


# Optidrive Applications Support Library

<b>Application Note</b>	<b>AN-ODP-2-034</b>
<b>Title</b>	<b>Using Hoist Mode</b>
<b>Related Products</b>	<b>Optidrive P2</b>
<b>Level</b> <b>4</b>	1 – Fundamental - No previous experience necessary 2 – Basic – Some Basic drives knowledge recommended 3 – Advanced – Some Basic drives knowledge required 4 – Expert – Good experience in topic of subject matter recommended

## Important Safety Notice

	<p>All Inverter Drives application notes are intended to provide general guidance concerning the use of drives in relevant applications. The information and diagrams contained within are for guidance purposes only, and do not claim to be complete, nor specifically relate to any customer applications. It is the responsibility of the system designer, installer and commissioning engineer to ensure that the drive operates in a safe manner throughout all operating conditions. By using this Application Note, you accept that Inverter Drives has no liability for any damage or claims resulting from the use of the information contained herein.</p>
	<p>All Application notes are subject to continuous updates, and may be changed at any time without prior notice.</p>
	<p>Inverter Drives products should not be used to perform any safety function beyond which they are certified for.</p>
	<p>Hoist applications are inherently dangerous. Incorrect selection of components, installation or commissioning can result in loss of control of the suspended load, potentially causing personal injury and/or equipment damage. The drive or a mechanical brake must always control the load.</p>
	<p>Hoist application should only be commissioned by engineers with sufficient experience and knowledge of the application to ensure safety is maintained at all times.</p> <p>All hoists should be designed with essential features to ensure safe operation such as end of travel limits, over-speed detection and fault monitoring. Correct control system and implementation is required to ensure that the drive may only operate the hoist when no other potentially dangerous condition exists.</p> <p>The Parameters listed in this Application Note are intended to assist with lifting/torque proving applications. It is the responsibility of the engineer and/or end user to correctly and safely configure the drive parameters, test all functionality and ensure all safety requirements in accordance with all applicable codes and standards are maintained in all conditions.</p>

## Overview

Optidrive P2 provides a dedicated Hoist Mode function to assist with safe commissioning of the drive in hoist applications.

Hoist mode provides the following operation features:-

- Direct control of the motor electromechanical holding brake.
- Pre-magnetisation and pre-torque of the motor prior to brake release.
- Detection of brake fault and trip.
- Holding torque during brake application on stopping.

This document describes how to enable the Hoist Mode function, and the parameters which can be adjusted to optimise its operation.

## Hoist Specific Application Requirements

In a hoisting or lifting application, a load will be raised or lowered, and it must be possible for the load to be held in position. For this reason, an electro-mechanical holding brake with sufficient torque capacity must be fitted. In order to safely lift the load, high starting torque must be available immediately when the brake is released, whilst stopping in position requires holding torque for a short period during which the brake is applied.

Hoist applications should be handled with care, and careful attention to the system design and operation. It is essential when using drives in hoist applications to consider the following points as a minimum.

### Drive Selection

It is of utmost importance to ensure that the drive operates at all times within its designed capacity to ensure safe operation in hoist applications. In many cases, hoist motors are selected based on intermittent duty, therefore the motor may operate infrequently and for short periods, often above the rated nameplate current or power capacity. For this reason, it is always advisable to select a drive power rating at least one rating higher than the motor rated power, e.g. for a 37kW / 50HP motor, the drive should be at least 45kW / 60HP.

In cases where the application has extremely high peak load demands, or is vitally important for production operation or safety critical, it is advisable to select a drive two ratings above the motor size, e.g. for a 37kW / 50HP motor, select a 55kW / 75HP drive. This over-sizing is intended to ensure the drive never operates close to its limit, and thereby remains safe at all times.

### Brake Resistor Selection

All hoist applications **must** have a brake resistor connected to the drive. The brake resistor must be selected to suit the application, which means it must be capable of dissipating the energy required to continuously operate the hoist at maximum designed load throughout the full range of movement.

As a general guide, the brake resistor can be selected based on the motor power, and a 50% duty cycle, e.g. for a 37kW / 50HP motor, a brake resistor capable of 37kW at 50% duty should be used. With experience and correct information, it is possible to calculate the size more accurately – the hoist manufacturer should be able to advise further.

The resistance should be selected based on the minimum resistance level permissible for the drive, refer to the appendix in the back of this document.

Whenever a load is lowered, the brake resistor may be active throughout the lowering; hence the brake resistor must also be capable of dissipating the rated power for the time period involved.

The Brake Resistor should be connected to the terminals labelled “+” and “BR” on the drive.

### Open Loop / Closed Loop Operation

Optidrive P2 can be used in closed or open loop hoisting applications (with or without feedback encoder). It is recommended to use closed loop where possible, as this provides additional safety. The encoder may be monitored and the drive stopped / motor brake applied in the event that the hoist speed deviates from the commanded speed. Open loop operation should only be used in applications where personal safety is not a concern.

When operating without encoder feedback, a risk assessment should be completed first to ensure safe system design. When commissioning the system, it is important to ensure that the output frequency of the drive is maintained above 2Hz at all times when the motor holding brake is released.

## Hoist Mode Operation

When operating in Hoist Mode, the motor holding brake is controlled directly from Relay Output 2 (Terminals 17 and 18). In order to ensure the safest possible operation the drive assumes a predefined operating status, which results in the following parameter settings effectively being ignored by the drive, and safe operating values assumed as follows :-

- P1-06 : Energy Optimiser is disabled
- P2-09 & P2-10 : Skip frequencies are disabled
- P2-26 : Spin Start is disabled
- P2-27 : Standby Mode disabled
- P2-36 : Start Mode is always edge triggered
- P2-38 : Mains Loss results in a coast stop (Motor holding brake will apply)
- P4-06 & P4-07 : Torque limit is fixed at maximum available torque
- P4-08 : Minimum torque limitation set to zero
- P4-09 : Maximum regenerative torque fixed at maximum permissible limit

### Important: Motor Rotation Direction

When operating in Hoist Mode, the motor must be connected to the drive so that when the drive receives a Run Forward command, the hoist travels in the upward direction. If necessary, the output phase connection sequence to the motor can be changed to ensure the correct direction of rotation.

### Hoist Mode Operation Flow Diagram

Hoist Mode operates according to the following sequence:-

Control Commands	Drive Actions
Run Command Applied	Drive Output Is Enabled
	Frequency Ramps to Brake Release Frequency / Speed P2-07
	Output torque is monitored until it exceeds the level set in P6-15
	Output Relay 2 closes to release the brake
	Output frequency / speed remains at P2-07 level for the time set in P6-13 Brake Release Delay
	Normal Operation / Drive Running
Run Command Removed	Output frequency ramps to Brake Apply Frequency / Speed P2-08
	Output Relay 2 opens to apply the brake
	Output frequency / speed remains at P2-08 level for the time set in P6-14 Brake Apply Delay
	Drive Output is disabled

## General Commissioning Guidelines

It is important that the drive is correctly commissioned in a hoist application to ensure safe operation. The following guidelines are intended to highlight some of the parameters that should be checked and adjusted during the commissioning process. The list is not intended to be exhaustive for all applications, but should provide a starting point for most purposes.

- Minimum and maximum operating speeds should maintain the hoist and motor within a safe operating band. Operation at very low speeds or attempting to hold the load at zero speed in open loop without the motor brake applied is not recommended.
- Over speeding motors to provide faster operation should only be used when the hoist operates without load. When a motor operates above it's rated speed, torque is reduced, which may result in dangerous or unsafe operation. Where over speeding is to be used in light or no load conditions, safe system design is imperative to ensure correct operation.
- Acceleration times in general should be set to a high enough value to ensure reliable smooth operation and allow sufficient operator control.
  - Generally, acceleration time values in the 5 – 10 second range will produce good results. Short acceleration times will increase the stress on mechanical components, and may also make the hoist difficult to control.
  - Deceleration times should be short enough to allow responsive control without excessive strain on any system components.

A key factor to consider when commissioning hoist applications is the ratio between the motor kW and the hoist maximum load capacity. The higher the kW value for a given tonne capacity, the faster the hoist will operate and the control becomes much more dynamic. The parameters values therefore need adapting based on the hoist design. The example parameter values shown below provide a starting point for hoists where a 4 pole motor is used. They should always be fine-tuned for each particular hoist application, and adapted according to the motor type, e.g. 4pole, 6 pole, 8 poles etc.

In general, the following basic principles apply:

Parameter	Estimate value from
Brake Release (Open) Speed	Closed Loop : Motor Slip + kW / Tonnes Open Loop : Motor Slip x ((kW / Tonnes) + 1)
Brake Apply (Close) Speed	Closed Loop : Motor Slip Open Loop : Motor Slip x (kW / Tonnes)
Torque Prove Level	$4 + ((kW / Tonnes) / 10)\%$

## Hoist Mode Commissioning Steps

The following procedure provides a step by step guide for start-up commissioning of hoist applications. In each application, there may be additional steps to follow, such as configuration of the drive digital inputs and outputs, which are explained in the drive User Guide. It is assumed that the drive is already correctly installed according to the instructions provided in the User Guide.

**Note:** Commissioning should be started without load and the hoist hook positioned close to the bottom of travel.

**Note:** Commissioning is much simpler using Optitools Studio PC software, which allows easy viewing and adjustment of all parameters, whilst also providing a scope function to visualise the behaviour of the crane during tests.

### **Step 1: Ensure the factory default parameters are loaded.**

In order to ensure safe commissioning, disconnect the drive terminal strip and reset the drive to factory default parameters using the procedure explained in the User Guide before starting.

### **Step 2: Connect the Hoist Brake Control.**

For correct hoist operation, the motor holding brake control circuit must be directly controlled from Relay Output 2 (terminals 17 and 18) on the Optidrive.

- Power must be provided to the motor brake, through a suitably rated contactor or relay.
- Refer to the brake for power supply voltage and current requirements.
- The contactor / relay operation should be directly controlled by the drive Relay output 2.
- The brake must not be powered from the output of the drive, e.g. U, V and W terminals.

### **Step 3: Select a suitable Control Terminal Macro function.**

Parameter P1-13 should be set to suit the wiring and control functions required. Examples are shown later in this document. Connect any control cables as required.

### **Step 4: Configure the basic motor settings.**

Switch on the power to the drive, and configure the motor parameters and operating mode as follows:-

- P1-07: Enter the motor rated voltage (Volts).
- P1-08: Enter the motor rated current (Amps).
- P1-09: Enter the motor rated frequency (Hz).
- P1-10: Enter the motor rated speed (RPM). This value is optional in open loop applications, but must be set in all closed loop applications.
- Do not enter incorrect values; enter each value exactly as shown on the motor nameplate, otherwise incorrect and potentially dangerous motor control performance can result.
- Enable Advanced Parameter Access by setting P1-14 = 201.
- Select the motor control mode, enter final motor details and autotune as follows:-
  - Set Parameter P4-01 = 0 for Vector Speed Control Operating Mode.
  - Enter the motor power factor from the motor nameplate in P4-05 (Cos  $\phi$ ).
  - Carry out an autotune by setting P4-02 = 1.
    - It is not necessary to disconnect the load, or remove the motor brake during the autotune.
    - The motor shaft may move during the autotune, so it is important that the hoist is at the bottom of its travel, and no load is present.

### **Step 5: Enter the Brake Resistor Data and enable the Brake Transistor.**

- P1-05: Set to 2 to enable the brake resistor.
- P6-19: Enter the brake resistor Ohmic value (Ohms).
- P6-20: Enter the brake resistor kW value (kW).

### **Step 6: Check the Direction of Operation.**

- With no load present on the hoist, check the operation at low speed (e.g. 5Hz) to ensure that when lifting the hoist, the drive receives a run forward command.
  - If necessary, swap any two motor phases (not input phases) to correct the direction of operation.

### **Step 7: Enter the Encoder Parameters for Closed Loop Operation.**

For open loop applications, this step may be ignored.

- The rated speed from the motor nameplate must be entered in P1-10 (RPM).
- Enter the PPR value from the encoder in P6-06 (PPR).
- With no load present on the hoist, operate the drive at low speed (e.g. 5Hz), and check the sign and value displayed in P0-58 (Hz).
  - When the hoist moves up, P0-58 must show a positive value. Downward movement should show a negative value.
    - If the values are reversed.

- On the encoder feedback interface, swap the wires in terminals 1 and 2.
- Swap the wires in terminals 3 and 4.
- Repeat the test.
- P0-58 value during operation should closely match (within 5%) the target operating speed.
  - E.g. if operating at 5Hz, P0-58 must display 5Hz + / - 5%.
  - If the value is not correct, check.
    - P1-10 value is correct.
    - P6-06 value is correct.
    - Encoder wiring and shield connection are correct.
- When the encoder operates correctly, enable closed loop operation by setting P6-05 = 1. In addition, enable Enhanced Generator Mode by setting P7-07 = 1.
- Define the acceptable speed deviation for the encoder in P6-07 (%).
  - This is the allowed error between the expected motor speed and the speed measured from the encoder.
  - If the limit is exceeded, the drive immediately trips, and applies the motor brake.
  - The value should be small enough to protect the system in the event of a loss of control of the system.
  - If the value is too small, nuisance tripping may occur.
  - Typically, 5 – 10% will provide acceptable performance with safety.

**Step 8: Enable Hoist Mode.**

- Enable hoist mode by setting P2-18 = 8.

**Step 9: Configure the Initial Acceleration and Deceleration Times.**

In general, hoist applications require relatively short acceleration and deceleration times to achieve good control. It is suggested as an initial starting point to use the following:-

- Acceleration Time P1-03: 5.0 – 10.0 (seconds).
- Deceleration Time P1-04: 2.0 (seconds).

These values can be adjusted later during testing with load if required.

**Step 10: Set the Brake Release Frequency / Speed.**

Enter a suitable Brake Release Frequency in parameter P2-07 (RPM / Hz). This is the frequency or speed which will be used to generate a holding torque prior to releasing the electro-mechanical brake.

Note: If P1-10 >0, the value entered / displayed is in RPM.

The initial value can be estimated according to the formula shown earlier in this document.

- E.g. for a 4 pole, 30kW motor with a nameplate speed of 1470 RPM used on a hoist with capacity 20 Tonnes.
  - Motor Slip = synchronous speed – rated speed = 30RPM.
  - kW / Tonnes = 30 / 20 = 1.5
    - For a Closed Loop application: Initial value for P2-07 = 30 + 1.5 = 32RPM
    - For an Open Loop application: Initial value for P2-07 = 30 x (1.5 + 1) = 75 RPM

The value can then be adjusted during the testing if required.

**Step 11: Set the Brake Apply Frequency / Speed**

Enter a suitable Brake Apply Frequency / Speed in P2-08 (RPM / Hz). When the hoist stops, this frequency will be used to maintain holding torque in the motor during the time in which the brake is applied.

The initial value can be estimated according to the formula shown earlier in this document.

- E.g. for a 4 pole, 30kW motor with a nameplate speed of 1470 RPM used on a hoist with capacity 20 Tonnes.
  - Motor Slip = synchronous speed – rated speed = 30RPM.
  - kW / Tonnes = 30 / 20 = 1.5
    - For a Closed Loop application: Initial value for P2-08 = 30 RPM
    - For an Open Loop application: Initial value for P2-08 = 30 x 1.5 = 45 RPM

The value can then be adjusted during the testing if required.

**Step 12: Set the Brake Release (Open) Time**

Enter the operating time for Brake Release (Open) in P6-13 (seconds). This is the time required by the brake when power is applied before the motor shaft may turn.

- If possible, obtain the value from the brake manufacturer.
- If this is not possible the time should be estimated or measured by starting the drive without load and observing when the brake opens. Typically, the value will be in the 0.2 – 1.0 second range.

**Step 13: Set the Brake Apply (Close) Time**

Enter the operating time for Brake Apply (Close) in P6-14 (seconds). This is the time required for the brake to close when the power is removed.

- If possible, obtain the value from the brake manufacturer.
- If this is not possible, the time can be measured or estimated by starting and stopping the drive and observing the operation of the brake. Typical values are in the 0.2 – 1.0 second range.

**Step 14: Set the Torque Prove Level.**

The Torque Prove Level is the level of torque which must be present on the motor before the brake is signalled to release. The value is entered in P6-15 (%) and is the % of motor rated torque.

An initial value can be estimated according to the formula shown earlier in this document.

- E.g. for a 4 pole, 30kW motor with a nameplate speed of 1470 RPM used on a hoist with capacity 20 Tonnes.
  - $\text{kW} / \text{Tonnes} = 30 / 20 = 1.5$ 
    - For a Closed Loop or Open Loop application: Initial value for P6-15 =  $4 + (1.5 \times 10) = 19\%$

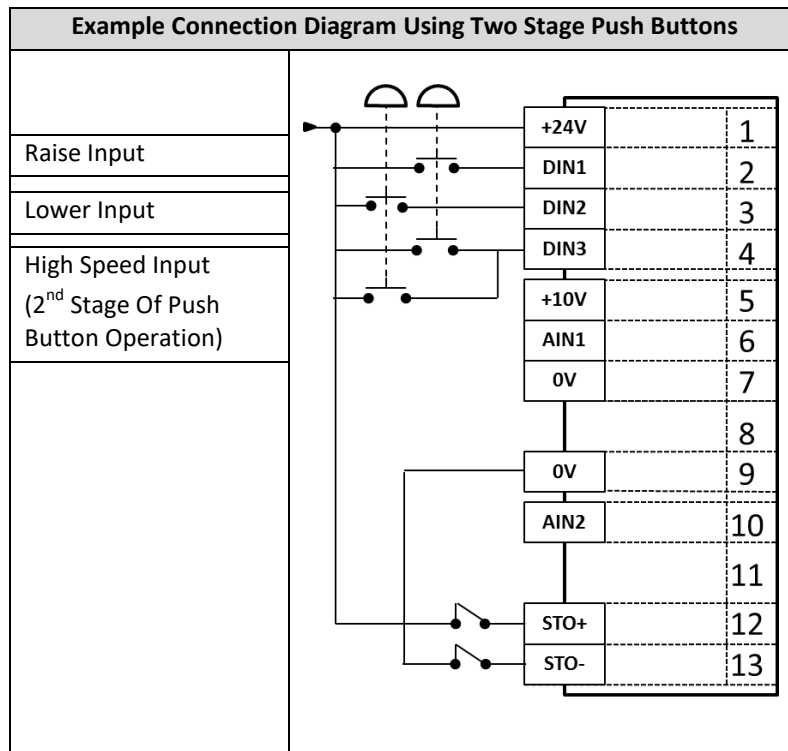
The value can be fine-tuned during testing. In general, the value should be in the 8 – 30.0% range, and can be increased if the hook appears to drop slightly before lifting when working with high loads.

Basic parameters are now set and the hoist may be operated, starting with no load and operating at low speed. If operation at no load and low speed is ok, check no load with maximum speed operation. If this is also satisfactory, load can gradually be increased, and continue testing and optimising the parameters throughout. Ensure operation is checked for raising and lowering.

## Connection Example - Two Speed Hoist Operation

In typical hoist applications, it is common to use a two preset speed approach, whereby a high speed is used for large movements, and a low speed is used for final position or operations which require more careful control. The high speed will normally be the rated speed of the motor, and the low speed will typically be 10 – 20% of this value.

Operation is normally controlled using a push button pendant operator station, which will have a Raise (Up) pushbutton and a Lower (Down) Pushbutton. The pushbuttons should be two stages, with the first stage used to enable the drive and select the direction, and the second stage used to select the High Speed operation. A simplified example wiring schematic is shown below:-

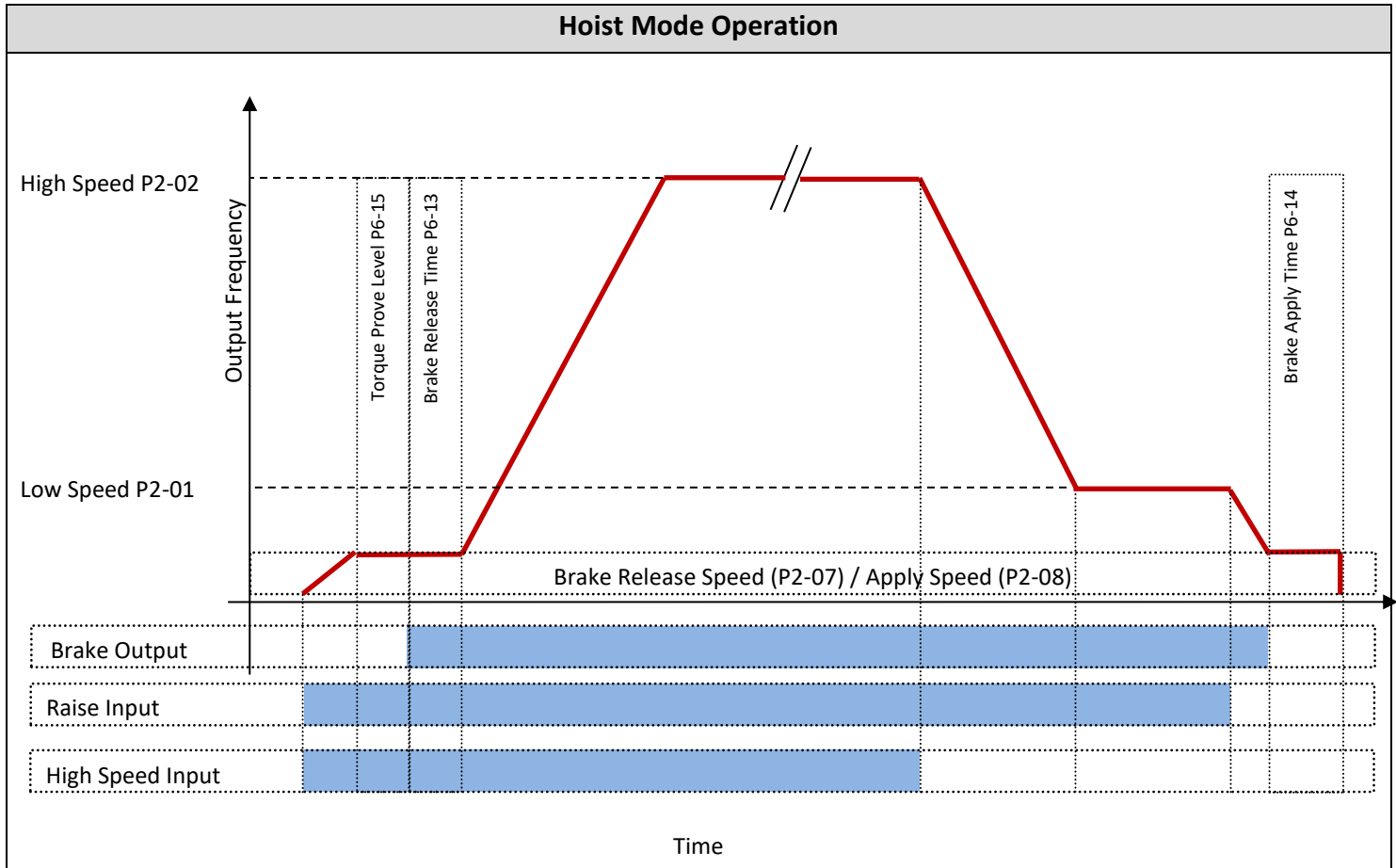


Using this example schematic, the following parameter settings are required:-

Par.	Description	Setting
P1-12	Control Source Selection	0 : Terminals
P1-13	Digital Inputs Function Select	12
P2-01	Lows Speed	E.g. 10 Hz
P2-02	High Speed	E.g. 50 / 60Hz

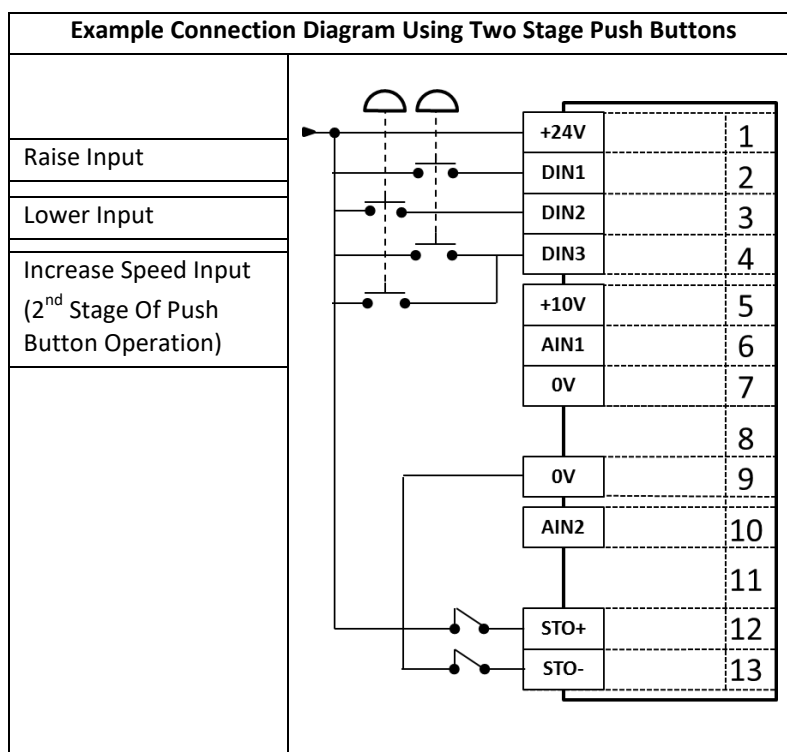


## Two Speed Operation Timing Diagram



## Connection Example - Variable Speed (Push Button) Hoist Operation

Hoist operation is also possible with variable speed control using two stage push buttons on a pendant, sometimes referred to as “Infinitely Variable Speed Operation”. In this mode, the first stage of push button operation starts the drive at minimum speed, or holds the current operating speed, whilst the second stage of push button operation causes the speed to increase. This allows the user to control the hoist at any speed between the minimum and maximum at any time. The connection diagram required for this is as shown below:-

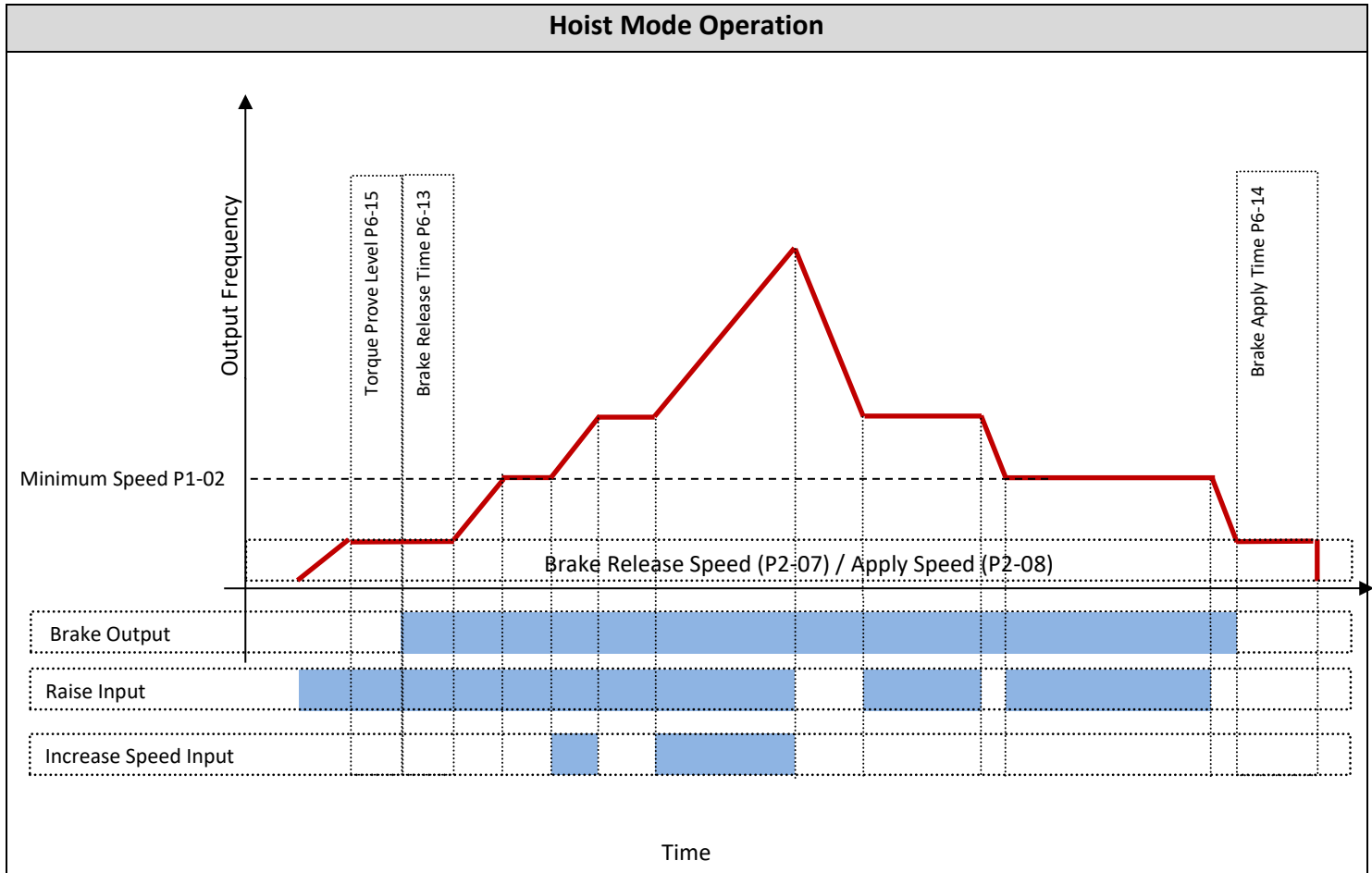


Using this example schematic, the parameter settings required are as shown below:-

Par.	Description	Setting
P1-02	Minimum Operating Speed	E.g. 10Hz
P1-12	Control Source Selection	1 : Keypad*
P1-13	Digital Inputs Function Select	20
P2-37	Keypad Mode Restart Control	6 : Current Speed

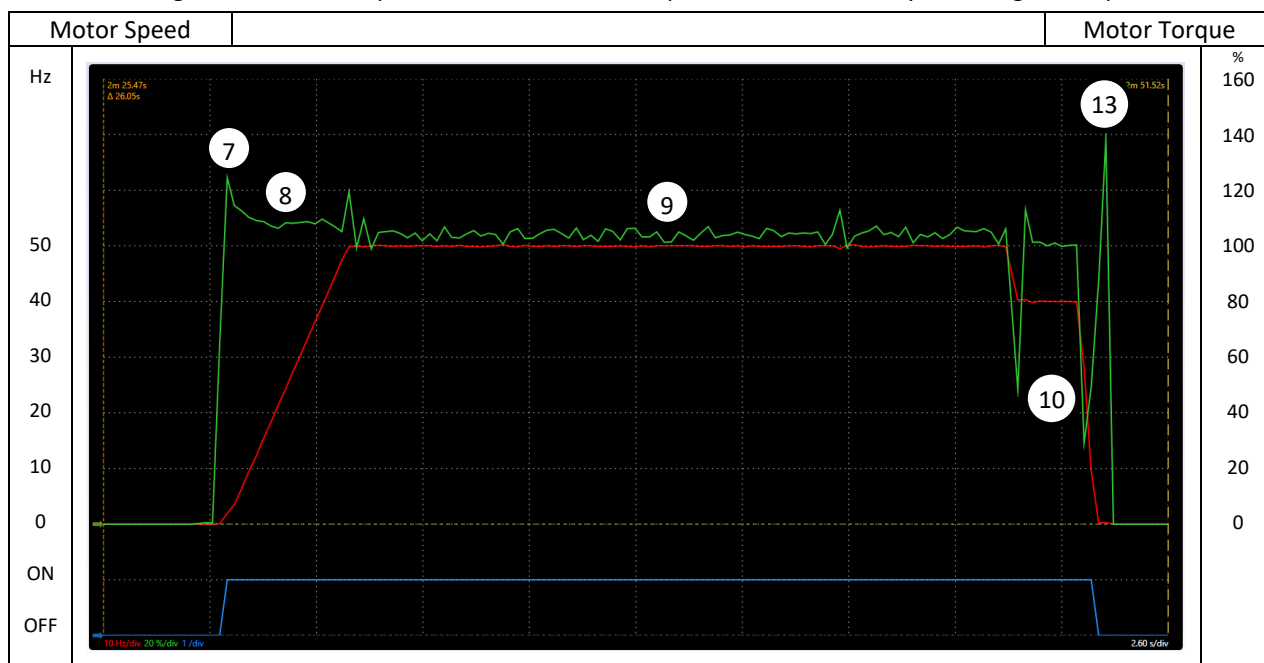
\*Whilst keypad operating mode of the drive is selected, setting P2-37 allows control to take place from the control terminals

### Variable Speed Mode Example Timing Diagram



### Example Scope Trace

Shown below is an example scope trace recorded in a hoist application, showing the typical behaviour when the system is correctly commissioned and operating at full load capacity. This is provided as an indication of the scope trace shape that can be achieved with a correct motor and drive combination and correct parameter settings. The parameter values shown below are to provide explanation of the graph and are not guaranteed to work in all applications. Each hoist requires specific parameter adaptation and tuning, and it should be possible to achieve similar performance results by following the steps shown above.



In this application, the motor has the following specification

- 400V
- 34.6 A
- 15kW
- 50Hz
- 1460 RPM
- 0.86 Cos  $\phi$

The drive used: ODP-2-44220-3KF42-TN (46A drive selected for 34.6A motor), with the following parameters settings:

Parameter	Value	Parameter	Value
P1-02	600 rpm	P6-05	1: Enable
P1-03	3.0 s	P6-06	1024
P1-04	0.5 s	P6-07	10.0 %
P1-05	2: Ramp to Stop with Brake Chopper Enabled	P6-14	0.3 s
P1-08	34.6 A	P6-15	30 %
P1-10	1460 rpm	P6-16	2.0 s
P1-13	12: [Stop/Run Fwd] [Stop/Run Rev] [Preset Speeds 1..8 Select]	P6-17	2.0 s
P2-01	600 rpm	P6-19	22 Ohm
P2-02	1200 rpm	P6-20	12.0 kW
P2-03	1500 rpm	P7-01	0.451 Ohm
P2-07	100 rpm	P7-02	0.338 Ohm
P2-08	45 rpm	P7-03	0.0528 H
P2-18	8: Hoist Brake Control (Enables Hoist Mode)	P7-04	13.4 A
P4-01	0: Speed Control (vector)	P7-05	0.074
P4-03	75.0 %	P7-06	0.0035 H
P4-04	0.150 s	P7-07	1: Enable
P4-05	0.86		

**Notes:**

1. Motor parameters are set according to the nameplate
2. Autotune is completed and the results can be seen
3. Brake resistor parameters are entered and the brake transistor enabled
4. An encoder is fitted, and the relevant parameters are set

5. Brake release speed is set to 100RPM. This was selected after testing showed it was necessary to have this level to avoid the hoist dipping slightly during starting with full load
6. Torque prove level set at 30% to ensure there is sufficient torque to hold the load on starting
7. During brake release, the actual motor torque peaks around 125%, then quickly reduces
8. 3 seconds acceleration time selected. This keeps the motor torque level around 110% during acceleration
9. During constant speed operation, motor torque is ~100%, so the motor and drive are correctly sized
10. Deceleration time is 0.5 seconds. Torque during deceleration is <100%, so this is acceptable
11. Brake apply speed set to 45 RPM, which provided smooth stopping without risk of dropping the load
12. Brake apply delay 0.3s ensure the load is held by the drive and motor while the brake operates
13. Torque peaks briefly at 140% as the brake applies to hold the load and before the drive output is disabled.
14. Ensure that operation is tested in directions, starting with no load, and gradually increasing load to ensure safe and smooth operation throughout.

## Fine Tuning the Parameters and Troubleshooting

Symptom	Suggested Solution
Load drops during brake release	<p>Increase the Brake Release Frequency / Speed P2-07</p> <ul style="list-style-type: none"> <li>- If required, safely disconnect the motor brake so that it cannot release, operate the drive and check the output torque either by using P0-12 to view on the drive display, or using the scope function in Optitools Studio. Ensure the motor can generate &gt; 100% torque, otherwise increase P2-07.</li> </ul> <p>Increase the Brake Release Torque Threshold P6-15</p> <ul style="list-style-type: none"> <li>- After ensuring that torque is generated as described above, increase the torque threshold level to ensure sufficient torque is generated before brake release.</li> </ul> <p>Reduce the Brake Release Delay P6-13</p> <ul style="list-style-type: none"> <li>- If the drive holds at the brake release frequency / speed after the brake is released, the Brake Release Delay time should be reduced to match the operating time of the brake</li> </ul> <p>Increase the Speed Loop Gain P4-03</p> <ul style="list-style-type: none"> <li>- Increasing the speed loop provides a “stiffer” control of the motor speed to match the commanded speed. Using the scope function in Optitools Studio, use two scope channels to compare the “Post Ramp Speed Reference” and the “Motor Speed”. Adjust the speed loop gain to provide a closer match between the two traces. Do not use excessive gain, as this may cause instability.</li> </ul>
High Load Current	<p>During hoist operation, use the Optitools Studio scope function to monitor</p> <ul style="list-style-type: none"> <li>- Motor Speed</li> <li>- Motor Torque</li> <li>- Relay Output 2</li> </ul> <p>On initial brake release with high load, motor torque can exceed 150% <i>briefly</i>. Torque should quickly reduce following the brake release.</p> <p>During acceleration of the load after brake release, motor torque should not exceed 125%. - If this value is exceeded, increase the acceleration time, P1-03.</p> <p>During constant speed operation, load torque should not exceed 100%</p> <ul style="list-style-type: none"> <li>- If this value is exceeded, confirm the motor and drive sizing, and ensure all motor parameters are correctly set and autotune successfully completed</li> </ul> <p>During stopping, a high torque peak is expected as the brake applies before the drive is disabled. The Brake Apply Delay P6-14 can be adjusted to ensure the drive output remains active only for long enough to hold the load.</p>
“SP-Err” Speed Error Trip	<p>This trip occurs if the speed measured by the encoder deviates from the commanded speed by a greater amount than the limit set in P6-07.</p> <p>Check the encoder wiring is correct, and installed according to the instructions in the User Guide.</p> <p>Check the Motor Rated Speed P1-10 (RPM) and Encoder PPR P6-06 parameters are correctly set</p> <p>Check the encoder feedback operation as described in step 7 above</p> <p>Increase the Encoder Speed Error Trip Level P6-07 (%)</p> <p>Increase the Speed Loop Gain P4-03</p>
O-I or hO-I	<p>Over Current Trip</p> <p>Trips on enable / start command : Check the motor and motor cable for short circuits</p> <p>Trips before brake release : Reduce Brake Release Frequency / Speed P2-07</p> <p>Trips during brake release : Increase Brake Release Torque Threshold P6-15</p>

**Appendix – Minimum Brake Resistor Values**

Drive Voltage Rating	Drive Power Rating		Minimum Permissible Brake Resistance (Ohms)
	kW	HP	
200 - 240	0.75	1	28
	1.5	2	28
	2.2	3	28
	4	5	22
	5.5	7.5	22
	7.5	10	13
	11	15	13
	15	20	7
	18.5	25	7
	22	30	3
	30	40	3
	37	50	3
	45	60	3
	55	75	3
75	100	3	
380 - 480	0.75	1	55
	1.5	2	55
	2.2	3	55
	4	5	55
	5.5	7.5	44
	7.5	10	44
	11	15	44
	15	20	25
	18.5	25	25
	22	30	25
	30	40	13
	37	50	13
	45	60	7
	55	75	7
	75	100	7
	90	150	7
	110	160	7
	132	200	7
160	250	7	
200	300	4	
250	350	4	
500 - 600	0.75	1	54
	1.5	2	54
	2.2	3	54
	4	5	54
	5.5	7.5	54
	7.5	10	43
	11	15	43
	15	20	43
	18.5	25	24
	22	30	24
	30	40	24
	37	50	13
	45	60	13
	55	75	6
75	100	6	
90	125	6	
110	150	6	

**Appendix:**

Revision History			
Issue	Comments	Author	Date
1	Application Note Creation / Release	KB	19/4/12
2	Additional information added, timing diagram corrected	KB	3/10/12
3	Completely revised	KB	22/6/17