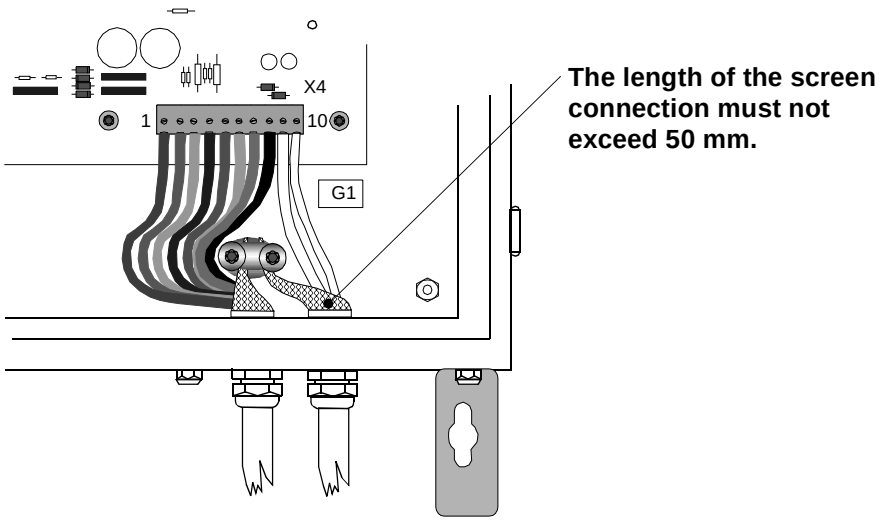


Figure 4-11. Connecting a reset signal in the electronics unit

The max. permitted cable length between the electronics unit and the RESET-button is 25 m. An intermediate relay can be used if a longer cable is required.

4.7.5 Connecting the indicating circuit

Connecting the alarm outputs is made on the supply and power amplifier board (QSDM 111B2), on terminals X2 and X3 (located at the bottom of the electronics unit).

The outputs can be connected to a superior system, external alarm device (siren, flashing light), scraper device, emergency stop, etc.

The alarm outputs X2 and X3 are identical.

Alarm output X2 gives a signal at the signal level set using SENSITIVITY.

Alarm output X3 gives a signal at the signal level set with the parameter SH.

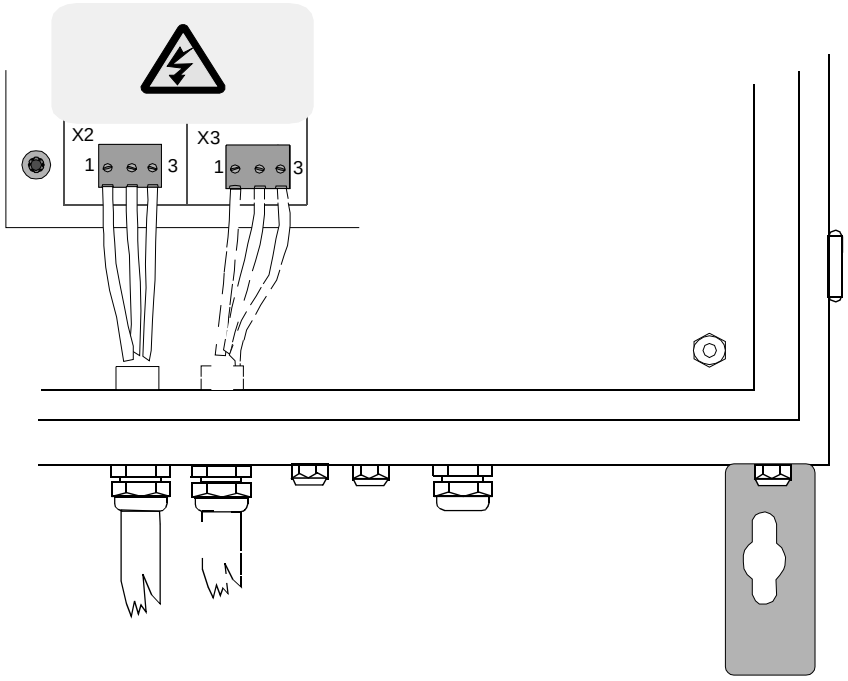


Figure 4-12. Connecting alarm outputs in the electronics unit

The relays are activated during normal operation, i.e. fail-safe operation.

An alarm or malfunction deactivates the relay and the contact switches over. This also happens in the event of a relay fault or when the metal detector is switched off.

The make-and-break contact on the output relays is fitted with varistors 70 J (2 ms), 250 V, as a contact protector.

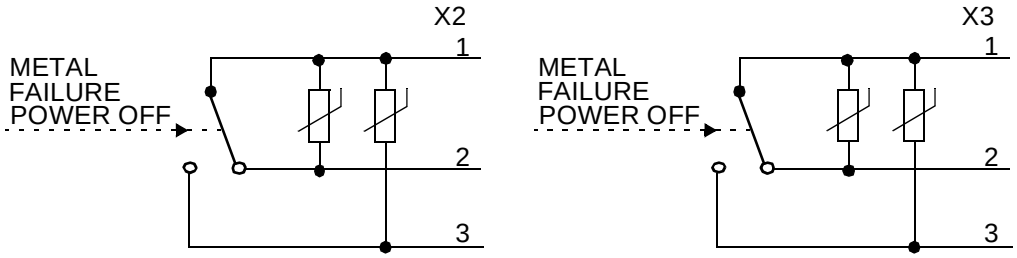


Figure 4-13. The contacts of the output relays with contact protection

To achieve the best indication, detect metal on the rising edge of the alarm signal. The length of the alarm signal depends on the size of the detected object. If a large object is detected, the alarm signal may be extended, see Section 5.6.6 Setting the alarm signal (AS).

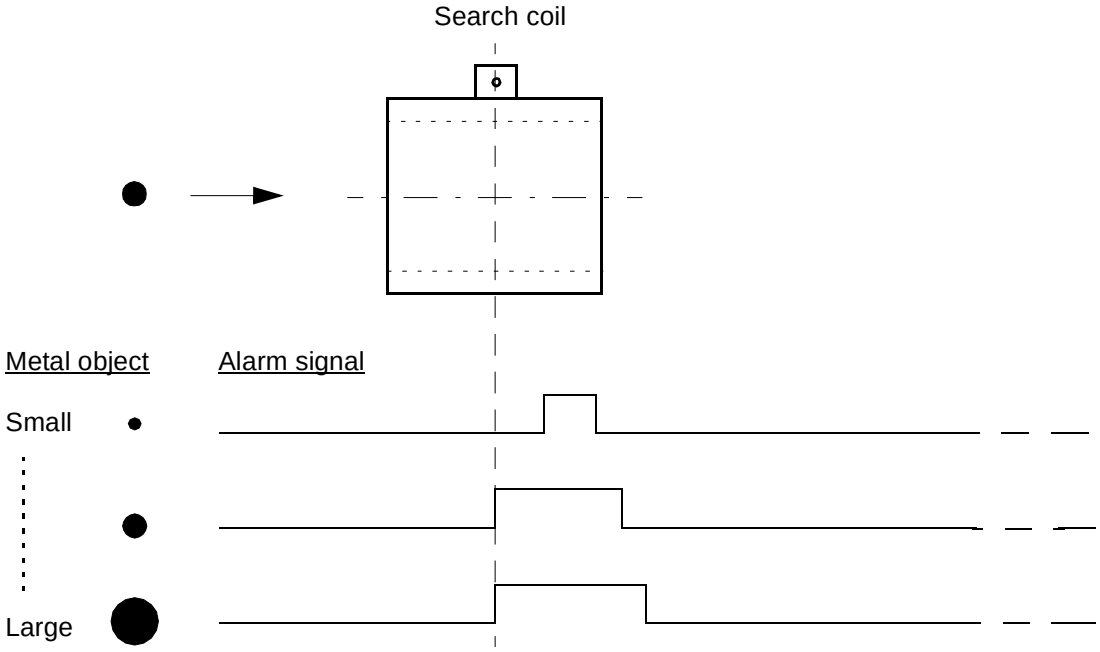


Figure 4-14. The length of the alarm signal for different sizes of detected metal objects

4.7.6 Connecting the mains supply

1. Connect the mains supply to terminal X1 in the electronics unit.
2. Connect the protective earth cable to the earth clamp on the mounting plate.

NOTE

The protective earth cable must be mounted with slack (see Figure 4-15).

3. Set the mains voltage on the terminal group on the transformer. Voltage ranges and a connection table are provided on a label on the transformer.

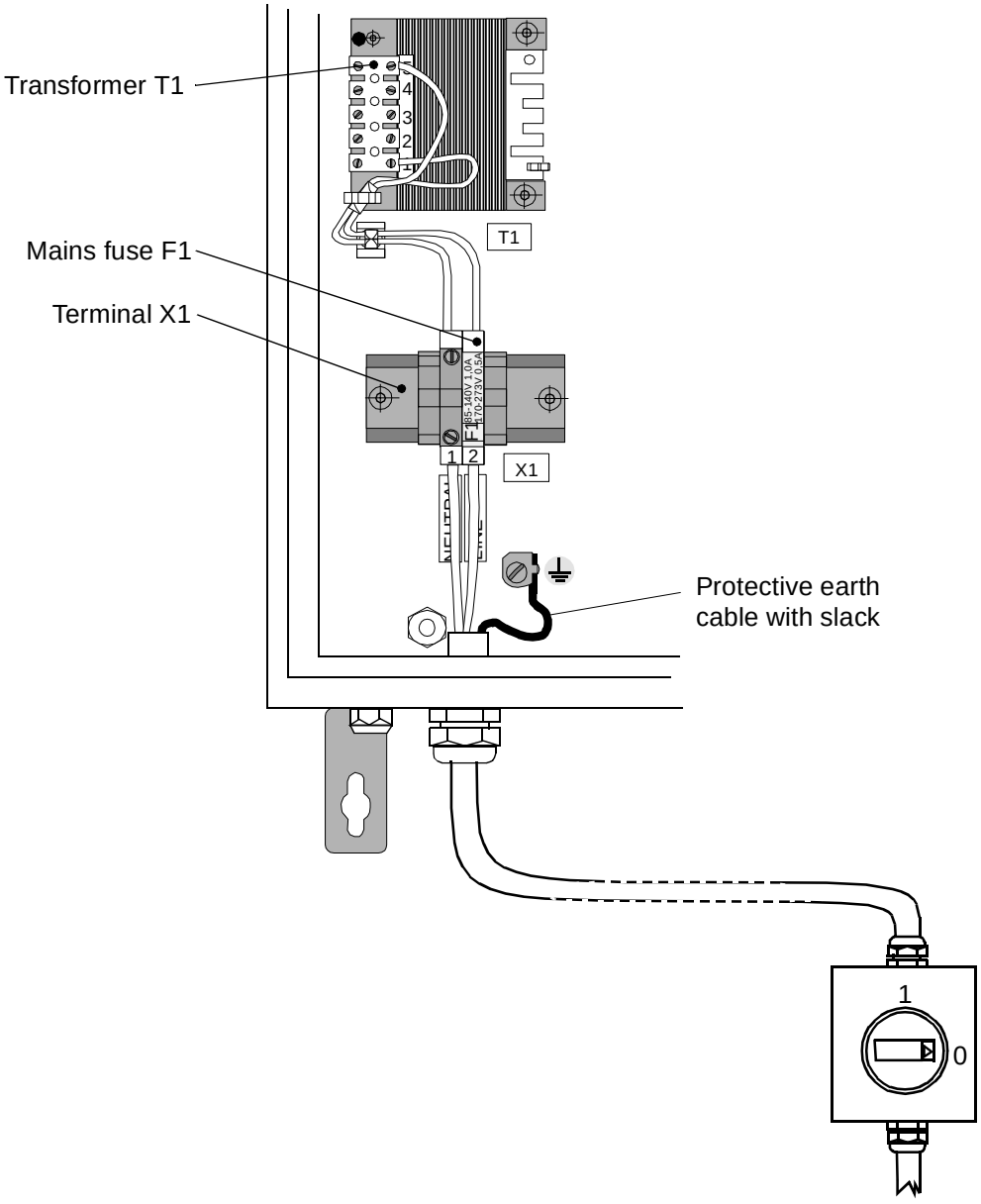


Figure 4-15. Connecting the mains supply

Chapter 5 Commissioning

5.1 General

To achieve the best possible function, follow the instructions in this chapter carefully.

These instructions assume that the metal detector has been installed according to Chapter 4 Installation.

5.2 Necessary equipment

The following equipment is necessary during commissioning:

- This User´s Guide
- A test object

5.2.1 Test object

The test object must have the same size and shape as the smallest object to be detected. For simple adjustment, the width, height and length of the object should be the same, i.e. a cube, ball or short cylinder. An oblong or flat object generates a signal depending on the angle of the object, which makes it harder to adjust the sensitivity.

When a certain type of object is expected, e.g. nails, this should also be used for test. In this case, the angle of the object must be considered (see Section 5.7 Adjusting the sensitivity setting for alarm output X2).

If stainless steel is to be detected, the test object must also be made of stainless steel. This material, due to less electric and magnetic conductivity**,** generates smaller signals than other metals.

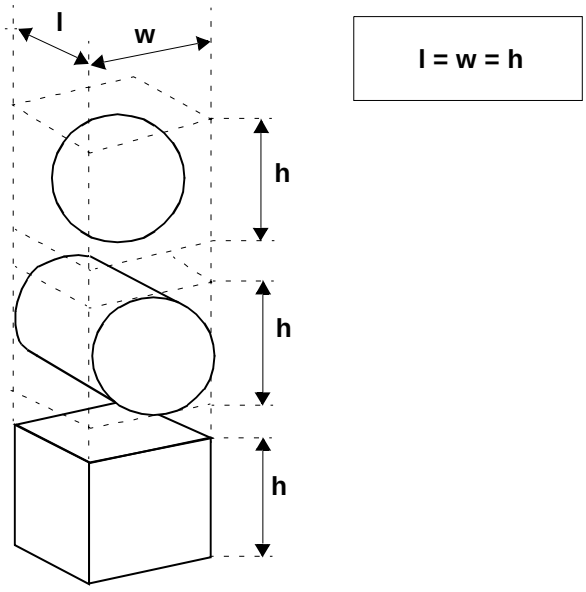


Figure 5-1. Recommended dimensions for the test object

5.3 Actions before the mains supply is switched on

Before the mains supply is switched on, check that:

- the electronics unit has not been damaged during transportation. Also check that all cables are properly installed.
- the signal cable is properly connected in the connection box on the search coil and in the electronics unit.
- the mains supply is properly connected.

5.4 Switching on the mains supply

The mains supply is connected when the fuse F1 is inserted in terminal X1. No fuse is inserted in the fuseholder at delivery. Select the type of fuse according to the mains voltage.

Table 5-1. Fuse selection for the metal detector

Mains voltage	Fuse
200 - 250 V AC	0.5 A
100 - 127 V AC	1 A

When the mains supply is connected, ON and FAILURE light up on the panel. After approx. 10 seconds FAILURE goes off and the indicators show the sensitivity and maximum travel speed settings.

When the mains is switched on, metal alarm is normally given until the metal detector has stabilized.

5.5 Automatic adjustment of the work point

After the mains has been switched on, it takes about 30 seconds before the metal detector has stabilized. After that full sensitivity is achieved.

5.6 Setting parameters

Before the metal detector is taken into normal operation, a number of parameters have to be set from the panel on the electronics unit. The parameters and their default settings are shown in Table 5-2. They are given in the same order as they appear when setting parameters (see Chapter 3 for information on how to set parameters).

If alternative “open signal processing” is selected (SE = 00), additional parameters will appear. It is normally not necessary to change these.

Table 5-2. Accessible parameters with their default settings

Indication on SENSITIVITY	Parameter	Explanation	Default value	Actual value (1)
on	EXCITATION ON	00 = No current fed to transmitter coil. 01 = Current fed to transmitter coil.	01	
Sn	SENSITIVITY	Set sensitivity.	70	
SP	MAX SPEED	Max. travel speed (m/s).	1.0	
CS	COIL SIZE	Inside diameter of the search coil (m).	1.0	
CL	CABLE LENGTH	Cable length between the electronics unit and the search coil (m).	25	
AS	ALARM SIGNALING	Max. number of metal pulses after a metal indication.	01	
SH	SENSITIVITY H	Set sensitivity for X3.	70	
SE	SIGNAL EVALUATION	The signal processing method used in the metal detector (readable only).	01	
dE	DEFAULT SIGNAL EVALUATION	Setting the signal processing method to be used after next start with change of signal processing method.	01	

(1) Use the table to note the actual values.

5.6.1 Supplying the transmitter winding in the search coil (on)

Parameter **on** is used to control the supply to the transmitter winding in the search coil.

The parameter is pre-set to 01, i.e. the search coil is supplied.

When the search coil supply is off (on = 00), the set sensitivity (SENSITIVITY) is flashing.

5.6.2 Default setting of the sensitivity for alarm output X2 (Sn)

Parameter **Sn** is used for setting the sensitivity in the detector.

Default value is 70.

5.6.3 Default setting of the max. travel speed (SP)

Parameter **SP** depends on the highest speed of the material to be transported through the search coil.

The value is given in meters per second (m/s).

5.6.4 Setting coil size (CS)

Parameter **CS** is determined by the length of the search coil. The length is normally the same as the inside diameter of the coil.

The value is given in meters (m).

5.6.5 Setting installed cable length (CL)

Parameter **CL** is determined by the cable length between the electronics unit and the search coil.

The value is given in meters (m).

5.6.6 Setting the alarm signal (AS)

Parameter **AS** determines the max. number of pulses at the alarm outputs when metal is detected.

Normal setting is AS=01, which gives one pulse per object at the alarm outputs. An external control system which receives this signal should interpret it as metal present during the complete pulse length.

Certain control systems can only act on the rising or falling edge of the alarm signal. This means that the control system may overlook a second object following a large metal object. In such cases, AS can be set between AS=02 to AS=10, which gives a maximum of 2 to 10 pulses. The last pulse may be longer than the leading pulses.

Setting AS=00 gives pulses continuously during the whole metal indication.

Depending on the setting of AS and the size of the detected object, the alarm signal can have different shapes (see Figure 5-2).

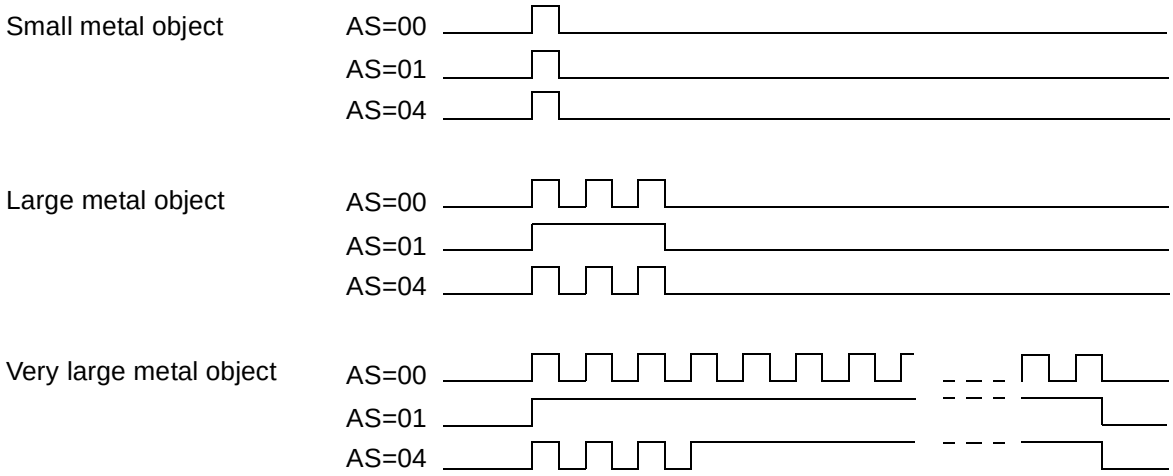


Figure 5-2. Shape of the alarm signal at different settings of AS (example)

5.6.7 Setting of sensitivity for alarm output X3 (SH)

1. Find out a suitable setting, 00 - 99, by using some test objects and by adjusting SENSITIVITY (see section 5.7).
2. Go to setting parameters (see section 3.5.2).
3. Step forward to parameter **SH**.
4. Adjust (+/-) parameter **SH** to desired value, i.e. the same value as for SENSITIVITY (parameter Sn).

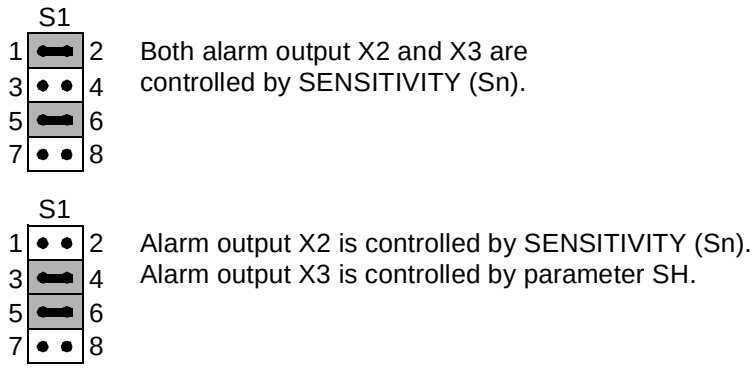


Figure 5-3. Strapping S1 on circuit board QSDM 111B2

5.6.8 Method used for signal processing (SE)

Parameter **SE** shows the signal processing method, used for evaluation of the search coil signal.

Normal value of the parameter is SE = 01.

5.6.9 Setting method for signal processing (dE)

Parameter **dE** determines the method for signal processing used after restarting the metal detector. The parameter settings is default dE = 01, and is normally not to be changed.

Change of signal processing method is described in Appendix A Changing signal processing method.

5.7 Adjusting the sensitivity setting for alarm output X2

The level indicator (LEVEL) has the same scale factor as the setting for sensitivity (SENSITIVITY). This means that the desired change of sensitivity can be read at LEVEL. For example, if the signal from the test object reaches LEVEL -20, SENSITIVITY should be increased by 20, so that LEVEL indicates 0.

The setting of the sensitivity determines the smallest detectable object. The higher the setting of SENSITIVITY, the smaller objects that can be detected. The highest setting of sensitivity is normally not possible to use in industrial environment, since different types of interference are always present.

The sensitivity setting value is determined by two factors:

- The smallest size of metal object to be detected.
- Limitations in the actual installation to maintain reliable function.

The test object should be moving through the search coil at the usual speed of the conveyor.

Oblong objects, such as nails, generate different signals, depending on how they are oriented relative to the coil. Worst case (i.e. smallest signal) is obtained when the nail is positioned at right angles to the axis of the search coil and the direction of transportation. If it is necessary to test with oblong objects, a number of different positions should be tested. If possible, the setting should be made for the position that results in the smallest signal. The setting will be simplified if the test is performed with a ball or similar object, (see Section 5.2.1 Test object).

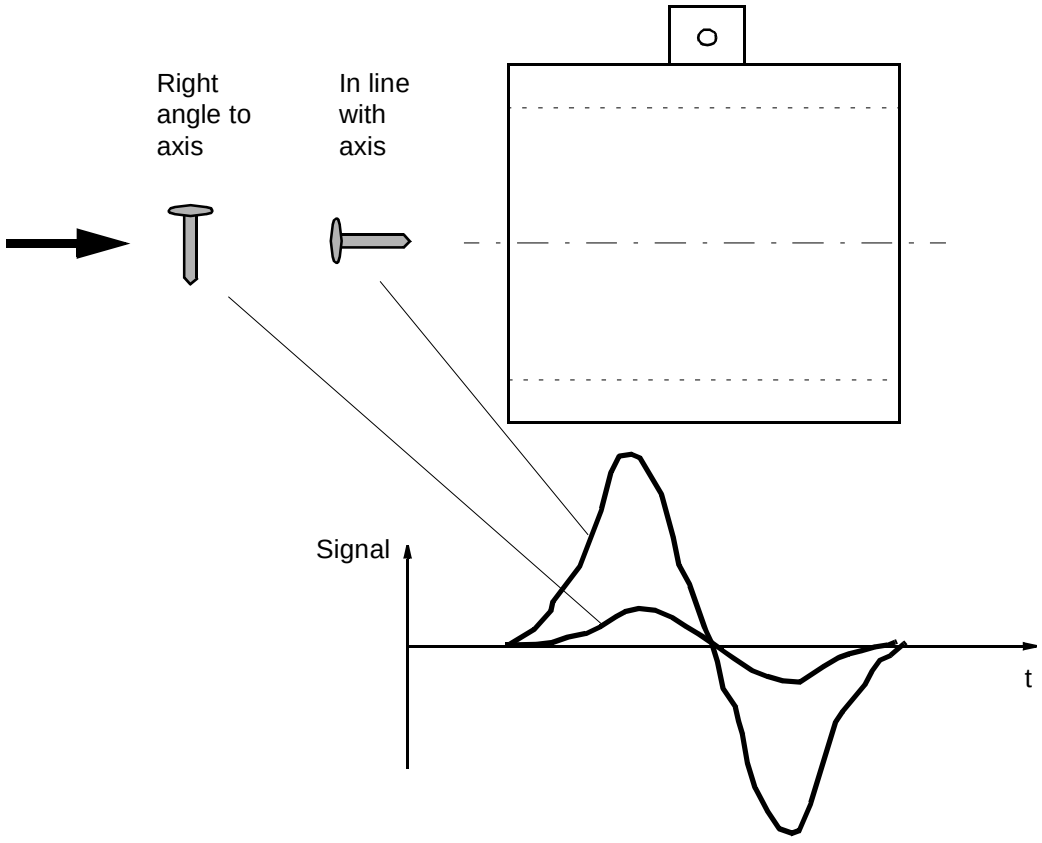


Figure 5-4. Dependence of angle for test objects

Chapter 6 Operation

6.1 General

After commissioning, the metal detector detects the presence of metal continuously without any operator involvement.

6.2 Safety

6.2.1 Personnel safety

DANGER

Individuals fitted with a heart pacemaker must not pass through the search coil.

DANGER

Work with great care when mains supply voltage is applied to the equipment. The mains supply voltage in the equipment can cause injury and even be lethal.

The following must be observed:

- All personnel working with and close by the measuring system must know the location of the mains power supply switch of the measuring system and how it is operated.
- Only use approved hoisting equipment when lifting the search coil.
- Process technicians must be present when testing and operating process objects.
- Remember that the conveyor can be controlled from another source.
- Only qualified service and maintenance personnel are allowed to work in the electronics unit.

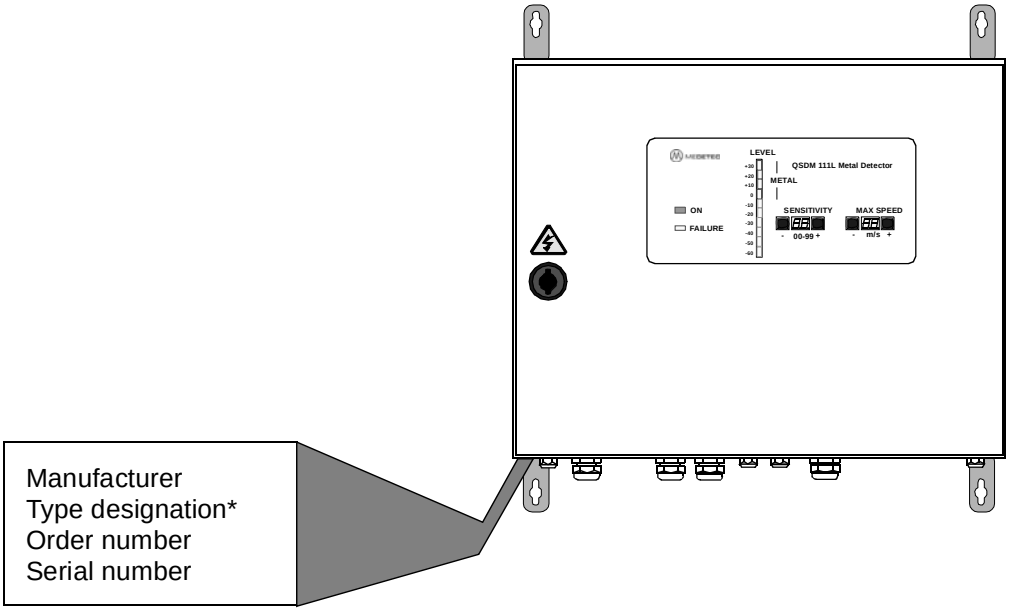
6.2.2 Equipment safety

Observe the following safety rules:

- Avoid discharge of static electricity by earthing both yourself and your tools before handling circuit boards and other parts of the equipment.
- **Handle the circuit boards carefully.** Note the warning label on the circuit boards.
- Use an earthed wristband when handling circuit boards. This gives optimum protection against static electricity discharges.
- When not installed in the equipment, always store circuit boards in envelopes of conductive plastic.
- **Always switch off the mains supply voltage to the measuring system before a unit is replaced.**
- Switch off the mains supply voltage to the measuring system and disconnect the cabling from the terminals before electrical welding is performed near the measuring system.

6.3 Marking

6.3.1 Electronics unit



* The type designation is QSDM 111LX
if the electronics unit has been upgraded
from QSDM 111K.

Figure 6-1. Marking of the electronics unit

6.3.2 Search coil

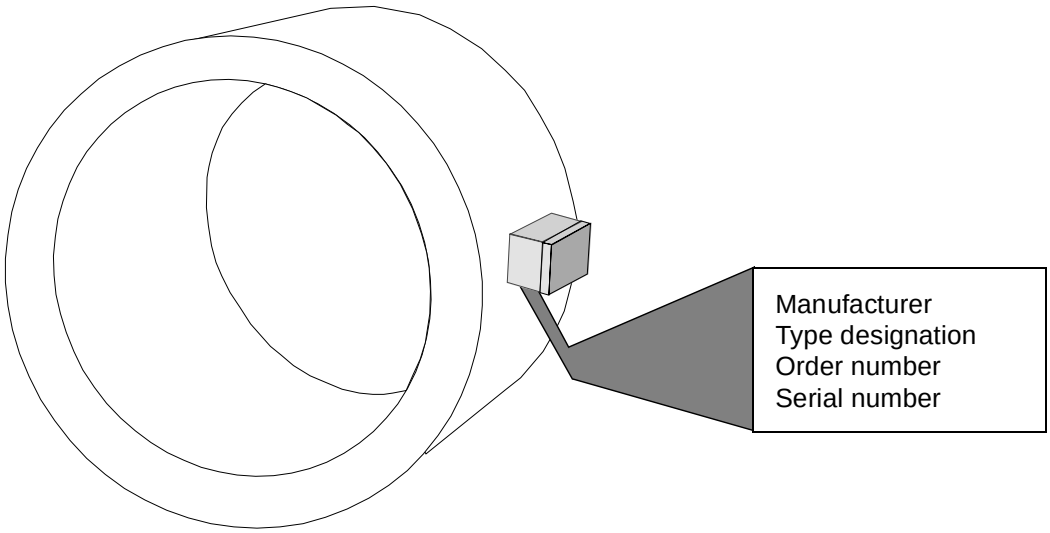


Figure 6-2. Marking of the search coil

6.4 Starting the metal detector

The metal detector can be started in three different ways:

- Normal start
- Start with change of signal processing method (see Appendix A)
- Start with default values (see Appendix A)

6.4.1 Normal start

Start the metal detector by switching on the mains supply voltage.

The metal detector is then ready to detect metal without any action from the operator.

NOTE

After the mains has been switched on, it takes about 30 seconds before the metal detector has stabilized.

When the mains is switched on, it is normal that a metal alarm is given before the metal detector stabilizes.

6.5 Metal alarm (METAL)

When detecting metal, either a break pulse or a continuous contact break is generated at the outputs of the alarm relays.

Automatic reset

If a break pulse is selected (X4:10 and X4:9 strapped), the metal alarm resets automatically after the metal object no longer affects the metal detector.

Manual reset

If manual reset is selected, the relay outputs are reset by pressing the RESET-button. (If the search coil is large and the setting of MAX SPEED is low, it is necessary to press the button for a few seconds.)

Chapter 7 Maintenance

7.1 General

Since the metal detector QSDM 111 is often installed in a harsh industrial environment, it is very important to check the equipment regularly.

7.2 Search coil

A search coil free from vibrations and with good screening against electromagnetic interference will improve the sensitivity of the metal detector.

Therefore:

- Verify that the search coil is still securely attached to its support
  (the tie around the search coil should be loosely tensioned).
- Remove rubbish resting on or in the search coil. Otherwise there is a risk that the rubbish will transmit vibrations from the conveyor to the coil.
- Check that no objects, such as stones, bark, ice, snow, etc., are present between the conveyor and the search coil.
- Check that the search coil is not mechanically damaged. Any damage should repaired as soon as possible with epoxy adhesive or similar.

7.3 Electronics unit

- Wipe clean the electronics unit before opening it to avoid rubbish and dirt entering.
- Clean the window with a soft cloth.

NOTE

Do not use a strong solvent!

- No other maintenance is normally required.

7.4 Spare parts

Table 7-1. Spare parts

Spare part	Reference	Old order number (ABB)	Order number (Medetec)
Electronics unit	QSDM 111L	3BSE021017R0001	M111L
Supply and power amplifier board	QSDM 111B2	3BSE021016R0001	M111L 2
Signal processing board	QSDM 111P2	3BSE021289R0001	M111L 48
Signal amplifier on search coil	QSDM 111R	3BSE009095R0001	M111R 1
Signal cable with screen (state the length)	MKFR 8 x 0.5 mm^2	1683 0013-2	M111L 97
Transformer	T1	3BSC730077R0001	M111L 7
Fuse 200 - 250 V AC	0.5 A, 5 x 20 mm	3BSC770001R0041	M111L 76
Fuse 100 - 127 V AC	1 A, 5 x 20 mm	3BSC770001R0044	M111L 77

Chapter 8 Fault-tracing

8.1 General

It is essential to be thoroughly familiar with the function and operation of the metal detector, as described in this User´s Guide, before starting any fault-tracing.

If a fault is located to a circuit board, the circuit board must be replaced.

The most common causes of faults in metal detectors are to be found close to the search coil. Faults in the electronics unit are unusual. Here is a list of faults in order of frequency.

1. Vibrations transmitted to the search coil.
2. Poor contact between metal parts close to the search coil.
3. Metal parts moving close to the search coil.
4. Electromagnetic interference.
5. Mechanical damage to the search coil or the signal cable.
6. Electrical faults.

8.2 Vibrations transmitted to the search coil

Vibrations cause small changes in the shape of the search coil, and this may lead to false detections.

The search coil must be firmly mounted to avoid transfer of vibrations from the conveyor.

The material on the conveyor must not touch the search coil.

Vibrations can also be transmitted to the search coil if objects such as bark, stones, soil, snow, ice, etc. accumulate between the search coil and the conveyor. Regular inspections are recommended. Clean if necessary.

Interference from vibrations can be suppressed by appropriate setting of MAX SPEED.

8.3 Poor contact between metal parts close to the search coil

Poor contact between metal parts is a common cause of interference. See Section 4.5 Poor contact between metal parts.

8.4 Metal objects moving close to the search coil

If interference from a large moving metal object close to the search coil is suspected:

- First check that the interference is not due to poor contact.
- Reduce the influence of the metal object on the search coil by screening.
  - Weld a plate into position between the moving metal object and the search coil, as far away from the search coil as possible.

8.5 Electromagnetic interference

Although the search coil is screened, it acts as a receiving aerial (antenna) for electromagnetic interference. The larger the coil, the more sensitive it is to such interference.

The electronics unit has several filtering functions for suppressing interference. However, complete suppression of interference cannot be achieved.

The most common source of interference is power cables close to the search coil. The interference often originates from thyristor-controlled equipment, which induces high frequency currents and voltages to the mains. Note that the mains may transmit such interference within a whole plant. An interferring cable close to the search coil is not necessarily connected to interferring equipment.

As a basic rule, power cables closer than 2-3 m from the search coil should be avoided. A cable positioned at right angles to the direction of the conveyor, generates most interferring signals. If a power cable is interferring, run that part closest to the search coil into a steel conduit. If the problem originates from grounding faults or ground currents, the cable may have to be equipped with a robust earth wire. The wire will then take care of the ground current, that otherwise would run through the mechanical structure.

A motor controlled by a static frequency inverter sends signals with a high and fluctuating frequency. It is important that motors and machines in general are connected with screened cable, in a way that minimizes ground currents.

Lifting magnets use very strong magnetic fields, which may cause interference in the metal detector. The distance between the lifting magnet and the search coil should be at least 2 m.

Thunderstorms may interfere with the metal detector during lightning discharge.

Electric welding close to the search coil (0-20 m) can cause false alarms. The welding cables should be kept together and the earth clamp connected close to the welding spot in order to minimise this problem.

8.5.1 Searching for an electromagnetic interference source

To make the metal detector sensitive to electromagnetic interference only, switch off the power supply for the transmitter winding of the search coil. This is done as follows:

- Go to the parameter setting.
- Set the parameter **on** to **00**.

With SENSITIVITY (parameter **Sn**) the highest sensitivity setting is searched, which can be used without a false alarm being generated. To achieve a good interference margin, the setting chosen should be at least 10 units higher than the sensitivity required to reliably detect the smallest metal object.

After the test, switch on the power supply to the transmitter winding in the search coil. This is done as follows:

- Go to the parameter setting.
- Set the parameter **on** to **01**.

8.6 Mechanical damage to the search coil or the signal cable

Minor damage to the search coil can be repaired with epoxy adhesive and glass-fiber matting.

Accidental contact between metal structures and the screen of the signal cable must be avoided. Pay special attention to sharp edges and places where the cable has moved as a result of vibrations. Repair damage with insulating tape and secure the cable.

8.7 Electrical faults

8.7.1 The FAILURE LED is lit

The FAILURE LED is lit whenever the built-in fault indication system detects a fault. The alarm output also indicates a fault. As long as the fault remains, the alarm output cannot be reset.

Detected faults are also shown with an error code, see Section 8.10 Error codes.

The FAILURE LED is also lit when the mains supply to the metal detector is first switched on. The LED goes off when the metal detector is initiated, after which the indicators will show sensitivity and max. travel speed or an error code.

8.7.2 The ON LED is not lit

Possible causes:

- No power supply at terminal X1.
- Fuse F1 is blown (X1:F1; 0.5 A for 200 - 250 V or 1 A for 100 - 127 V).
- Fault in the transformer, cables or circuit boards in the electronics unit.

8.8 False alarm

Spurious metal alarms are often caused by conditions in the immediate surroundings of the search coil. Electrical faults are generally rare.

The LEVEL indicator can be used to trace interference. To obtain good performance, interference should be sufficiently low not to affect the uppermost green LED.

Investigate if the LEVEL signal coincides with mechanical stress and movements close to the search coil.

8.8.1 Connecting instruments for fault indication

An analogue recorder or an oscilloscope can be connected to the metal detector.

Connect the signal input of the instrument to the test outlet BAR and connect the signal earth to 0V.

The signal at the test outlet is the same as shown on the LEVEL indicator. The level 0 V corresponds to the level for metal alarm. The signal is adjusted so that 1 V corresponds to 10 units on the LEVEL indicator (and SENSITIVITY), which corresponds to a signal level change of 1.58 times.

The test signals IM and RE are the signal's imaginary and real parts (magnetic and resistive parts).

8.8.2 Identifying the reason for false alarm

Allow the smallest metal object that is to be detected to pass through the search coil at normal speed and at the least sensitive place, i.e. in the center of the search coil. The instrument (and LEVEL, which is logarithmic) will then show the signal from that object.

NOTE

The signal from the test object must always be greater than any interference.

Allow the conveyor to:

- stand still,
- run without load,
- run with normal load,
- etc.

Start a successively larger part of the plant and note when the interference becomes greater than the signal from the test object. This is a relatively fast way of locating a source of interference.

8.8.3 Actions when a source of interference is found

Eliminate any source of interference you find.

NOTE

It is important to eliminate any found source of interference, before the fault-tracing is continued. Usually, many sources of interference influence the performance and a smaller source may be hidden behind one just identified.

Continue the fault-tracing in the same way until all sources of interference have been eliminated.

If interference is encountered whenever the conveyor is standing still, the source is probably an external magnetic field, such as from power cables or ground currents.

A common source of interference is poor contact between metal parts close to the search coil. Poor contact can be detected by pulling different metal parts close to the coil while at the same time observing the instrument. Act according to Section 4.5 Poor contact between metal parts.

8.9 Loss of metal alarm

If a metal alarm is not signalled, the settings of MAX SPEED or SENSITIVITY are too low.

Check that the external control system reads the metal signal in an appropriate way. The parameter AS may be set incorrectly. The metal detector indicates metal continuously as long as there is metal present in the search coil. If more than one object are close together, this may result in only one long metal indication.

Check that the transmitter winding in the search coil is supplied with current (on = 01). If the transmitter winding is not supplied (on = 00), SENSITIVITY flashes.

8.10 Error codes

An error code is shown automatically if there is an unacknowledged fault in the metal detector. If the fault is temporary, the metal detector will operate normally again when the fault ceases. The error code will be displayed until it is acknowledged. If an error occurs SENSITIVITY shows **Er** (Error) and MAX SPEED shows the error code number. The error codes are listed in Table 8-1, together with recommendations.

An error code is acknowledge by pushing MAX SPEED + or MAX SPEED –. If there is more unacknowledged faults, the next error code will be shown. When all the faults have been acknowledged MAX SPEED shows "--" for a short time. Then the first remaining fault is shown again. When there are no remaining faults SENSITIVITY and MAX SPEED will be shown at the indicators.

Table 8-1. Error codes

Error code	Designation	Measure
Er 01	Fault in the program memory of the electronics unit (FLASH)	Replace the circuit board QSDM 111P2.
Er 02	Fault in the parameter memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 03	Fault in the read and write memory of the electronics unit (RWM)	If the fault is frequent, replace the circuit board QSDM 111P2.
Er 04	0V-measuring is faulty in the electronics unit	Replace the circuit board QSDM 111P2.
Er 05	Unbalance voltage from the search coil is too high	Check that the search coil is not damaged. Also check that no foreign metal object is inside the search coil.
Er 06	+5V to the filter is faulty in the electronics unit	Replace the circuit board QSDM 111P2.
Er 07	-5V to the filter is faulty in the electronics unit	Replace the circuit board QSDM 111P2.
Er 08	+12V to the A/D-converter is faulty in the electronics unit	Replace the circuit board QSDM 111P2.
Er 09	-12V to the A/D-converter is faulty in the electronics unit	Replace the circuit board QSDM 111P2.
Er 10	The supply to the transmitter winding of the search coil is faulty (also caused by Er 16 and Er 17)	Check if the signal cable to the search coil is damaged. If not, replace the circuit board QSDM 111B2.
Er 11	+30V-supply is faulty in the electronics unit	Replace the circuit board QSDM 111B2.
Er 12	+25V-supply is faulty in the electronics unit	Replace the circuit board QSDM 111B2.
Er 13	+15V-supply is faulty in the electronics unit	Replace the circuit board QSDM 111B2.
Er 14	-15V-supply is faulty in the electronics unit	Replace the circuit board QSDM 111B2.
Er 15	+5V-supply is faulty in the electronics unit	Replace the circuit board QSDM 111B2.

Table 8-1. Error codes

Error code	Designation	Measure
Er 16	The current limit is exceeded for the supply to the signal amplifier at the search coil	Check if the signal cable to the search coil is damaged. If not, replace the preamplifier board QSDM 111R at the search coil.
Er 17	The current limit is exceeded for the power amplifier to the search coil	Check if the signal cable to the search coil is damaged. Check the search coil. Replace the circuit board QSDM 111B2.
Er 18	A parameter has been changed due to a new setting of another parameter	If COIL SIZE is changed, the setting of MAX SPEED may be outside the allowed limits. This error code indicates that MAX SPEED has been adjusted to fall inside the new allowed limits.
Er 19	Fault has occurred during start of the memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 20	Fault when reading in the program memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 21	Fault when erasing in the program memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 22	Fault when writing to the program memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 23	Fault when reading in the parameter memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 24	Fault when writing to the parameter memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 25	Fault when re-reading in the parameter memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 26	Fault when erasing in the parameter memory of the electronics unit (FLASH)	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 27	The memory of the electronics unit (FLASH) has been used incorrectly	Restart with default settings. Replace the circuit board QSDM 111P2 if the fault persists.
Er 28	The microprocessor in the electronics unit has been overloaded	Acknowledge the fault. If it persists or reoccurs, contact MeDetec.
Er 29	Internal fault in the program	Acknowledge the fault. If it persists or reoccurs, contact MeDetec.
Er 30	Insufficient compensation	Faulty search coil or improper search coil installation
Er 31	Unstable compensation	Faulty search coil or improper search coil installation

Appendix A Changing signal processing method

A.1 General

This appendix describes the different methods for signal processing and how to change between them.

A.2 Parameters for displaying and changing between signal proc. methods

The actual signal processing method can be read and changed from the panel unit. General information on how to read and change parameters is given in Section 3.5 Indirect panel functions.

A.2.1 Displaying signal processing method (SE)

This parameter shows the method for signal processing used to evaluate the signal from the search coil. The signal processing method can only be changed in connection with a restart of the metal detector. The change is not made directly in this parameter, but through the parameter dE.

A.2.2 Setting signal processing method (dE)

This parameter decides which signal processing method is to be used if the metal detector is started in such way that a change is performed (see Section A.4.2 Start with change of signal processing method).

A.3 Signal processing methods

The metal detector has three predefined methods for signal processing suitable for different applications. Furthermore, there is an open alternative of signal processing, where all the parameters in the signal processing can be changed freely.

Table A-1. Predefined alternatives of signal processing

Alternative of signal processing	Parameter value (SE and dE)
Open signal processing	00
Default setting	01
Magnetic mode	02
Resistive mode	03

A.3.1 Default setting

The metal detector is delivered with the default setting. It is suitable for most applications.

The default setting detects both the magnetic part (the imaginary part) and the resistive part (the real part) of the received signal. This gives the highest possible signal from a metal object.

NOTE

The default setting assumes that the transported material is not electrically or magnetically conductive.

A.3.2 Magnetic mode

With the method “Magnetic mode”, only the magnetic part of the signal is detected, while the resistive part is suppressed. This is suitable when the transported material is slightly electrically conductive and gives an interference signal if the default setting is used. Aluminum foil can also be suppressed with this setting.

The sensitivity to common steel, copper and aluminum is the same as for the default setting, but lower for stainless steel.

A.3.3 Resistive mode

With the method “Resistive mode”, only the resistive part of the signal is detected. This is suitable when the transported material is magnetically conductive, but is non-metallic. Ore, which contains iron, is an example of such a material.

All metals are detected, but the sensitivity is somewhat lower than at default setting.

A.3.4 Open signal processing

With this method, it is possible to read and freely set all parameters in the signal processing.

NOTE

Correct setting requires a thorough knowledge of signal processing in the metal detector. Therefore, open signal processing must only be used after consultation and instructions from ABB.

A.4 Start and initiation of the metal detector

When the mains supply voltage is switched on, the metal detector can be started in one of three different ways:

- Normal start.
- Start with change of signal processing method.
- Start with default values.

A.4.1 Normal start

At a normal start, the metal detector keeps all the parameter values set before the mains supply was switched off. A normal start does not require any particular actions, except switching on the mains supply voltage.

A.4.2 Start with change of signal processing method

Change the signal processing method by setting the number of the parameter **dE**, DEFAULT SIGNAL EVALUATION, to the desired method (see Table A-1).

Switch off the mains supply voltage.

Change to the new signal processing method by switching on the mains supply voltage and at the same time pushing SET until the metal detector has started, i.e. until the indicators on the panel display numerical values.

All parameter values, which are not directly affected by the change-over, are kept when changing between two signal processing methods.When changing to the open signal processing method, all parameter values are kept from the signal processing method used previously.

A.4.3 Start with default values

In certain situation it can be necessary to start the metal detector with default values according to Table 3-4. This means that preset settings are lost and all parameters must be set again.

Start with default values by simultaneously while switching on the mains supply voltage pushing SET, SENSITIVITY – and MAX SPEED –
until the indicators on the panel display numerical values.

Appendix B Drawings

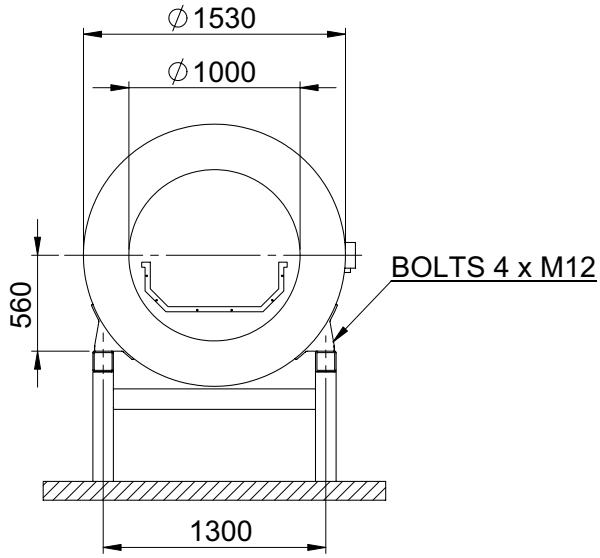
B.1 About this chapter

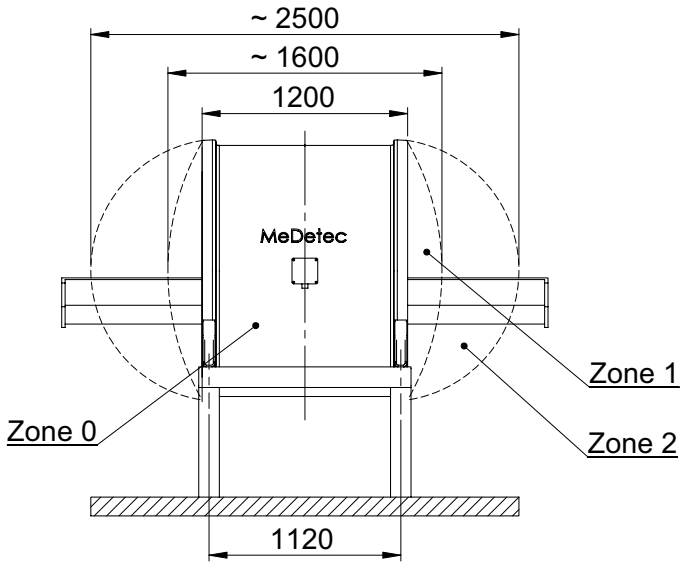
This appendix contains general drawings for the metal detector.

Refer to order documents to see what drawings that apply.

B.2 Installation Drawing, Circular Search Coil, Metal Free Zones

QSDM 112 - Metal Free Zones



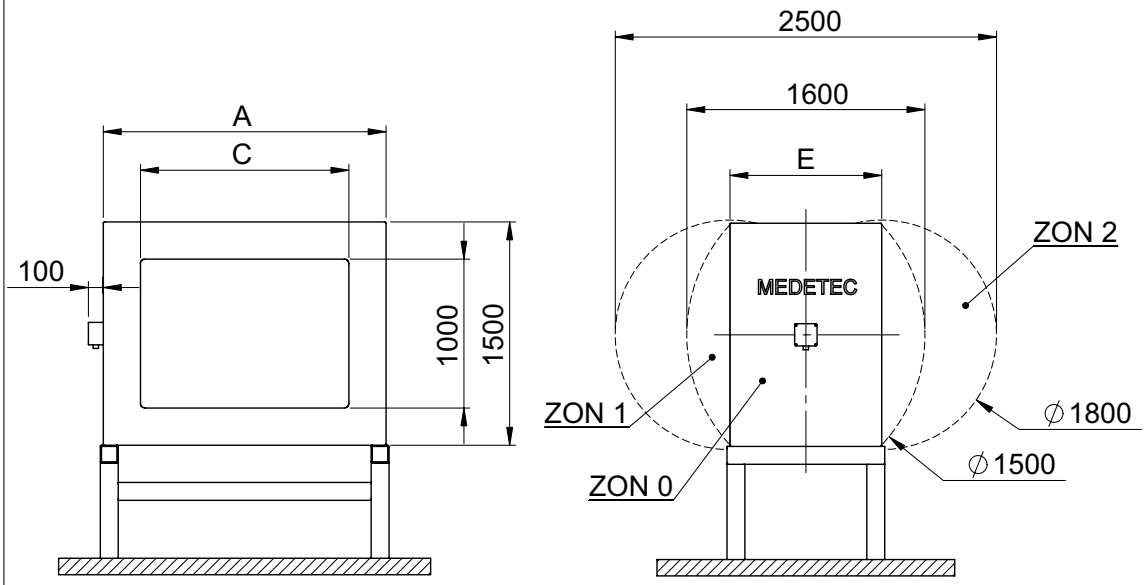


Maximum sensitivity can only be achieved if the following requirements of metal-free zones are considered:

- Zone 0 must be totally metal-free (inside of detector).
- Zone 1 is allowed to contain small non-moving metal objekts.
- Zone 2 is allowed to contain small moving objekts.

B.3 Installation Drawing, Circular Search Coil, Metal Free Zones

QSDM 111 - Metal Free Zones



Modell	A	C
QSDM 111S1010	1500	1000
QSDM 111S1210	1700	1200
QSDM 111S1410	1900	1400
QSDM 111S1610	2100	1600
QSDM 111S1810	2300	1800

Maximum sensitivity can only be achieved if the following requirements of metal-free zones are considered:

- Zone 0 must be totally metal-free (inside of detector).
- Zone 1 is allowed to contain small non-moving metal objekts.
- Zone 2 is allowed to contain small moving objekts.

MeDetec AB
Siktgatan 1
S-162 50 Vällingby
Sweden
Telephone: +46 (0) 8 563 084 74
Telefax: +46 (0) 8 563 084 76
Internet: www.medetec.se

M111LMENG
2006-03