Commander SE as open loop lift drive

1. Introduction

The lift market demands robust and cost-effective lift drives for retrofit as well as for new installations. Especially with low-cost solutions, the initial cost advantage in the purchase of materials is quickly offset or even reversed to a cost disadvantage by expensive commissioning.
Hence inverters for this type of solution must combine the following features:

- standard equipment at low price level
- compact and robust inverter construction (single-board electronics, few plug connections)
- sensorless technology (avoid sensors and sensor cables as well as interference)
- flexible, adaptable motor model
- few parameters
- simple programming and optimization
- convenient braking control
- S-shaped ramp smoothing for high travel comfort
- open loop vector control
- floor level accuracy < ± 5mm

All the features listed are ideally combined in one unit – the Commander SE from Control Techniques.

The open loop drive is suitable for lifts up to 630 kg load and 1.0 m/sec speed. The following drive and resistors should be used depending on the speed and the load:

Working load	Speed	Commander SE	Braking resistance
320 kg	0.6 m/sec	SE23400300 (3 kW)	0.6 kW / 80 ohm
	1.0 m/sec	SE23400400 (4 kW	0.8 kW / 80 ohm
450 kg	0.6 m/sec	SE23400400 (4 kW)	0.8 kW / 80 ohm
	1.0 m/sec	SE23400550 (5.5 kW)	1.2 kW / 40 ohm
630 kg	0.6 m/sec	SE23400550 (5.5 kW)	1.2 kW / 40 ohm
	1.0 m/sec	SE23400750 (7.5 kW)	1.6 kW / 40 ohm

Higher resistors powers may be necessary, if the total efficiency (shaft + gearbox) is better than 70%.

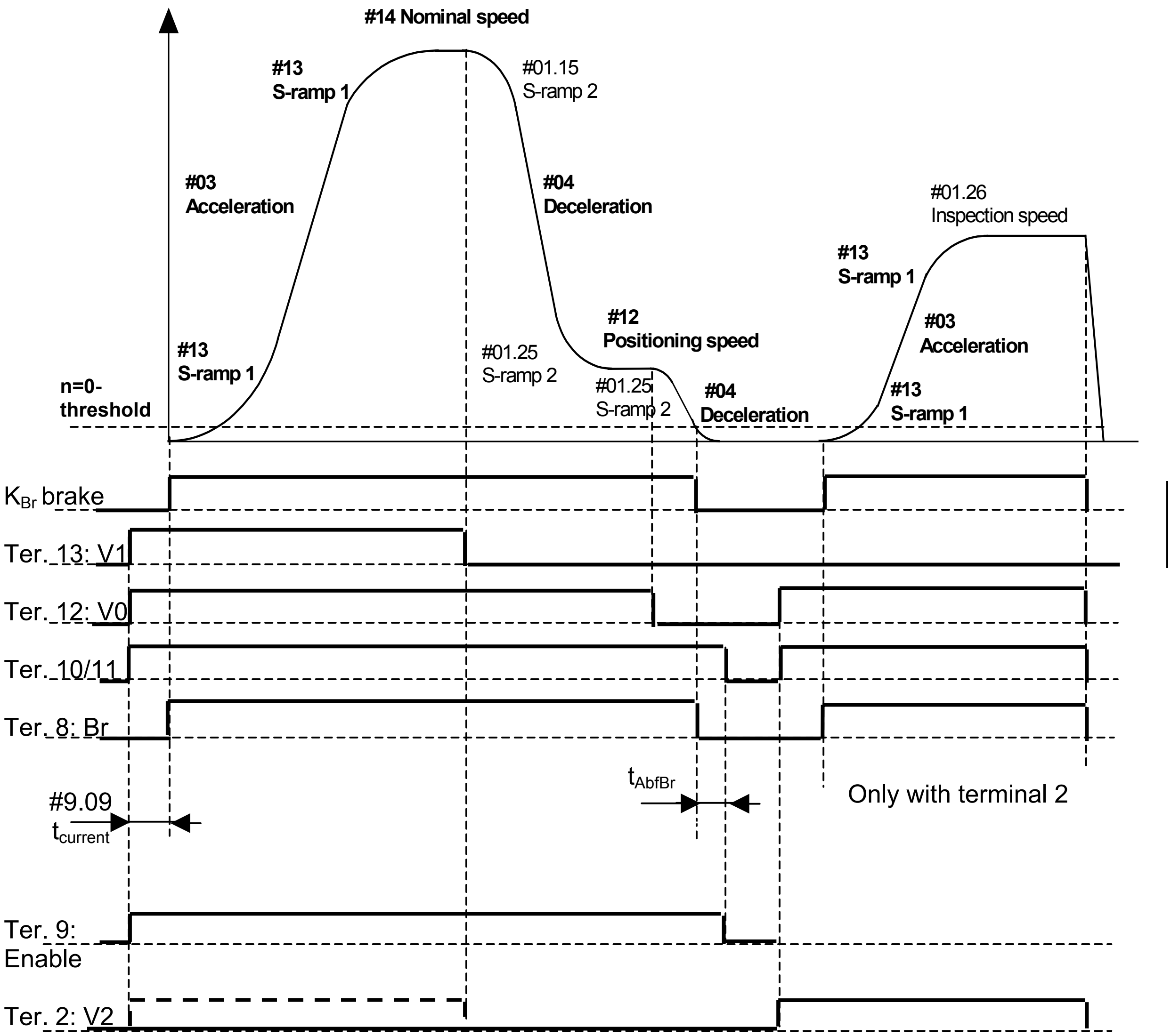
Compliance with the following notes will result in a very simple commissioning of an open loop lift drive with Commander SE.

History:	Issue	1.0.7	
26.09.01	V1.0.0	Dr. U. König	• Basic Version
19.10.01	V1.0.1	Dr. H. König	• Fundamental test
29.10.01	V1.0.2	Dr. H. König	• Complete revision and correction • Subdivided into braking control by lift control or by SE • Switching of the S-ramp for soft start • Ramp stop removed
20.11.01	V1.0.3	Dr. H. König	• Switching of the S-ramp modified • Ramp stop expanded again
27.11.01	V1.0.4	Dr. H. König	• Power data expanded
04.04.02	V1.0.5	Dr. H. König	• Commissioning modified for setting up with Quick-Key
07.04.02	V1.0.6	Dr. H. König	• Terminal 9 always enable, therefore Terminal 2 as Preset Bit 2
12.04.02	V1.0.7	Dr. H. König	• Note: Setting #0.40 = Auto at commissioning

2. Control

With the lift control, the travel curve and the brake are controlled by the Commander SE. The following diagram shows the travel curve and the associated signal time cycle.

2.1. Travel curve and signal time cycle



Operation of the internal braking control:

Terminal 9 is always used as enable. Terminal 2 can be used as additional speed input if more than two speeds are requiered. As a result an inspection speed and an intermediate speed can be used as well. However, it should be noted that with inspection or intermediate speed, the positioning speed must also be controlled via Terminal 12, which initiates the braking control.

The delay $t_{current}$ is generated by internal inverter functions and adjusted in steps of 0.1sec in the range 0.1sec to 2sec (max. 25sec). The time $t_{current}$ is required in order to build up momentum in the motor and to prevent stalling of the load when the brake is released. The adjustable starting roundness avoids any travel against the brake, and hence prevents any starting jerk.

The brake apply can be adjusted in fine steps via the n = 0 speed of rotation threshold #3.05, so that the brake is applied at standstill. Afterwards, after a delay t_{AbfBr} the Enable signals (T. 9) must be disabled, which will disable the inverter output and stop the current.

The brake contactor K_{Br} is directly controlled by the signal on Ter. 8, which is generated by internal logic.

Irrespective of which type of braking control is chosen, the braking relay (K_{Br}) must be connected in series with an auxiliary contact of the Healthy relay, so that in the event of a drive error, the brake operates in all circumstances.

2.2. Setting parameters

The following section explains in detail the parameter setting of the Commander SE for the lift application. If the drive is already programmed or will be programmed via Qick-Key, the following is only for information. The setup has to be proceeded with Chapter 3.

Setting of the travel curve and the starting optimisation is carried out on site using menu 0 parameters accessible over the drive keypad.

2.2.1 Basic parameter setting

The basic parameters are set in Menu 0

Parameter	Setting		Meaning
#02	60	Hz	Maximum frequency = Nom. motor frequency + Slip
#03	3	sec	Acceleration ramp / 100 Hz
#04	3	sec	Deceleration ramp / 100 Hz
#05	Pr		Speed reference select presets
#06	xxx		Motor rated current
#07	yyy		Motor rated speed
#08	zzz		Motor rated voltage
#09	vvv		Motor power factor
#10	L2		Enable Parameter access to #11 to #54
#11	0	Hz	Electrical halt
#12	5 – 10	Hz	Positioning speed
#13	10	-	S Ramp1
#14	50	Hz	Nominal speed
#22	A		Load indication as active current in amperes
#23	Fr		Speed indication as frequency in Hz
#30	0		Braking with braking resistance (Fast ramp)
#35	0 or 2		= 0, if down signal on Ter. 11 and up signal Ter. 10 = 2, if direction on Ter. 11 and start command on Ter. 10
#38	1		Measurement of the motor model at first start
#39	uuu		Motor rated frequency (if different to 50Hz)

- If cosφ is not quoted #09=0.85
- If rated speed is not quoted #08=60*f/p (f=50Hz or corresponds to #39)

2.2.2. Setting parameters for lift operation

To set the following parameters the SE-Soft commissioning software (+ laptop) is necessary. For the lift control, the inverter parameters must be set as follows:

1. Braking control

#9.04	= 8.05	If positioning speed active
#9.06	= 10.02	and controller is enabled
#9.09	= 1.0	after magnetisation time
#9.10	= 12.10	enable selector
#12.08	= 10.03	If n > 0
#12.11	= 2.03	then start timer function T2 for brake release. Brake signal enables PID output for delay of the ramp.
#8.21	= 2.03	Output braking signal
#8.11	= 1	Output on Ter. 8 inverted, if braking relay is connected between Ter. 8 and Ter. 4 (0V)

2. S- ramp control

#1.23	= 4.0	Setting parameter S-ramp 1 (starting)
#1.25	= 2.0	Setting parameter S-ramp 2 (normal)
#2.06	= 1	enable S-ramp
#14.02	= 1.25	
#14.03	= 1.23	
#14.08	= 1	Enable PID
#14.09	= 10.05	and below setpoint (accelerate)
#14.11	= 0	
#14.16	= 2.07	then slow S-ramp 1, otherwise fast S-ramp 2

4. Activating Ter. 2 for inspection and intermediate speed

#1.26	= 20	Setpoint Inspection
#1.28	= 35	Setpoint V Intermediate
#12.03	= 7.01	if actual frequency
#12.04	= 50	less than 50% nominal speed
#12.05	= 10	
#12.07	= 1.47	

Attention: When the parameters have been set, parameters must be saved via SESoft, so that the change in terminal functions are done.

Control functions

Release brake (control) = $(!\#10.03 \vee \#8.05) \wedge \#10.02$

Ramp stop (#2.03) = as long as brake is blocked

T_1 – time for field build-up (value is set in #09.09)
T_3 – application time of brake (can be influenced by suitable choice of #3.05)

Advantages over previous variants

- The brake timing on starting can be set independently of the brake timing on stopping.
- The brake is applied when the drive trips or on drive supply failure.
- In addition, the magnetisation of the motor can be set.
- A separate starting optimisation can be set.
- The control system operates independently of whether the control uses 1-wire or 2-wire travel signals.

2.2.3. Speed selection

Ter. 9	Ter. 2	Ter. 13	Ter. 12	Speed	Parameter
Enable	**V Bit 2**	**V Bit 1**	**V Bit 0**		
X				**0 (Stop)**	**# 1.21**
X			**X**	**Positioning speed**	**# 1.22**
X		**X**	**X**	**Normal speed**	**# 1.24**
X	**X**		**X**	**Inspection speed**	**# 1.26**
X	**X**	**X**	**X**	**Intermediate speed**	**# 1.28**

It should be noted that, at all speeds of travel, the positioning speed must be controlled via Ter. 12, which releases the braking control.

3. On-site commissioning

Commissioning on site takes place in the **following sequence** (to follow this order reduces the time taken):

1. Enter motor nameplate values
2. Adjustment of slip compensation
3. Optimisation of travel curve
4. Optimisation of positioning accuracy
5. Optimisation of starting
6. Optimisation of stopping

3.1. Enter motor nameplate values

Entering the following values from the motor nameplate

#06	xxx		Motor rated current
#07	yyy		Motor rated speed
#08	zzz		Motor rated voltage
#09	vvv		Motor power factor
#14	50	Hz	Speed of travel
#38	1		Measurement of the motor model at first start
#39	uuu		Motor rated frequency (if different to 50Hz)
#40	Auto		Automatically calculation of the motor poles

Now the lift should be started with inspection speed to make the Non-Rotating static autotune.

3.2. Adjustment of slip compensation (Positioning speed):

To adjust the slip compensation the empty car (nominal load) is to run in both directions at positioning speed. The adjustment is done by reduced the nominal speed (#07) from the synchronous speed until the shaft speeds for booth directions is approximately the same. **That is the most important adjustment in achieving a car positioning that is almost independent of the load.** This adjustment can be done by measuring the speed in the liftcontrol or by measuring the time for x turns of the traction sheave.

Example:	Motor speed (example):	1500 r.p.m.
	Motor frequency:	50 Hz
	Motor number of poles:	4-pole

Setting #07	Meas. speed upwards (clock.)		Meas. speed downwards (anticlock.)
1450	V upward (clock.)	>	V downward (anticlock.)
1380	V upward (clock.)	>=	V downward (anticlock.)
1300	V upward (clock.)	=	V downward (anticlock.)
1250	V upward (clock.)	<=	V downward (anticlock.)

The selected value is 1300 for Pr. #07.

3.3. Optimisation of travel curve:

The preset values of the acceleration and braking ramps are adjusted to give accelerations of 0.7m/sec^2 for a nominal speed of 1.0m/sec. At lower nominal speeds the values should be reduced proportionately.

#03: The acceleration #03 is varied very slightly to give the most comfortable acceleration possible.

#04: The stop distance is matched to the actual lift conditions by means of the deceleration time #04.

3.4. Optimisation of positioning accuracy:

The stopping sensors are adjusted after the optimization of the travel curve. Tests should then be carried out with an empty and a loaded car. The difference should not exceed 1cm. If this is exceeded, an improvement can be achieved by changing #12 (positioning speed).

#12: Enter values between 3 and 8Hz for a good positioning accuracy.

3.4. Optimisation of starting:

Uncontrolled movement of the load when the brake is released must be avoided. To achieve this, the motor must be sufficiently magnetised. This adjustment is made with #9.09, which is set to a typical value of 1.0 sec. A change should only be necessary if there is a problem, and is not anticipated in the power range up to 11 kW with standard motors. The set up of this value can be done with SESoft.

9.09 Magnetising Time for the motor

The starting is optimized by means of an additional adjustable S-ramp for starting. This is set via #13. The release time for the brake and also the softness of the load take-up can be adjusted with this.

#13: Increase by a jerk at the start, decrease when moving back.

3.5. Optimisation of stopping:

The brake application threshold during stopping is adjusted by the “n = 0”- threshold #3.05. This value is factory set to 1.0 Hz and is not expected to be changed. The set up of this value can be done with SESoft.

3.05 Threshold for brake application

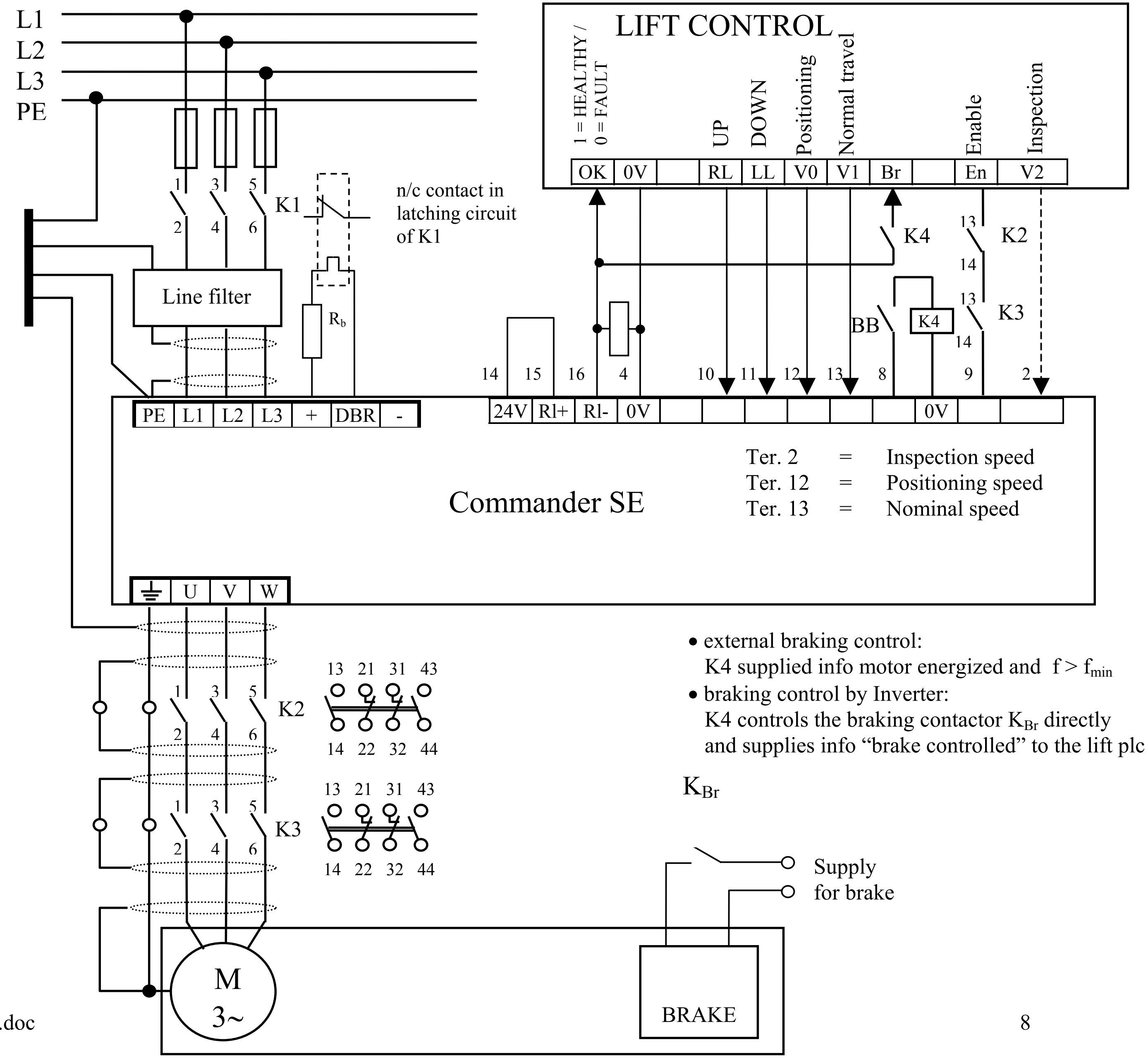
3.6. Summary:

The setup is done using following parameters in Menu 0

Parameter	Setting		Meaning
#06	xxx		Nom. motor current
#07	yyy		Nom. motor speed
#08	zzz		Nom. motor voltage
#09	vvv		Motor power factor
#14	50	Hz	Speed of travel

Optimisation takes place with the following parameters in Menu 0

Parameter	Setting		Meaning
#03	3	sec	Adjustment of acceleration
#04	3	sec	Adjustment of the deceleration distance
#07	yyy		Adjustment of the positional accuracy
#12	5 – 10	Hz	Adjustment of the positioning distance
#13	10	-	Soft start optimisation



- external braking control:
  K4 supplied info motor energized and $f > f_{min}$
- braking control by Inverter:
  K4 controls the braking contactor K_{Br} directly and supplies info “brake controlled” to the lift plc