

# MineCat 140 KE Remote Control System



## Operator Manual

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## **WARNING**

**It is of uttermost importance that the operator doesn't start operating the machine only after reading this manual. Additional documentation on machine handling and operation procedures for demining must be properly understood first.**

**Follow the suppliers instructions regarding education and training of machine operators prior to using the machine.**



## Electrostatic discharge protection

The remote control system must only be serviced by trained personnel following the restrictions and guidelines given in the Technical Manuals.

Opening the equipment without having this knowledge may impose additional damage to the equipment and will make warranty void.

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# **1. Introduction**

The intention behind this manual is to provide a description on how to operate the MineCat 140 KE with the remote control system.

The manual gives an overview of the controls on the operator panel and describes the content of the main menu that the operator will need to use during normal operations. It will also describe the meaning of the different alarms and warnings that may be encountered during operations and some suggestions to appropriate actions.

It is however important to notice that this is primarily a description of the operating procedures for the remote control system. Even though there are references to possible causes to the problems and brief descriptions of the relationship with the hydraulic and mechanical systems, these are only intended as “helpful” references and not as accurate descriptions of the machine itself. These details must be found elsewhere in the machine documentation.

## 2. System Description

NRC-1 is a two way remote control system specially designed for use on the MineCat Series demining machines. It gives the operator full control of all functions on the machine as well as gives the operator full access to all necessary information about the status of the machine. All at a maximum distance of more than 1 km, far more than what is necessary for safe control of the machine under real operating conditions.

### General features:

- Operational radio range well above 1 km.
- Rechargeable batteries giving more than 10 hours continuous operation.
- Integrated alarm handling system with high intensity audible alarm.
- Dual level ALARM/WARNING to differentiate critical and non critical situations.
- Menu system giving the operator remote access to all available machine data including system parameters, temperatures, pressures and flailing control setup.
- Control system will automatically shut down engines and sub-functions in case of an alarm situation to prevent the situation from leading to more serious damage.
- Speed stabilizer ensures correct flailing speed under varying soil conditions.
- Coded communication prevents interfering signals from taking control of the machine.
- Automatic stop on all forward movement within 1 second in case of communication loss (interference, jamming or radio failure).
- Automatic shut down of all machine functions after 20 seconds loss of communication.
- Emergency stop buttons on both operator panel and machine gives instant stop of all engines and movement.
- Double watchdog functionality in machine mounted equipment ensures that any single processor failure will bring the machine to an instant stop to avoid uncontrolled behaviour.
- Operating frequency can easily be changed within the 440-450 MHz band only by connecting the operating panel to the machine by the umbilical cable and changing frequency from the menu system. (Radio modules with other frequency bands may be delivered on request)
- All electronics, especially the machine mounted units, are designed to operate under harsh environments with respect to vibration and heat. System will operate from -20°C and up to in excess of +70°C.
- “Dead man button” functionality on operator panel for increased safety.
- 2 x 16 character information displays on operator panel equipped with backlight for use under varying ambient light conditions.
- Optional differential RTK (Real-Time Kinematic) GPS/GLONASS based guidance system which enables the machine to operate automatically and in straight line under poor visibility.

### 3. Operator Panel Unit

The Operator Panel Unit (OPU) is the main tool for the operation of the MineCat 140 KE. The OPU is either carried by the operator in a chest harness, placed on a tripod or fitted in an armoured vehicle or an armoured tower.

It may be used on internal batteries that provides up to 10-12 hours operation or it may be connected to an external supply, such as the supplied 230VAC/13.2VDC charger, or directly to a car battery of 12 or 24VDC (10-30VDC). The panel is internally protected against reverse polarity.

The radio communications uses the  $\frac{1}{4}$  wavelength whip fitted directly on the OPU, or an external antenna connected by cable to the antenna TNC-connector. External antenna should be used if the panel is operated from within an armoured vehicle, a car or in any other location that may act as a shielding for the radio communication. Otherwise, a reduction in operational distance may be the result.

The OPU has a layout as shown on figure 1.

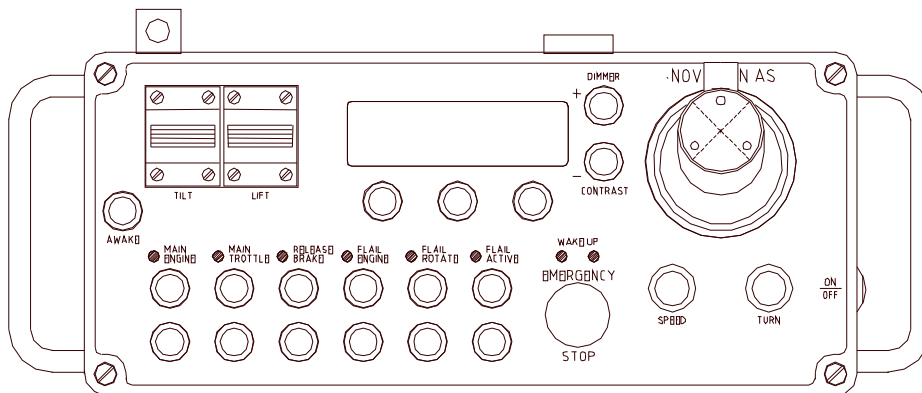


Figure 1: Operator panel front layout

#### Operator Panel Unit characteristics:

- Weatherproof and durable enclosure
- ON/OFF switch protected behind carrying handle
- $\frac{1}{4}$  wave antenna whip with TNC connector
- Connector with dust cap for umbilical cable
- Operator awake button
- Green function start buttons
- Red function stop buttons
- Yellow status LED's to indicate current status
- Emergency stop button for increased safety
- Two-axis hand operated manoeuvring joystick
- Single-axis finger operated handles for flail control

- 2 x16 character alphanumeric LCD display with laminated front glass
- Adjustable LCD backlight for optimal readability under varying conditions
- Function buttons for menu navigation and parameter adjustment
- Separate dimmer and contrast adjust buttons
- Rotary speed control knob
- Rotary turn control knob
- Red and orange high intensity warning LED's for AWAKE timeout
- Chest carrying frame with harness

### 3.1 ON/OFF Switch and external connector

The OPU is switched ON or OFF by pressing the ON/OFF button on the right side. The button is protected against accidental hits by the stainless steel carrying handle. The button also has built in delay to discard short accidental hits. The combined external supply and umbilical connector is located just below the ON/OFF switch and not shown on this figure. This connector must always have the dust cap fitted when not in use to avoid dirt and water getting into the connector.

### 3.2 Automatic switch off

To save power when not in use, the operator panel has a built in power saving feature. If the panel operates on internal batteries and doesn't receive any valid response from the machine within 10 minutes, the panel will issue a short "beep" and switch itself off. This feature will save battery power if the operator switches off the machine main switch, but forget to switch off the operator panel at the same time. In this case, the panel will switch itself off 10 minutes later. When operating on external supply, this feature will not be active as there is no need to save power.

### 3.3 Charging display

If the OPU is in the OFF state while being connected to external power, it will display either

CHARGING	94.7 %	or	FULLY	CHARGED
0.75 A	8.12 V			

During charging, the values below indicates the total battery charging (shown as 0.75 A) and the battery voltage, (shown as 8.12 V).

The value of 94.7% indicates that it is currently charging the batteries and that the battery charge is calculated to 94.7% of full charge, i.e. that the batteries are almost fully charged.

Please note that while being connected to an external supply, the panel will never be completely switched off. In "Off" state with external supply, the internal electronics will be

operational and handle the charging of the batteries and the display will show the charging state as shown above. Radio communication and “operational” functions will however be disabled until switched to “On” state by pressing the ON/OFF button.

### 3.4 Display group

The display group consists of the 2 line by 16 character LCD display (Liquid Crystal Display) and 5 buttons for menu navigation and display adjustment.

The two display adjust buttons are located on the right side of the display. They are used for adjusting the display to fit the viewing conditions, such as adjusting backlight and contrast. It may be necessary to adjust the backlight according to varying ambient light conditions, while the contrast may be adjusted for optimal viewing under varying temperature conditions.

Note that during low temperature conditions, the display will get slow and the “afterglow” may be annoying during menu operations and when looking at fast changing variables. In this case, it may be possible to optimise the display speed by adjusting the contrast a little up or down. It might improve the speed even if no change in contrast is observed.

It may also be a good idea to use the backlight in this case even though the ambient lighting conditions are good. This is because the backlight will emit some heat that may increase the display speed a little more (after some delay for the heating to take place).

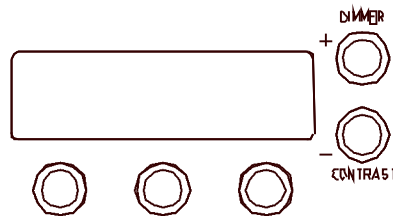


Figure 2: Display with display buttons

#### 3.4.1 DIMMER button

The upper right button is the DIMMER button. By pressing this button, the display will enter the “Dimmer Adjust” mode and the DIMMER and CONTRAST buttons will now act as + and – buttons for adjusting the display intensity up or down. The buttons will return to normal functions after 2 seconds of inactivity.

In “Dimmer Adjust” mode, the display will show the following text:

DIMMER ADJUST: 5
---------------------

The dimmer controls both the display backlight and the LED-indicators on the panel. Dimmer level 1 is the lowest intensity intended for night operation. Increasing values increase the intensity, even though the display intensity will reach its maximum already on step 4. From step 5-8, only the LED intensity will continue to increase. Level 9 is the daylight level. In this case, the display backlight is considered useless and is switched off to save power. The LED indicators change from steady light at full intensity (step 8) and to flashing light at full intensity (step 9). Flashing light is used to ease visibility in strong sunlight.

### 3.4.2 CONTRAST button

The lower right button is the CONTRAST button. By pressing this button, the display will enter the “Contrast Adjust” mode and the DIMMER and CONTRAST buttons will now act as + and – buttons for adjusting the display contrast up or down. The buttons will return to normal functions after 2 seconds of inactivity.

In “Contrast Adjust” mode, the display will show the following text:

CONTRAST ADJUST : 5
------------------------

Normally a contrast setting of 5 will be optimal. Reducing the value will weaken the display contrast and may even make the text totally invisible. Increasing the value will make the display darker and finally it may be all dark. It may also go dark at high temperatures which mean that the contrast may have to be reduced as the temperature rises.

Since the display will never be all blank (“-- \*\* --” is the way the OPU indicates an empty display), a totally blank display must be regarded as too low contrast and one should then try increasing the value. Since the “help-text” on the display is invisible in this case, it might be a little confusing. It’s therefore important that the operator makes himself familiar with how the DIMMER- and CONTRAST-adjust functions work, so that the buttons may be operated in the correct sequence even when nothing can be seen on the display.

### 3.4.3 Soft keys

Below the display are three unspecified buttons, so called “soft keys”. These buttons have different functions depending on the selected menu and index. During navigation around in the menus, the buttons usually have these functions: MOVE LEFT, HOME, and MOVE RIGHT. This may either be shown as the text " << HOME >> " on the lower line or it may not be shown at all if the lower line is used for other information. The rule is that the button acts as described here unless some other functionality is explicitly indicated by the text on the display.

In some cases, some or all of the three buttons have different functions. This will then be shown as a describing text in the display directly above the buttons. Just follow the instructions. See the manual for more information if the short text, due to limited space, doesn’t give a satisfactory explanation of its function.

### 3.5 Tilt and Lift handles

The TILT/FORCE and LIFT/GAIN handles are located in the upper left corner of the panel.

TILT/FORCE is used for controlling the movement of the TILT cylinder and thereby the vertical position of the flail or for force adjustment when the system is in “Force Control” mode (see description).

LIFT/GAIN is used for raising and lowering the flail frame (and the flail engine module – if fixed to the frame) or for flail gain adjustment when the system is in “Force Control” mode (see description).

The handles gives downward movement when pushed forward and upward movement when pulled backwards.

When used for adjusting values during “Force Control” flailing, the handles will increase the value when pushed forward and reduce the value when pulled backwards.

### 3.6 The ON/OFF buttons

The group of 12 buttons in the lower left part of the display is the ON/OFF buttons or START/STOP buttons. This group is mainly used to start or stop engines, releasing or engaging the brake or adjusting the main throttle.

The buttons are in pairs of one RED button in the bottom and one GREEN button above it. GREEN is the operational state of the function, i.e. the button one should press to start a function. The yellow LED indicator above will be lit when the function is active.

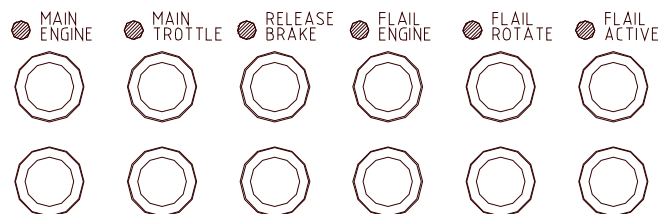


Figure 3: The ON/OFF button group

#### 3.6.1 Main Engine

Start and stop of the main engine (prime mover). Pressing the green START button from “Off” position (LED off) will activate the glow plugs for 8 seconds. It will also open the fuel valve and make the engine ready for starting. The starter will be engaged after 1 second if the button is still being depressed.

Note that while the starter is engaged, the glow plugs are switched off to reduce the peak load current on the battery and thus reducing the voltage drop during start. In warm climates, using

the glow plugs has little effect and the START button can then be pressed and keep it depressed until the motor starts running.

In cold weather, when glowing is necessary for start, the button should just be pressed shortly to activate the glow plugs and open the fuel valve. The LED will be lit. Then after 5-10 seconds, the START button is pressed again to engage the starter until the engine ignites and starts running. The glow plugs are switched off when the starter is engaged to reduce the peak current during starting – a peak current that may otherwise cause problems for old or poorly charged batteries.

To increase the willingness to start in cold conditions, a voltage stabilizer may be fitted. This is a unit that is fitted inside the CTU and IFU boxes and which supplies the electronics with power during the first critical seconds after the starter is engaged – the moment when the voltage drop is at its highest.

In warm weather, just press the button once and keep it depressed until the motor is running. The starter engages automatically after 1 second.

Note that if the starter is kept running for more than 15 seconds, a protection feature will be activated and automatically stop the starter. Simultaneously, a warning will be given to inform the operator. If more than 15 seconds of starter engagement is necessary for the engine to ignite, just release the START button for a brief moment and then continue for another 15 seconds.

Pressing the STOP button will switch off the fuel supply and shut down the main engine if the flail engine is already stopped and the main throttle is in idle. It will then automatically activate the brakes.

If the flail engine is running, it will first initiate a shutdown of this engine before allowing the main engine to be stopped by the STOP button. If the flail is running, it will first have to initiate a flail stop sequence and throttle down the flail engine before it may be stopped.

If the main throttle is higher than idle, pressing the red STOP button will reduce the throttle one step, but it will not shut down the engine. First when throttle is down to idle, an engine shutdown will take place.

The restrictions on stopping the engines are implemented to ensure a controlled and safe shutdown without damaging the engines, especially the turbochargers. Since throttle on the flail engine is controlled by an actuator with hydraulic supply from the main engine, it is crucial that the main engine is kept running until the actuator has slowly reduced the throttle on the flail engine to idle and brought it to a controlled stop. The same apply to the reduction in main throttle.

**Note:**

Stopping a turbocharged engine while the turbocharger fan is running at full speed (which is the case under full throttle) may wear down the bearings as the turbocharger will lose the lubrication oil pressure long before the fan stops rotating.



***In cases where the engine needs to be stopped immediately, use the EMERGENCY STOP button instead as this will override all restrictions and halt both engines instantly.***

### **3.6.2 Main throttle**

The main throttle may be increased 4 steps above idle, 5 steps in all. The green ON button increases the throttle, the red OFF button decrease the throttle. The LED is lit as long as the throttle is higher than idle.

### **3.6.3 Release brake**

Pressing the green ON button will release the software brake and enabling the prime mover to operate. Pressing the red OFF button disables any movement of the prime mover.

Most machines does not have a physical brake, this is only a way of disabling the actuators controlling the drive speed. The vehicle will then stay steady regardless of joystick or knob activation.

Some vehicles may have optional physical brakes, check the machine specifications.

### **3.6.4 Flail Engine**

Start and stop of the flail engine. Pressing the green START button from “Off” position (LED off) will activate the “Quick Start” pre-heater for 10 seconds. It will also open the fuel valve and make the engine ready for starting. The starter will be engaged after 1 second if the button is still being depressed.

In cold weather, when glowing is necessary for start, the button should just be pressed shortly to activate the glow plugs and open the fuel valve. The LED will be lit. Then after 5-10 seconds, the START button is pressed again to engage the starter until the engine ignites and starts running. The glow plugs are switched off when the starter is engaged to reduce the peak current during starting – a peak current that may otherwise cause problems for old or poorly charged batteries.

To increase the willingness to start in cold conditions, a voltage stabilizer may be fitted. This is a unit that is fitted inside the CTU and IFU boxes and which supplies the electronics with power during the first critical seconds after the starter is engaged – the moment when the voltage drop is at its highest.

In warm weather, just press the button once and keep it depressed until the motor is running. The starter engages automatically after 1 second.

Note that if the starter is kept running for more than 15 seconds, a protection feature will be activated and automatically stop the starter. Simultaneously, a warning will be given to inform the operator. If more than 15 seconds of starter engagement is necessary for the engine to ignite, just release the START button for a brief moment and then continue for another 15 seconds.

Pressing the red STOP button will switch off the fuel supply and shut down the flail engine if the flail engine throttle is already in idle.

If the flail is running, it will first have to initiate a flail stop sequence and throttle down the engine before it may be stopped.

The restriction on stopping the engine at full speed is to ensure a controlled and safe shutdown without damaging the engine, especially the turbocharger.

**Note:**

Stopping a turbocharged engine while the turbocharger fan is running at full speed (which is the case under full throttle) may wear down the bearings as the turbocharger will lose the lubrication oil pressure long before the fan stops rotating.

***In cases where the engine needs to be stopped instantly, use the EMERGENCY STOP instead as this will override the restriction and halt the engine instantly.***

### 3.6.5 Flail rotate

Pressing the green START button will first throttle up the engine to full throttle, then it will slowly start the flail pump and thereby make the flail start rotating. The LED will be lit as long as the throttle is higher than idle.

Pressing the red STOP button will first slowly reduce the flail pump until the flail stops rotating, then it will slowly reduce the throttle to idle. Then the LED will go off.

If gear 3 was selected prior to pressing “flail rotate”, the machine automatically forces a change down to gear 2 to ensure enough torque on the tracks for the flailing operation. This forced gear change is signalled by the following message:

FORCING GEAR  
CHANGE : 3 -> 2

### **3.6.6 Flail active**

Pressing the green button will activate the flail. Exactly what happens will depend on the flail mode selected.

In “Free Float” mode, pressing the green ON button will open the free float bypass valve and disable the force from the hydraulic tilt cylinder. Only the lift from the rotating flail will keep the flail floating in this case.

Pressing the red OFF button will close the valve again and enabling the hydraulic tilt cylinder to be controlled by the tilt handle.

In “Force Control” mode, pressing the green ON button will activate the force control loop and give it control over the hydraulic tilt cylinder.

Pressing the red OFF button will deactivate the control loop and transfer the control back to the tilt handle.

## **3.7 Prime mover control**

The prime mover control group is used for driving and steering the vehicle. It consist of one hand operated two axis joystick and two additional knobs.

The joystick has one large “Joystick Enable” button in front. This button is used to sense when the operator puts his hand around the joystick and instructs the program to transfer control from the knobs to the joystick. This button must be kept depressed as long as the joystick is used.

The joystick has 4 buttons on top. It looks just like on big button, but pressing off centre in one of the four quadrants (see fig. 4) will activate the corresponding button. The best result is usually obtained if the button is pressed closer to the rim. It is also important to press in centre of the quadrants, i.e. either straight backwards, 90 degrees right, 90 degrees left or straight forward. Pressing on the border between the quadrants (indicated by the dotted lines) may result in no activation at all.

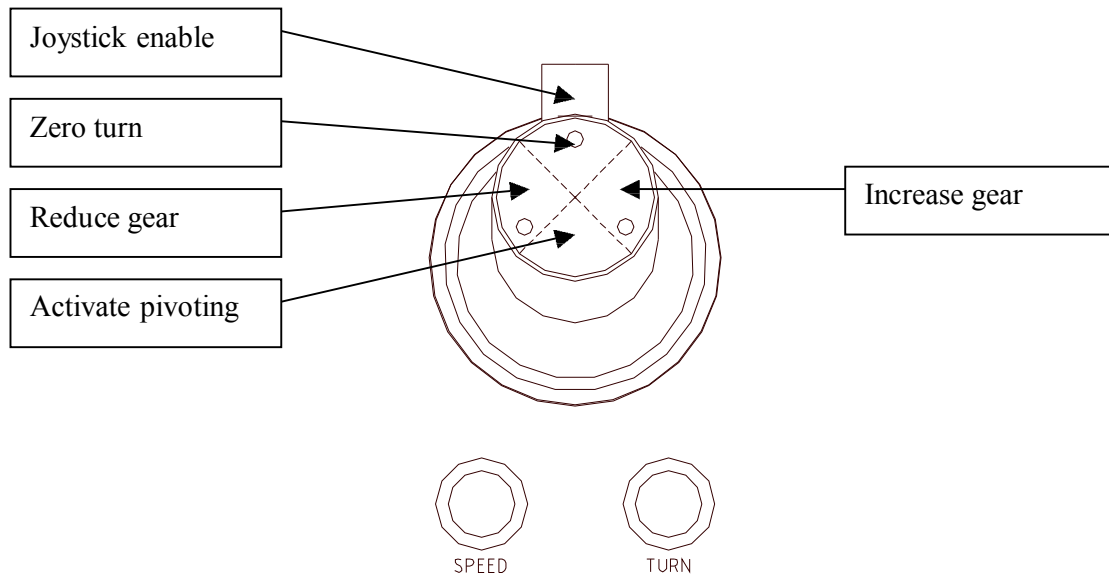


Figure 4: Prime mover control

### 3.7.1 Joystick operation

The easiest way of operation is to use the single hand joystick. By taking a good grip and pressing the “joystick enable” button, control of the vehicle is transferred to the joystick. Provided that the main engine is running and the brake is released, pulling the joystick forward will now make the vehicle move forward. Pulling it backward will make the vehicle go backward.

By moving the joystick sideways at the same time as the forward/backward movement, the vehicle will turn in the same direction.

During turning, it is important to notice that the turning rate will be higher at slow speed than at high speed. A hard right turn at low speed will halt the right track and only give movement on the left track.

As the speed increases above 30% speed, the maximum turning rate will decrease from 100% and down to 30% at full speed. This means that halting one belt at maximum turn will only take place below 30% speed. Above this speed, both belts will turn and the relative speed difference will decrease, increasing the turn radius. This implies that the vehicle will have its optimal manoeuvrability below 30% speed.

The reduction in turn ratio at high speed is implemented to give a softer turning during high speed transportation along roads.

In limited space, it might be necessary to have the vehicle turn around its own axis. This can be achieved by pressing the “activate pivoting” button with the thumb. As long as it is being kept depressed, the drive control will be in pivot-mode. In this mode, any turn at low speed will bring the tracks to move in opposite directions and thus make the vehicle turn “on the spot”. Increasing the speed will slowly reduce the pivoting similar to the varying steering rate

described earlier. At one point, the reversing of one track will stop and they will finally be turning in the same direction. It will however always give a higher turning rate with pivoting enabled than it would without, independent of speed setting.

Please observe that speed has to be applied for the turning even though it doesn't give any forward or backward movement. Just pulling the joystick sideways won't do. Also observe that slow pivoting forward right will give the same result as slow pivoting backward left. In both cases, the vehicle will turn clockwise. Forward left or backward right will give a counter clockwise pivoting.

### 3.7.2 Gear selection

The MineCat 140 KE has 3 different "gears", or to be more specific, a high and low speed mode using the same physical gear and a high speed gear.

"Gear" is the slow speed mode. In fact, it is the same physical gear as "gear" 2, but with a reduction on the joystick speed to ¼ of normal speed. This means that full forward/backward movement of the joystick will only give +/- 25% speed to the tracks, thus reducing the risk of "overreacting" while manoeuvring in restricted spaces.

"Gear" 2 is the same physical gear but with no reduction in speed. This means that the machine will be faster and the risk of "overreacting" while manoeuvring in restricted spaces is larger.

"Gear 3" is a true high gear giving higher speed and consequently reduced torque on the belts. Due to the reduced torque available for driving, the risk of overloading the prime mover engine (main engine) is much larger. Therefore, gear 3 is only allowed during normal driving and not during flailing. Attempts to change to gear 3 during flailing will be rejected. Also, if gear 3 is selected when flailing is started, the gear selection will automatically be forced down to gear 2 to give maximum torque for the flailing operation.

In general, one should use "low gear" for fine manoeuvring and "high gear" for transportation. Also note that the "gear 1" selection only affect the joystick ratio and has no effect when using the knobs.

Switching gear must be done with a "double click" on the button. The first button activation will bring up the following message on the display:

CHANGE "GEAR" FROM 1 TO 2 ?
--------------------------------

This display will stay for 1-2 seconds and within this time one has to press the button a second time to confirm the "gear" shift. When the gear switching is accepted by the system, the following message will appear for 2 seconds:

"GEAR" NO. 2 SELECTED
--------------------------

If one attempts to change gear up while already being in highest gear, the following message appears:

```
HIGHEST "GEAR"  
ALREADY IN USE
```

One exception is if one tries to change gear from gear 2 to 3 while flailing is active. In this case, the change is denied with the following message:

```
HIGHEST GEAR = 2  
WHILE FLAILING
```

If gear 3 was selected prior to start of the flailing operation, the machine automatically forces a change down to gear 2 to ensure enough torque on the tracks for the flailing operation. This forced gear change is signalled by the following message:

```
FORCING GEAR  
CHANGE: 3 -> 2
```

If one attempts to gear down while already being in lowest gear, the following message appear:

```
LOWEST "GEAR"  
ALREADY IN USE
```

### 3.7.3 Zero turn button

In front of the joystick is a fourth button called "Zero Turn" which is intended for use when not operating the joystick. It is only used when driving with the SPEED/TURN knobs. Pressing this button will then clear the turn rate and bring the vehicle back to a straight course. It is well suited for setting the course straight after an evasive action.

### 3.7.4 Speed and turn knobs

The speed and turn knobs can be used for steering when the joystick is not used. Using the joystick means that one has control of the speed/turn all the time. While walking with the remote control, it can be tricky to keep the joystick steady in one position and the result will usually be a very "jerky" steering. In this case, it is better to let go of the joystick and continue with the knobs instead.

During flailing operations, it is good practice only to use the knobs. This will ensure a fine and stable operation which is crucial for good flailing. Using the joystick in this case will give to unstable steering and speed and thus result in poorer flailing.

The knobs go positive on clockwise rotation and negative on counter clockwise rotation.

The knobs are incremental, meaning that they have no absolute position. Turning the turn knob to 50% turn and then pressing the zero turn buttons will bring the turn back to 0% turn even though the knob is still in the same position. Its current position has now been the new zero-position. This applies also to the speed knob.

This approach simplifies the transfer of control between knobs and joystick. To transfer control from knobs to joystick, just move the joystick with an open grip (not pressing the “Joystick Enable” button) to a position that fits approximately with the current speed and turn rate and then press the “joystick enable” button. Steering is now transferred softly from its current values and to the new values defined by the joystick position.

Returning control from the joystick to the knobs is even simpler. Just keep the joystick steady while opening the grip and release the “Joystick Enable” button. As soon as the button is released, the current speed/turn setting is transferred to the knobs and the joystick can be released back to its neutral position.

### 3.7.5 Awake button – automatic system shutdown

The awake button is a safety feature. When any engine is started, this button has to be pressed at regular intervals to tell the control system that the operator is awake and in control. Any other button or knob activation, including operation of the TILT and LIFT handles, will also do the job. The AWAKE button is the button to use if there is no reason to press any of the others. The AWAKE button can easily be activated by the left thumb if one has the hand resting on the carrying handle.

If the button is not activated, the LED’s above the EMERGENCY STOP button will start to flash, the first one after approx. 20 seconds, and then both will start flashing. After 25 seconds there will be a single warning beep and after 35 seconds a continuous pulsed audible alarm will start with increasing intensity. Finally, if nothing has been done after 50 seconds, a system shutdown will take place, an automatically executed EMERGENCY STOP.

In case of an AWAKE timeout, the following message will appear:

- NOT AWAKE - SYSTEM SHUTDOWN
----------------------------------

Pressing the AWAKE button or any other button will reset the system again.

**Note:**

Only moving the SPEED/TURN joystick will not act as an AWAKE reset.

### 3.8 Emergency Stop

In case of an event that needs instant stop of engines and vehicle movement, the EMERGENCY STOP may be used.

However, it is important to realize that the EMERGENCY STOP is only for use in Emergency situations. Using this button for stopping the engines in other situations is not advisable, except for one case described below. Pressing this button will send an instant stop message to the vehicle and then cut all communication after 1 second. The result is that all engines will be shut down instantly, regardless of their current state or throttle setting. This may be harmful to the engines, especially the turbocharger bearings. See the MAIN- and FLAIL-button descriptions for more details on this issue.

#### 3.8.1 Use of Emergency Stop as Remote System Reset

The only advisable use of the EMERGENCY STOP in “non emergency” cases is to initiate a remote system reset of the vehicle control routines. If something wrong happens with the control software and its parameters, it may be possible to initiate a restart of the control routines by initiating an EMERGENCY STOP and leave the button depressed for 5 seconds. This procedure should however only be used if all engines and functions have already been stopped in a controlled manner and all status LED’s are switched off.

**Note:**

While the EMERGENCY BUTTON is being depressed, the communication will be switched off and the display will be locked to the text:

EMERGENCY STOP IS ACTIVATED
--------------------------------

Therefore, it will not be possible to scroll through menus or do any other actions. To use menus and check the vehicle state, release the EMERGENCY STOP first to restart the communication. All engines will already be shut down so this will be safe.

**Note:**

During EMERGENCY STOP, everything is switched off instantly, except the actuator and sensor supply. This is because supply to actuators is necessary for making an instant stop of vehicle movement. It will go off automatically after another 30 seconds.

The actuator and sensor supply will always be switched on when there is communication with the remote operator panel. If communication is lost due to jamming, radio failure, panel switch off or emergency stop, then the sensor and actuator supply will be switched off automatically after 30 seconds of inactivity to save power.

#### 3.8.2 Automatic System Shutdown

In case of problems with communication, the system will automatically stop all movement of the vehicle after one second loss of communication. After 5 seconds loss of communication, it



will automatically start a controlled shutdown of all engines and finally shut down the whole machine.

Problems with communications may be due to jamming from noise transmitters, interference from other equipment using the same frequency or from failure in the radio communication modules.

See the local status panel messages for information on possible causes.

### **3.8.3 Communication security**

The communications uses framed messages with checksums and a built in identifier code that is to be specific for each set of vehicle and operator panel. Running two systems with different identifier on the same channel will therefore not be possible. Neither of the vehicles will react to commands from the other panel and the operator panels will also tell the operator that it has detected other machines on the same frequency. See local status panel messages for description.

## 4. Main Display and Menu System

The MineCat 140 KE display and menu system is divided into three main parts, the OPERATING DISPLAY, the MAIN MENU for displaying and adjusting selected parameters during operation and the TECHNICAL MENUS for use during testing and fault finding.

This document describes the OPERATING DISPLAY and the MAIN MENU that are intended for use by the operator during normal demining operations.

The remaining menus are of technical art and is intended only for supervisory and maintenance personnel that need to access more technical and system specific information. All the technical details are listed in separate documents.

### 4.1 Operating Display

Normally, the display will show a standard display depending on the kind of operation and operating modes that are selected.

In idle state, the display will show:

MINECAT 140 KE
----------------

This text will be displayed until the brakes are released. The display will then change to the driving mode display:

+1.05km/h	-5 %
FORCE	: *** Bar

The upper line displays the vehicle speed in “km/h” with a sign in front showing the direction. “+” is forward, “-“is backward.

The upper line also shows the current turn rate as a percentage value in the upper right corner. The sign in front shows whether the vehicle is turning left or right. “+” is right, “-“is left. The value goes between -100 and +100 which correspond to maximum left and right joystick movement.

When the flail is started (FLAIL ROTATE), then the lower line will start displaying the actual flail pressure instead of the three stars.

#### Note:

Flail pressure is the actual pressure differential between the input and output ports of the flail pump. This is almost equal to the pressure differential across the hydraulic flail motor, except for a minor pressure loss in the hoses between pump and motor. It is the differential pressure that is converted into rotational momentum on the flail shaft and hence it will give a

reasonable correct indication of the actual work produced by the flail, given a constant hydraulic flow. The flow is again proportional to the flail engine rpm which is reasonable stable in flailing mode. Therefore, using the flail motor pressure (differential) as basis for the control gives a good control of the actual work produced by the flail.

The flailing depth will of course also depend on the type of soil, flailing speed; weather conditions and so on, details that are discussed elsewhere.

During the flailing process, additional information about the flailing can be displayed on the lower line by pressing the right button. The display will then change as shown:

+0.45 km/h	+2 %
+15%	1985 rpm

The values shown on the lower line is the tilt cylinder speed on the left and the flail engine rpm on the right. The tilt cylinder speed tells whether the flail is being lifted up from the ground (+) or lowered down against the ground (-) and the speed of the adjustment. The rpm gives the operator an indication of how the flail engine is running and especially if the engine is overloaded and loses rpm. This can give important information about whether the pressure setting might be too high for the current soil conditions.

The right and left buttons can be used for toggling back and forth between the pressure and tilt/rpm reading according to what the operators need.

#### 4.2 Adjusting flail force and flail gain

The operator also has access to adjust the flail pressure and flail gain during the flailing operations simply by operating the TILT and LIFT handles during FORCE CONTROL flailing. In this case, the TILT handle is no longer controlling the tilt directly, but affects the flail pressure setting instead. When the TILT handle is moved slightly off its idle position, the lower line will change to:

FORCE >> 125 Bar
------------------

The arrow replacing the column indicates that the display is now showing the setpoint value instead of the measured value. Moving the handle up or down will now change the setpoint and the rate of change is proportional with the handle movement. If one only wants to check the setpoint value, just pull slightly in the handle, enough to change the display, but little enough to avoid changing the value.

A similar approach may be used for adjusting the flail gain during operation. This might be necessary as the machine moves over bumpy terrain or terrain with varying soil condition. In this case, moving the LIFT handle will change the lower display line to:

FLAIL GAIN: 0.45
------------------

The flail gain may now be adjusted up and down by pushing (increase) or pulling (decrease) the handle. The rate of change is proportional to the handle movement.

### **4.3 Alarms and warnings**

During operation, different kinds of alarms and warnings may also pop up on the display followed by an audible sound. These messages are described more in detail in a separate section describing the alarms and warnings.

## 5. Main menu

MAIN MENU is the menu intended for use during operation and all variables and parameters that is to be used or modified during the transport and flailing operations are located here. Since it is for use by all machine operators, it is essential that all operators are familiar with the content of the MAIN MENU and know the essential details connected to all the parameters and variables.

Since this is a menu that is only intended for displaying selected variables during a limited period of time before returning to the OPERATING DISPLAY, an automatic return function is implemented. If the operator has entered the menu, the menu will automatically be closed and display returned to the OPERATING DISPLAY 60 seconds after the last display operation (activation of any the three display buttons).

Display may otherwise be forced back to the OPERATING DISPLAY by pressing the centre button. The centre button acts as a return button as long as there is normal variable information on the lower line (info text and values) or if the text “HOME” is displayed above the centre button. If there is any other text displayed above the button, indicating that the centre button is now assigned to an other function, for example “YES”, then the button will not act as a return button. To return in this case, one has to move sideways in the menu to an other display where a return is legal. In any case, automatic return after 60 seconds of inactivity will always take place regardless of the text on the lower line.

To move between the different values and parameters (indexes) in the MAIN MENU, the right and left display buttons may be used to jump to the neighbouring value. These buttons acts as a move buttons as long as there is normal variable information on the lower line (info text and values) or if the text “<<” or “>>” is displayed above the buttons. If there is any other text displayed above the buttons, indicating that the buttons are now assigned to an other functions, then the buttons will not act as a move button. In this case, one just has to follow the possible choices shown by the text above the buttons and press the button that corresponds with the desired function. In any case, automatic return after 60 seconds of inactivity will always take place.

Most of the information in the MAIN MENU is measurements that give vital information about the state of the machine, such as engine oil pressures, engine temperatures, hydraulic temperatures, flail pressures, tank levels and battery and charger status.

The MAIN MENU has a few indexes with more than just measured values, the FLAIL CONTROL and FLAIL GAIN indexes.

The FLAIL CONTROL enables selection of flail mode (FREE FLOAT or FORCE CONTROL), flail rotation direction (NORMAL- or REVERSE ROTATION) and adjustment of FLAIL FORCE (pressure setpoint) if FORCE CONTROL mode is selected.

The FLAIL GAIN enables control of the gain for the flail force control loop. This value may be adjusted according to desired flail force, flail speed and soil condition based on acquired experience from similar conditions. The optimum is a highest possible value for fast response to ground variations, but low enough to avoid instability.

Note that during flailing operations, the pressure setpoint and flail gain may be adjusted “on the fly” by pulling or pushing on the TILT and LIFT handles as described earlier.

## 5.1 Main Menu Navigation

The MAIN MENU is entered from the OPERATIONS DISPLAY simply by pressing the centre button once. It will then switch to the MAIN MENU's start display:

```
SELECT DATA
<< HOME >>
```

This index is shown only the first time when the menu is entered and will never reappear as long as one stays within the menu. The different indexes can be thought of as being side by side on a circle and can be navigated by the left and right button as shown by the arrows. If one goes right through all indexes one suddenly gets back to the first index again and the same will apply if one goes left. After passing the first index, one will get to the last one again. Knowing where on the list the wanted value is to be found will be helpful when finding the easiest way. Indexes on the end of the list should therefore easiest be accessed from the back using the left button instead of going right through the whole list.

The index list looks like this (\* below indicates indexes with sub-indexes, ? below indicates indexes that may not always appear):

- (15) - (MENU START) - (1) - (2) (3) - (4) - (5) - ... - (11) - (13) - (13) - (14) - (15) -  
? \* \*

Note: When selecting a pressure or temperature value for display, one may get the word "ERROR" instead of the actual value. This indicates that there has been detected an error situation in connection with the sensor reading and that there is no valid value to display. This is however only an indication of a sensor problem and tells nothing about the selected value itself. The temperature or pressure may be safe within limits even though it is impossible to sense and display the value.

Sensors with invalid data will also be ignored by the alarm system, which means that there is no monitoring of these values. As a result, there is a risk of damaging the machine in case a critical situation should occur while the alarm sensing is out of order. See warning and alarm section for more details.

### 5.1.1 Flail pump pilot pressure

```
FLAILPUMP PILOT
PRESS. : 19 Bar
```

Displays the flail pump pilot pressure, the output pressure for the feed pump supplying the main flail pump with hydraulic oil from the reservoir. This is the pump that supplies the flail circuit with new oil to replace the oil that is returned from the hydraulic flail motor to the hydraulic tank. Low pressure on this pump may indicate a loss of reservoir oil or damage to the flail circuit. See flail operations description and alarm system description for more details on these values.

### 5.1.2 Main engine oil pressure

MAIN ENGINE OIL PRESS. : 2.9 Bar
-------------------------------------

Displays the main engine lubrication oil pressure. This is the pressure from the oil pump supplying the pressurized lubrication oil. Low pressure on this pump may either signal loss of lubrication oil or a serious damage to oil pump or engine. See main (prime mover) engine description and alarm system description for more details on this value.

### 5.1.3 Flail engine oil pressure

FLAIL ENGINE OIL PRESS. : 2.9 Bar
--------------------------------------

Displays the flail engine lubrication oil pressure. This is the pressure from the oil pump supplying the pressurized lubrication oil. Low pressure on this pump may either signal loss of lubrication oil or a serious damage to oil pump or engine. See flail engine description and alarm system description for more details on this value.

### 5.1.4 Main engine coolant temperature

MAIN ENGINE TEMP. : 95 °C
------------------------------

Displays the main engine cooling temperature. The engine temperature signals the state of the cooling system. High temperature indicates either loss of cooling fluid or that the cooling system, for some reason, is unable to dissipate all the heat produced by the engine. See main (prime mover) engine description and alarm system description for more details on this value.

### 5.1.5 Flail engine coolant temperature

FLAIL ENGINE TEMP. : 95 °C
-------------------------------

Displays the flail engine cooling temperature. The engine temperature signals the state of the cooling system. High temperature indicates either loss of cooling fluid or that the cooling system, for some reason, is unable to dissipate all the heat produced by the engine. See flail engine description and alarm system description for more details on this value.

### 5.1.6 Main hydraulic oil temperature

MAIN HYDRAULIC TEMP. : 85 °C
---------------------------------

Displays the main hydraulic circuit oil temperature. High temperature indicates that the main hydraulic system, for some reason, is unable to dissipate all the heat produced. See main (prime mover) hydraulics description and alarm system description for more details on this value.

### 5.1.7 Flail hydraulic oil temperature

FLAIL HYDRAULIC TEMP. : 85 °C
----------------------------------

Displays the flail hydraulic circuit oil temperature. High temperature indicates that the flail hydraulic system, for some reason, is unable to dissipate all the heat produced. See flail circuit hydraulics description and alarm system description for more details on this value.

### 5.1.8 Flail engine RPM

FLAIL ENGINE RPM 1890
--------------------------

Displays the flail engine RPM (number of rotations per minute). Note that during flailing operations, flail engine rpm can more easily be accessed by pressing the right button (see Operating Display).

### 5.1.9 Main fuel tank level

MAIN FUEL TANK LEVEL : 96 %
--------------------------------

Displays the fuel level in the main engine fuel tank, presented as percentage of full tank capacity. The main engine fuel tank is located in the bottom of the vehicle. See alarm system description for more details on this value.



### 5.1.10 Flail fuel tank level

FLAIL FUEL TANK LEVEL : 96 %
---------------------------------

Displays the fuel level in the flail engine fuel tank presented as percentage of full tank capacity. The flail engine fuel tank is located in the back of the vehicle. See alarm system description for more details on this value.

### 5.1.11 Battery voltage

BATTERY VOLTAGE 13.8 Volt
------------------------------

Displays the battery voltage on the vehicle. See alarm system description for more details on this value.

### 5.1.12 Panel battery status

PANEL BATTERY 7.6 V 55 %
-----------------------------

Displays the battery voltage in the remote operating panel and the current charging state of the remote operating panel battery pack shown in percentage of full battery capacity.

Please observe that the charging state is calculated from measuring the current going in and out of the battery packs during charge and discharge. It cannot accurately measure or calculate the internal self discharge of the battery pack. The actual charge state may therefore be lower than what is indicated, depending on storage temperature, battery aging state and time since last charge.

The most accurate charging state will therefore be obtained shortly after a full discharge followed by a full charge.

### 5.1.13 Radio Frequency

FREQ: 440.600MHz << CHANGE >>
----------------------------------

<p><b>NOTE:</b> This index is only visible if EASY FREQUENCY CHANGE is enabled from the protected, technical SPECIAL menu. It must be considered carefully whether local telecom regulations and risk of interference to other equipment can justify giving the operator free access to this feature. In many countries, these frequency bands are restricted and a licence must be obtained for every single frequency to be used. In this case, frequency adjustment should only be available to the supervising technician.</p>
--

Shows the radio frequency currently in use by the system. If necessary, the radio frequency can be changed by pressing the centre button, provided that the machine is connected by umbilical cable. After pressing the centre button, the following displays will appear:

FREQ: 440.600MHz
LESS HOME MORE

The frequency may now be changed up or down by pressing the LEFT or RIGHT buttons. LEFT button decreases frequency in steps of 25kHz (0.025MHz), while the RIGHT button increases frequency in steps of 25kHz (0.025MHz).

On the standard system, the radio operates with a frequency band of 10MHz, ranging from 440.000MHz to 449.975MHz. This gives a total of 400 available channels for operation.

When the desired frequency has been selected, the centre button (HOME) is depressed. The display will change to:

-- WAIT --
HOME

In less than a second the display will change to:

ACKNOWLEDGED
HOME

This indicates that the frequency change has been carried out both in the CTU and the OPU and that the umbilical cable now may be disconnected and operation continued by radio on the new frequency.

In case a problem is encountered, the ACKNOWLEDGE message will not appear. This indicates that the radio modem in either the OPU or CTU has failed to respond correctly to the new frequency setting.

In case of problems, one may then attempt to repeat the operation a few times before discarding. The last attempt in case continuing problems will be to switch off both the main switch on the machine and the operator panel switch and let the system be switched off for 30 seconds. One may then switch on the system and try again.

In case of problems, there might also be a slight possibility that changing back to the original frequency may solve the problem temporarily. In case one of the radios fail on the attempted frequency change, it might be stuck at the original frequency and this is why such an attempt may work, even if it signals a failure situation.

In case the CHANGE button is pressed while the system communicates by radio, the following message will appear:

ONLY BY CABLE HOME
-----------------------

It is now only possible to return to the main menu by pressing the centre button. The two adjustment buttons are disabled.

**First connect the panel by umbilical cable, wait a minute to let the system switch to cable communication and try again.**

### 5.1.14 Flail control parameters

```
FLAIL CONTROL
<<  YES  >>
```

Index used for accessing the FLAIL CONTROL parameters. Note that the centre button is now used for entering the FLAIL CONTROL setup instead of being used as a HOME button. After pressing the centre button, one will now move one level down to the next selection and the following text will appear:

```
FLAIL CONTROL
MODE HOME ROT
```

By pressing the left button, one gets down to the mode selection (13-1). By pressing the right button, one gets down to the rotation selection (13-2). Pressing the centre button (HOME) will bring the display back to the start of the MAIN MENU (" SELECT DATA").

#### Note:

It may seem a little confusing that the HOME button moves back to the beginning of the MAIN MENU and not only one step back to the top of the FLAIL CONTROL submenu. The reason for this is that HOME should always bring control back towards the top of the whole menu and finally out of the menu. Jumping to the top of the FLAIL CONTROL submenu would redefine the centre button to YES and by the next pressing of the button, one would be brought back down into the menu again. This could be annoying in a stressed situation, and this possibility is therefore avoided.

This way of returning from an index-submenu is general for all the menus in the remote control system. Returning from an index-submenu always brings control back to the start of the corresponding menu.

#### 5.1.14.1 Mode Selection

```
FREE FLOAT          OR          FORCE CONTROL
FREE HOME FORCE     FREE HOME FORCE
```

As shown, the text in the upper line may vary, depending on which mode that currently selected. If the flail system is currently in FREE FLOAT mode, then the first text will appear. If the flail system is currently in FORCE CONTROL, then the second text will appear.

If the left button is pressed, the top text will change to "FREE FLOAT" and except from the changing top text, the display will be the same.

If the right button is pressed however, the display automatically moves to the next level and the following text will be seen:

```
FORCE : 123 Bar
LESS HOME MORE
```

By pressing the left and right buttons, the flail hydraulic pressure may now be adjusted in steps of 5 Bar to the desired pressure suitable for the flailing operation. The pressure may be adjusted between 25 Bar and 400 Bar (300 Bar in REVERSE ROTATION).

When the desired pressure has been selected, the centre button will transfer control one step up and back to the mode selection again.

#### 5.1.14.2 Direction of rotation

NORMAL ROTATION
NORM HOME REV

 or 

REVERSE ROTATION
NORM HOME REV

As shown, the text in the upper line may vary, depending on which direction of rotation that is currently selected. If the flail is currently in NORMAL ROTATION, then the first text will appear. If the flail system is currently in REVERSE ROTATION, then the second text will appear.

NORMAL ROTATION is defined as the flail going away from the vehicle on top and towards the vehicle in the bottom. This means that the flail will throw the soil backwards towards the vehicle. This is the normal way of operation, as the name implies.

REVERSE rotation means that the flail rotates away from the vehicle in the bottom, thus throwing any soil or debris forward away from the vehicle. This mode is mostly used for wiping clean hard surfaces, for examples wiping roads and runways free of dirt and UXO's without damaging the surface.

Pressing the left and right buttons will change the direction setting and the top display will change accordingly.

Pressing the centre button (HOME) will bring control back to the start of the MAIN MENU ("SELECT DATA").

#### 5.1.15 Adjust flail gain

ADJUST GAIN
<< YES >>

Index used for accessing the ADJUST GAIN parameter. Note that the centre button is now used for entering the ADJUST GAIN sub-index instead of being used as a HOME button. After pressing the centre button, one will now move one level down to the next selection and the following text will appear:

FLAIL GAIN: 0.40
LESS HOME MORE

By pressing the left and right buttons, the flail regulator gain may now be adjusted in steps of 0.05 to a suitable gain for the coming flailing operation (based on prior experience). When the desired gain has been set, the centre button (HOME) will bring control back to the start of the MAIN MENU ("SELECT DATA").

**Note:**

The flail gain is parameter telling the control system how much correction to the hydraulic flail tilt cylinder that should be given as response to a given deviation in pressure based on the formula:

$$\text{tilt\_cylinder\_speed} = (\text{measured\_pressure} - \text{programmed\_pressure}) * \text{flail\_gain}$$

Take as example a situation where the flail pressure is set to 100 Bar and the flail gain is set to 0.40. If the measured pressure in a given situation is found to be 50 Bar, i.e. too low pressure, then the formula will give a cylinder response of  $(50-100)*0.4 = -20\%$  (Cylinder moves the flail towards ground at 20% speed).

## 6. Alarms and Warnings

Alarms and warnings are messages that pop up during operation, informing the operator about situations on the machine which are critical or situations that may be critical if they are not taken care of.

There are two levels, warnings and alarms.

Warnings is – as the name implies – just a warning that something has happened which may lead to a critical situation. The situation is not critical yet.

Typical examples are low oil levels, low fuel levels or temperatures that are starting to get high.

Alarms are situations that have already reached a level where damage is eminent. Typical examples are oil pressures too low to sustain a satisfactory lubrication or temperatures above critical level – probably with boiling cooling fluid.

Coolant temperature and oil pressure alarms always lead to automatic shutdown of the affected engines in the fastest and most suitable way to prevent the damage from escalating.

Situations that are worsening will always lead to a warning before it leads to an alarm. So if the situation is not abrupt, as with a broken hose or similar happening, the situation can often be stopped after warning has occurred if appropriate actions are taken by the operator.

### 6.1 Operator panel – local messages

These warnings are information about a local situation in the operator panel that may affect the operation. Some warnings disappear automatically, some may be acknowledged/silenced by pressing the centre display button, but this may differ between the different messages.

#### 6.1.1 Radio modem error

RADIO MODEM SETUP FAIL : 25
--------------------------------

May appear during startup. Indicates that a radio modem malfunction has been detected. The value to the right on the lower line indicates the type of error detected.

A value of “0” indicates that the operator panel cannot get a valid response from the radio module within the panel.

A value greater than 1 indicates that the modem is responding, but has detected an internal error.

Contact the technician.

### 6.1.2 Memory restore errors

MEMORY RESTORE  
BLOCK FAIL

MEMORY RESTORE  
DATA INVALID

MEMORY RESTORE  
FRAM ERROR

May appear during startup or anytime during use. Indicates that the processor has encountered a problem during restore of information from FRAM backup or during updating of variables in the same memory.

These messages are usually not critical as the restored data is mostly calibration data that the panel may operate without, just with a slight degradation in joystick and handle accuracy.

The only serious case is if an unrecoverable problem affects the machine ID-code. In this case, the panel and vehicle will not be able to communicate by radio, and hence there will be no response to panel operation.

If this happens, connect the panel by umbilical cable to let the vehicle and panel synchronize the ID-codes, before disconnecting the cable again. If there is a critical FRAM error, do not switch off the panel power after disconnecting the cable as the ID-code will then be lost again.

Contact technician for check and recalibration.

### 6.1.3 Empty battery warning

EMPTY BATTERY  
RECHARGE NOW

May appear during startup. Indicates that the operator panel ran out of power when it was in use the last time and that it haven't been recharged yet. Using the panel without charging it first is not possible as it will run out of power again almost instantly.

### 6.1.4 Low battery warning

LOW BATTERY

May appear anytime during use. Indicates that the battery voltage in the panel is about to reach a level where loss of communication may soon happen. Stop and connect to an external supply before commencing, if possible.



### 6.1.5 Channel collision warning

AN OTHER MACHINE  
ON THIS CHANNEL

May appear anytime during use. Indicates that the operator panel detects data from an other machine with different identity code.

Shut down system and contact technician for changing to a new radio channel.

### 6.1.6 Channel jamming warning

RADIO JAMMING  
ON THIS CHANNEL

May appear anytime during use. Indicates that the operator panel detects traffic on the channel that disrupts the MineCat communication. This traffic is not of MineCat origin, as interference from an other MineCat would instead give the message described in section 5.1.5.

Shut down system and contact technician for changing to a new radio channel.

### 6.1.7 Communication switching messages

SWITCH TO RADIO  
COMMUNICATION

May appear during use if the operator panel need to switch from cable to radio communication, for example when the umbilical is disconnected.

SWITCH TO CABLE  
COMMUNICATION

May appear during use if the operator panel need to switch from radio to cable communication, for example when the umbilical is connected. It may also appear if the panel loses contact with the vehicle by radio while being supplied from an external power source. It will then soon try to switch back to radio again, as cable communication is impossible, and it will continue switching back and forth until contact by radio is re-established.

## 6.2 System warnings and alarms

These warning/alarm messages are combined messages that can appear as either warnings (not critical) or as alarms (critical).

The system messages are generated by the CTU and indicates situations that occur on the vehicle itself, as compared to the local OPU-generated messages described in section 5.1

All warnings appear with the text: " > WARNING 03 << " on the upper line and the warning description on the lower line. The number to the right is a warning index number that specifically identifies each warning.

All alarms appear with the text: " >> ALARM 03 << " on the upper line and the alarm description on the lower line. The number to the right is an alarm index number that specifically identifies each alarm.

All new warnings and alarms are accompanied by an intermittent audible alarm with a volume and tone that will increase slowly to maximum if not acknowledged within a reasonable time.

New alarms cannot be acknowledged the first 5 seconds after they are started to avoid accidentally acknowledging the alarm before it has been properly observed by the operator. This could be the case if the operator was already busy pressing the buttons for menu navigation when the warning/alarm was triggered.

When the warning/alarm is ready to be acknowledged, the ">" and "<" signs will change to "- " indicating that it may now be acknowledged.

After pressing the display button, the acoustic alarm sound will be silenced and the message " ACKNOWLEDGED " will appear on the upper line for a few seconds, indicating that the warning or alarm has been acknowledged by the operator.

## 6.2.1 Engine and hydraulic oil pressure warnings and alarms

### Index 01: Main engine oil pressure warning/alarm

MAIN ENGINE OIL

Main engine lubrication oil pressure. Indicates loss of oil pressure. Check oil level.

Alarm will initiate an instant shutdown of both engines to prevent engine damage.

Warning goes on below: 1.8 Bar  
Warning goes off above: 2.2 Bar

Alarm goes on below: 0.8 Bar  
Alarm goes off above: 1.8 Bar

### Index 02: Flail engine oil pressure warning/alarm

FLAIL ENGINE OIL

Flail engine lubrication oil pressure. Indicates loss of oil pressure. Check oil level.

Alarm will initiate an instant shutdown of engine to prevent engine damage.

Warning goes on below: 1.8 Bar  
Warning goes off above: 2.2 Bar

Alarm goes on below: 0.8 Bar  
Alarm goes off above: 1.8 Bar

### Index 03: Flail pilot oil pressure warning/alarm

FLAIL PILOT OIL

Flail oil feed pump pressure. Indicates loss of feed pressure on flail pump.

Warning goes on below: 15 Bar  
Warning goes off above: 18 Bar

Alarm goes on below: 13 Bar  
Alarm goes off above: 15 Bar

## 6.2.2 Engine and hydraulic oil temperature warnings and alarms

### Index 05: Main engine coolant temperature warning/alarm

MAIN ENGINE TEMP

Main engine coolant temperature. Indicates overheating of engine. Check coolant level, radiators and cooling fans.

Alarm will initiate a speed reduction to idle but leave the engine running for optimal cooling.

Warning goes on above: 97 °C  
Warning goes off below: 95 °C

Alarm goes on above: 99 °C  
Alarm goes off below: 97 °C

### Index 06: Flail engine coolant temperature warning/alarm

FLAIL ENG. TEMP

Flail engine coolant temperature. Indicates overheating of engine. Check coolant level, radiators and cooling fans.

Alarm will initiate a speed reduction to idle but leave the engine running to cool down.

Warning goes on above: 98 °C  
Warning goes off below: 95 °C

Alarm goes on above: 103 °C  
Alarm goes off below: 98 °C

### Index 07: Main hydraulic oil temperature warning/alarm

MAIN HYDR. TEMP

Main hydraulic oil temperature. Indicates overheating of hydraulic oil in main circuit.

Warning goes on above: 90 °C  
Warning goes off below: 85 °C

Alarm goes on above: 95 °C  
Alarm goes off below: 90 °C

**Index 08: Flail hydraulic oil temperature warning/alarm**

FLAIL HYDR. TEMP

Flail hydraulic oil temperature. Indicates overheating of hydraulic oil in flail circuit.

Warning goes on above: 90 °C

Warning goes off below: 85 °C

Alarm goes on above: 95 °C

Alarm goes off below: 90 °C

**6.2.3 Low voltage warnings**

**Index 10: Battery voltage – low warning**

BATTERY VOLTAGE

Low battery voltage on starter battery when engine is not running.

Warning goes on below: 10.0 V

Warning goes off above: 11.0 V

**Index 11: Generator voltage - low warning**

GENERATOR VOLT

Low battery voltage on starter battery when engine is running. Indicates that the generator (alternator) is not working properly.

This warning may occur shortly after start with a poor battery and before the generator has stabilized the voltage. The warning should disappear within seconds.

If the warning continues for a longer time, check the battery voltage on the menu and observe if the voltage is rising or not. If the voltage doesn't rise above 13.0V within a reasonable time, contact the technician.

Warning goes on below: 12.5 V

Warning goes off above: 13.0 V

**Index 12: IFU voltage drop warning**

IFU VOLTAGE DROP

Indicates that the interface unit has detected a serious voltage drop and that all outputs controlling power consuming loads, except the actuator supply, has been switched off to prevent the voltage from dropping even lower.

This protection will go into action during attempted start of engines with a poorly charged battery. Letting the power drop even further will not give any positive result as the control system will soon lose control and being forced to restart.

Recharge battery before attempting a new start.

**6.2.4 Low fuel and oil level warnings**

**Index 15: Main fuel level – low warning**

MAIN FUEL LEVEL

Low fuel level in main fuel tank. Go to the main menu to check the tank level.

Warning goes on below: 15% (main fuel tank below this level)  
Warning goes off above: 30% (flail fuel tank above this level)

**Index 16: Flail fuel level – low warning**

FLAIL FUEL LEVEL

Low fuel level in flail fuel tank. Go to the main menu to check the tank level.

Warning goes on below: 15% (flail fuel tank below this level)  
Warning goes off above: 30% (flail fuel tank above this level)

**Index 18: Flail oil level - low warning**

FLAIL OIL LEVEL

Low oil level in flail hydraulic tank.

Stop flail and refill oil as soon as possible.

## 6.2.5 Filter clogged warnings

### **Index 22: Main hydraulic low pressure oil filter clogged warning**

MAIN OIL FILTER

Main hydraulic low pressure oil filter is clogged.

Stop engine and replace filter as soon as possible.

### **Index 23: Main hydraulic high pressure oil filter clogged warning**

MAIN OIL FILTER

Main hydraulic high pressure oil filter is clogged.

Stop engine and replace filter as soon as possible.

### **Index 25: Flail hydraulic oil filter clogged warning**

FLAIL OIL FILTER

Flail hydraulic oil filter is clogged.

Stop flail and replace filter as soon as possible.

## 6.2.6 4-20 mA sensor - failure warnings

### **Index 31: 4-20mA sensor #1 failure warning**

4-20mA #1 METEMP

Sensor failure on 4-20 mA sensor #1 – main engine temperature (METEMP). Indicates a sense current below 3.5mA or above 20.5mA.

Contact technician and proceed with care as main engine temperature warning/alarm is now disabled.

### **Index 32: 4-20mA sensor #2 failure warning**

4-20mA #2 MEOILP

Sensor failure on 4-20 mA sensor #2 – main engine oil pressure (MEOILP). Indicates a sense current below 3.5mA or above 20.5mA.

Contact technician and proceed with care as main engine oil pressure warning/alarm is now disabled.

### **Index 33: 4-20mA sensor #3 failure warning**

4-20mA #3 FETEMP

Sensor failure on 4-20 mA sensor #3 – flail engine temperature (FETEMP). Indicates a sense current below 3.5mA or above 20.5mA.

Contact technician and proceed with care as flail engine temperature warning/alarm is now disabled.

### **Index 34: 4-20mA sensor #4 failure warning**

4-20mA #4 FEOILP

Sensor failure on 4-20 mA sensor #4 – flail engine oil pressure (FEOILP). Indicates a sense current below 3.5mA or above 20.5mA.

Contact technician and proceed with care as flail engine oil pressure warning/alarm is now disabled.



**Index 35: 4-20mA sensor #5 failure warning**

4-20mA #5 FLOUTP

Sensor failure on 4-20 mA sensor #4 – flail pump output pressure (FLOUTP). Indicates a sense current below 3.5mA or above 20.5mA.

Automatic contouring will not work in this case as this sensor is crucial for correct operation. Contact technician.

**Index 36: 4-20mA sensor #6 failure warning**

4-20mA #6 FPILOT

Sensor failure on 4-20 mA sensor #6 – flail pilot pump pressure (FPILOT). Indicates a sense current below 3.5mA or above 20.5mA.

Contact technician and proceed with care as flail pilot oil pressure warning/alarm is now disabled. Automatic contouring may also be affected.

**6.2.7 Variable resistance sensor - failure warning**

**Index 41: CTU – RVAR sensor # 1 failure warning**

CTU RV1 MHYDTEMP

Sensor failure on variable resistance sensor # 1 on CTU - main hydraulic temperature sensor (MHYDTEMP). Indicates a measured value below 10 ohm or above 3300 ohm, i.e. outside normal operating range.

Contact technician and proceed with care as main hydraulic temperature warning/alarm is now disabled.

The sensor input is designed to handle sensors at normal operating temperatures. During start in cold weather, around 0 °C or colder, the sensor may temporarily indicate a failure situation (ERROR) until the oil temperature rises above +5 - +10 °C. This indication is caused by the sensor interface and is not a real error situation. Due to this, sensor fail warning is inhibited until the main engine temperature rises above 50 °C to avoid false warning.

**Index 42: CTU – RVAR sensor # 2 failure warning**

CTU RV2 FHYDTEMP

Sensor failure on variable resistance sensor # 2 on CTU - flail hydraulic temperature sensor (FHYDTEMP). Indicates a measured value below 10 ohm or above 3300 ohm, i.e. outside normal operating range.

Contact technician and proceed with care as flail hydraulic temperature warning/alarm is now disabled.

The sensor input is designed to handle sensors at normal operating temperatures. During start in cold weather, around 0 °C or colder, the sensor may temporarily indicate a failure situation (ERROR) until the oil temperature rises above +5 - +10 °C. This indication is caused by the sensor interface and is not a real error situation. Due to this, sensor fail warning is inhibited until the flail engine temperature rises above 50 °C to avoid false warning.

**Index 43: IFU – RVAR sensor # 1 failure warning**

IFU RV1 MAINFUEL

Sensor failure on variable resistance sensor # 1 on IFU - main fuel tank sensor (MAINFUEL). Indicates a measured value below 10 ohm or above 3300 ohm, i.e. outside normal operating range.

Contact technician and proceed with care as main fuel tank warning is now disabled

**Index 44: IFU – RVAR sensor # 2 failure warning**

IFU RV2 FLAIFUEL

Sensor failure on variable resistance sensor # 2 on IFU - flail fuel tank sensor (FLAIFUEL). Indicates a measured value below 10 ohm or above 3300 ohm, i.e. outside normal operating range.

Contact technician and proceed with care as flail fuel tank warning is now disabled

## 6.2.8 Digital output – failure or protect warnings

### Index 51: Digital output failure warning

DIGITAL OUTPUT

Indicates that an output failure has occurred on one of the digital smart-relay outputs on the interface unit (IFU). The output is most probably overloaded and the current limiter function has been activated to prevent damage. Contact technician.

This alarm does not include the “actuator and sensor supply” output – see index 52.

### Index 52: Actuator and sensor supply failure warning

ACTUATOR SUPPLY

Indicates that an output failure has occurred on the digital smart-relay outputs on the interface unit (IFU) supplying power to sensors and actuators. The output is most probably overloaded and the current limiter function has been activated to prevent damage.

Contact technician if the problem continues.

## 6.2.9 Smart relays and outputs – failure warning

### Index 61: Main engine starter - smart relay warning

MAIN START FAIL

Indicates that an output failure has occurred on the high-power smart relay output for the main engine starter.

Contact technician.

### Index 62: Main engine glow plugs - smart relay warning

MAIN GLOW FAIL

Indicates that an output failure has occurred on the high power smart-relay output for the main engine glow plugs.

Contact technician.

**Index 63: Main fuel valve - failure warning**

MAIN FUEL FAIL

Indicates that an output failure has occurred on the high power output for the main fuel valve.

Contact technician.

**Index 64: Main gear - failure warning**

MAIN GEAR FAIL

Indicates that an output failure has occurred on the high power output for the main gear selector.

Contact technician.

**Index 65: Flail engine starter - smart relay warning**

FLAIL START FAIL

Indicates that an output failure has occurred on the high power smart-relay for the flail engine starter.

Contact technician.

**Index 66: Flail engine glow plugs - smart relay warning**

FLAIL GLOW FAIL

Indicates that an output failure has occurred on the high power smart-relay for the flail engine glow plugs.

Contact technician.

**Index 67: Flail engine fuel valve – failure warning**

FLAIL FUEL FAIL

Indicates that an output failure has occurred on the high power output for the flail engine fuel valve.

Contact technician.

**Index 69: Tilt bypass valve - failure warning**

BYPASS VALV FAIL

Indicates that failure has occurred on the high power output controlling the tilt bypass valve.

Contact technician.

**6.2.10 Special warnings**

**Index 71: Main throttle actuator warning**

MAIN THROTT. ACT.

Indicates that an error situation is detected and reported by the main engine throttle actuator. This may be due to internal failure, loss of hydraulic power or a jammed link.

Contact technician if no obvious reason can be found.

**Index 72: Flail throttle actuator warning**

FLAIL THROT. ACT.

Indicates that an error situation is detected and reported by the flail engine throttle actuator. This may be due to internal failure, loss of hydraulic power or a jammed link.

Contact technician if no obvious reason can be found.

**Index 73: Left speed actuator warning**

LEFT SPEED ACT.

Indicates that an error situation is detected and reported by the left side pump-speed actuator. This may be due to internal failure, loss of hydraulic power or a jammed link.

Contact technician if no obvious reason can be found.

**Index 74: Right speed actuator warning**

RIGHT SPEED ACT.

Indicates that an error situation is detected and reported by the right side pump-speed actuator. This may be due to internal failure, loss of hydraulic power or a jammed link.

Contact technician if no obvious reason can be found.

**Index 75: Tilt valve warning**

TILT VALVE

Indicates that an error situation is detected and reported by the tilt proportional valve. This may be due to internal failure or loss of hydraulic power.

Contact technician if no obvious reason can be found.

**Index 77: Starter motor protection warning**

STARTER PROTECT

Indicates that one of the starter motors has been kept continuously engaged for more than 15 seconds and has been switched off by the system to prevent overheating of the starter and subsequent damage.

**Index 78: Emergency stop warning**

EMERGENCY STOP

Indicates that the EMERGENCY STOP button on the machine is activated and thus inhibits start of the engines.

**6.2.11 System failure warnings and alarms**

**Index 91: IFU communication timeout alarm**

IFU TIMEOUT

Indicates that a timeout has occurred on the communication with the interface unit. This may be due to an electronic failure, a cable problem or a transient error.

First attempt to restart the system by switching off the vehicle main switch for 5 seconds, then switch on again. If problem reappears, contact technician.

**Index 92: IFU program restart warning**

IFU RESTART

Indicates that a restart of the program in the interface unit has occurred. This may be due to an electronic failure, a cable problem or a transient error.

First attempt to restart the system by switching off the vehicle main switch for 5 seconds, then switch on again. If problem reappears, contact technician.

**Index 93: Radio modem setup warning**

RADIOMODEM SETUP

Indicates that the control unit electronics cannot get a valid response from the radio module within the control unit.

This problem would normally also give loss of radio communication as a result. The warning should therefore only be seen after switching to umbilical cable for communication. If this message is visible when using radio communication, it is obviously not a critical error. In this case operation may be continued with care.

Contact the technician.

**Index 94: CTU memory restore warning**

FRAM ACCESS FAIL

Indicates that the CTU-processor has encountered a problem during restore of calibration information from its local FRAM memory. This warning should only appear when starting up the system.

In case of this failure, the system will use default calibration values wherever possible. If radio contact with machine is still established, communication parameters must be correct and operations may then continue, even though small errors (max. 2-3%) may be observed in sensor measurements.

Contact technician for recalibration.

**Index 95: Illegal machine**

ILLEGAL MACHINE

This version of the control system software is designed to be used on both MineCat 140 KE and MineCat 230 KE. Differences between the two machines are handled by selecting the proper machine type in the technical menu. An additional sensor input on the IFU tells the system whether the machine is a MineCat 140 KE (12V on sensor pin) or a MineCat 230 KE (no voltage on sensor pin).

This warning indicates that the sense input indicates a different machine type than what the system is programmed for (in the technical menu).

Contact technician to verify machine type and select proper setting.