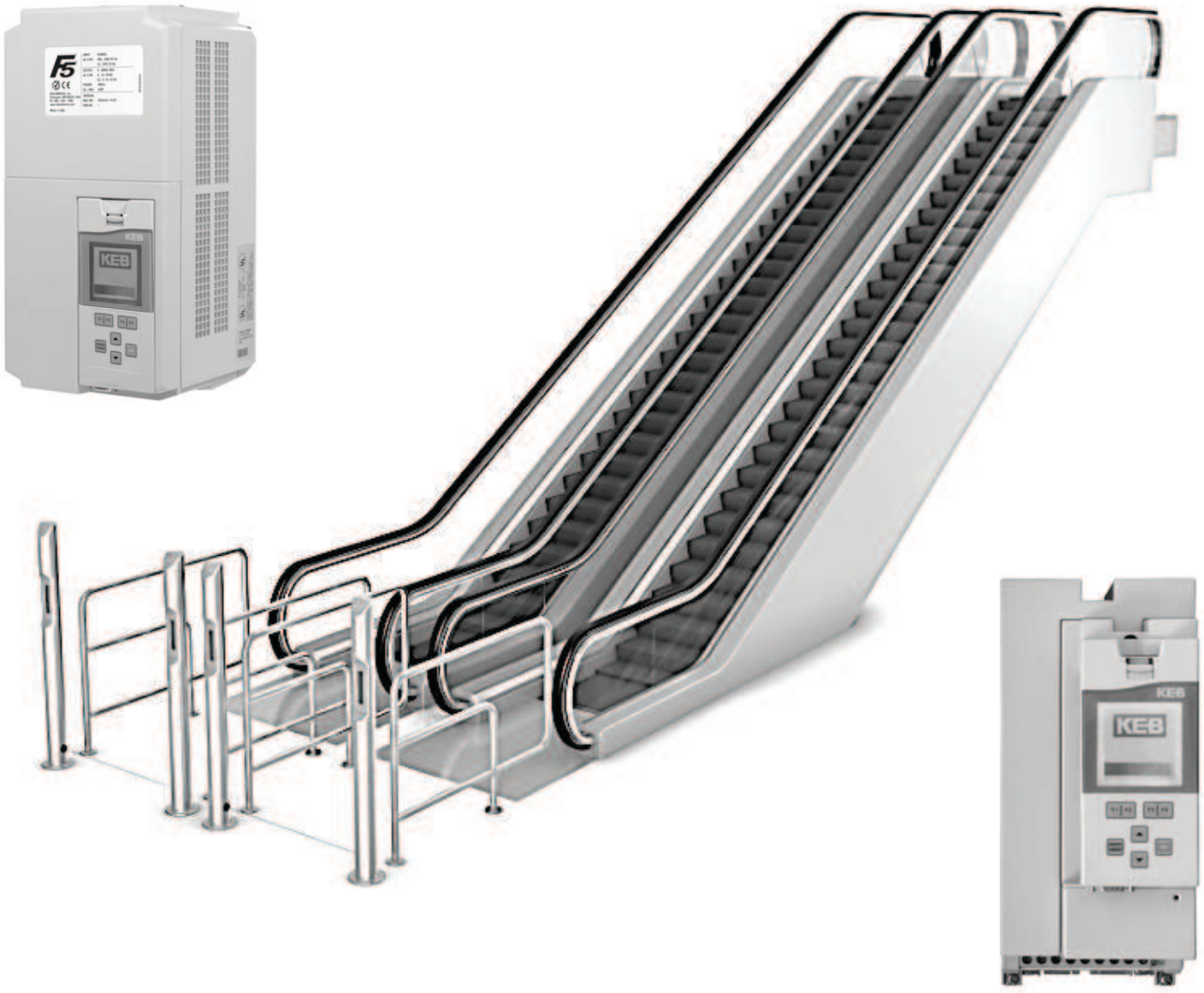
COMBIVERT F5



ESCALATOR DRIVE

Application Manual

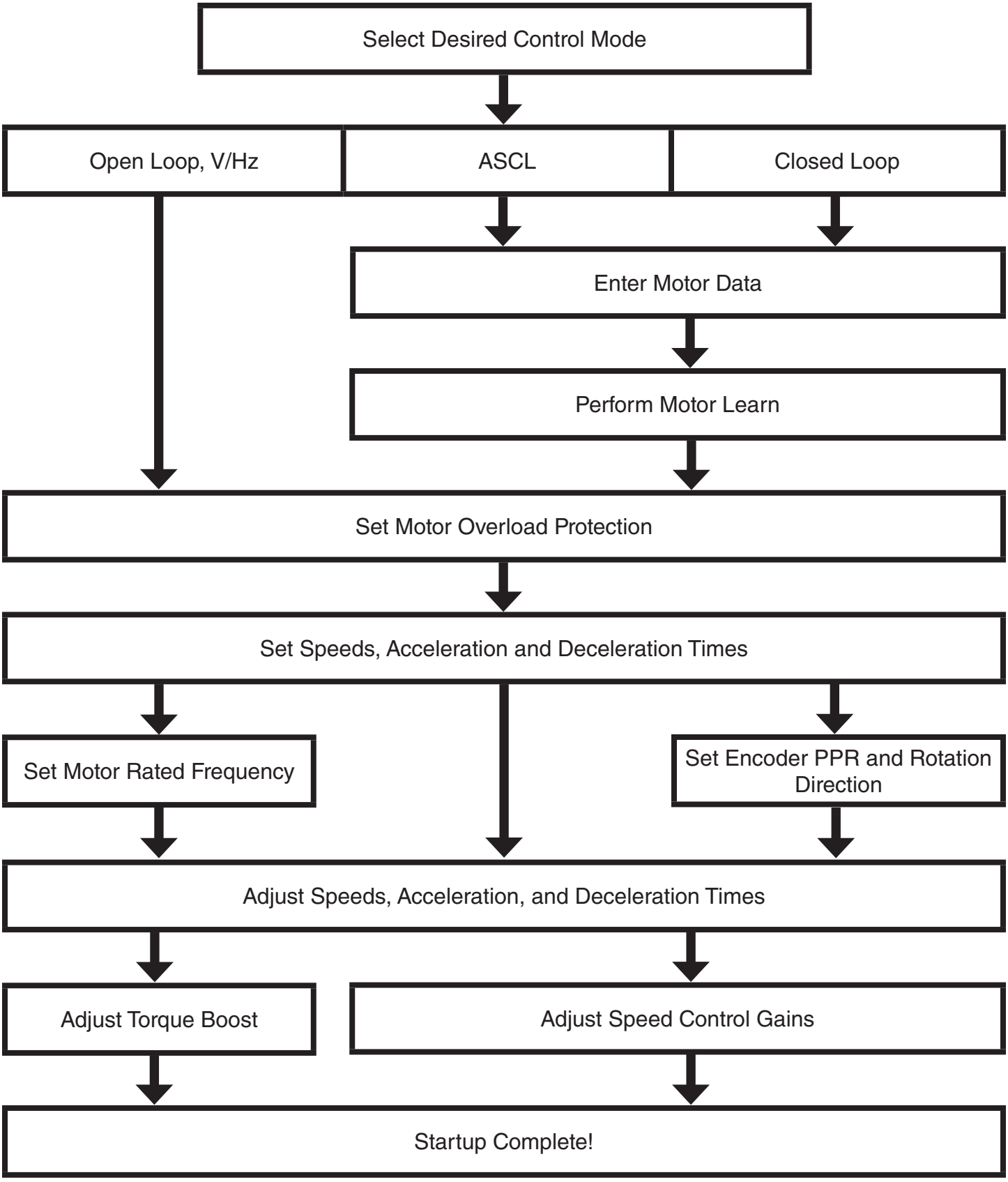
00F5LUZ-KE03

Escalator

Table of Contents

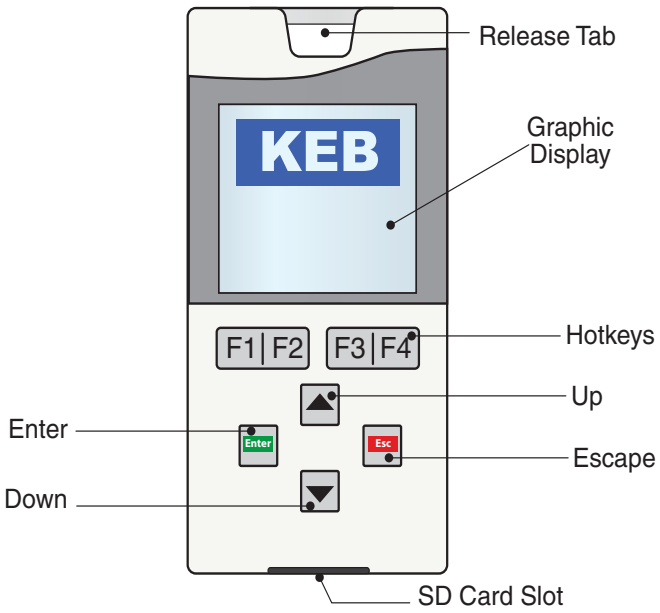
For information regarding power ratings, fusing, certifications, etc., please reference the F5 power stage manual available from KEB America. Visit our website at www.keb.de or our blog at www.keb-blog.com

1. Startup Procedure



2. Keypad Overview

The KEB Escalator drive uses an operator keypad which provides a user interface.



Button	Name	Function
▲ ▼	**Up/Down**	Increment/Decrement through menu or values
Enter	**Enter**	Selects a parameter or group, Enters *Edit Mode*, Save parameter setting
Esc	**Escape**	Backs out of parameter group or exits *Edit Mode*
F1 | F2 F3 | F4	**Hotkeys**	Keys correspond to display LCD text above Allows a user to quickly jump menus

When adjusting a parameter, press “ENTER” to access *Edit Mode*. Parameter values can only be changed in *Edit Mode*.

Up/Down - Can be used to increment or decrement the number. Press the ENTER key to save the change.

F4 Hotkey (NUM) - Pressing the F4 key in *Edit Mode* allows the user to adjust each placeholder value. The other Hotkeys change the placeholder or add a decimal point. Press “ENTER” to save the changes.

- >> : Used to move placeholder for adjustment.
- . : Inserts decimal point.
- <- : Used as a backspace to move placeholder for adjustment.
- + - : Used to change the sign of the value.

3. Control Circuit and Input/Output Logic Tables

Displayed below are the X2A terminal strip connections, input/output logic tables, typical run values and output conditions and functions. The table below shows the Input Status, CP25 numerical value. It is the sum of the individual input weightings. For example, Forward High Speed = 2069 = ST (1) + F (4) + I1 (16) + ID (2048).

X2A Reference

Pin	Name	Description
1	AN1+	Analog Input 1, +
2	AN1-	Analog Input 1, -
3	AN2+	Analog Input 2, +
4	AN2-	Analog Input 2, +
5	ANO1	Analog Output 1
6	ANO2	Analog Output 2
7	CRF	Analog Supply, +10V
8	COM	Analog Common
9	COM	Analog Common
10	I1	Step Speed 1
11	I2	Step Speed 2
12	I3	No Function
13	I4	No Function
14	F	Forward
15	R	Reverse
16	ST	Enable
17	RST	Reset
18	O1	At Speed (AS)
19	O2	Drive Ready (RDY)
20	24V	24V Output
21	V_{IN}	20 ... 30V Input
22	0V	Digital Common
23	0V	Digital Common
24	NO	Relay 1 RDY
25	NC	
26	COM	
27	NO	Relay 2 DRO
28	NC	
29	COM	

Digital Speed Selection	Input Status CP25	X2A Inputs Active					Internal
		Enable	Fwd	Rev	I1	I2	ID
		1	4	8	16	32	2048
Forward High Speed	2069	1	1	0	1	0	1
Reverse High Speed	2073	1	0	1	1	0	1
Forward Low Speed	2085	1	1	0	0	1	1
Reverse Low Speed	2089	1	0	1	0	1	1
Forward Inspection	2101	1	1	0	1	1	1
Reverse Inspection	2105	1	0	1	1	1	1

Symbol: 1 = Input is active
0 = Input is not active

The table below shows the Output Status as displayed in CP26. Add the outputs to determine the state.

X2A Output Status, CP26					
Name	O1	O2	Relay 1	Relay 2	OD (Internal)
Default	AS	RDY	RDY	DRO	AS LT (Internal)
Pin(s)	18	19	24...26	27...29	Internal
Value	1	4	8	16	128

The table below shows typical run values for the Input and Output Status parameters, CP25 - 26.

Typical Run Values		
	Input Status, CP25	Output Status, CP26
Forward High Speed	2069	143
Reverse High Speed	2073	143
Forward Low Speed	2085	143
Reverse Low Speed	2089	143
Forward Inspection	2101	143
Reverse Inspection	2105	143

The table below describes the output functions and the conditions they must satisfy to become active.

Function	Conditions
At Speed (AS)	Active when Actual Motor Speed, CP28 is +/- 100 rpm (ASCL, Closed Loop) or when CP28 is equal (Open Loop, V/Hz) to Commanded Speed, CP27 above 100 rpm.
Ready (RDY)	Signal turns off when a drive fault occurs.
Drive On (DRO)	Enable, direction, and motor phase current check passes. Drive is outputting current.
At Speed (AS) LT	Lower threshold for At Speed. Turns on when CP28 speed is 100 rpm or greater.

4. ASCL Control Startup Steps

Asynchronous Sensorless Closed Loop (ASCL) uses a control alogrithm to automatically measure and model the motor characteristics without encoder feedback. ASCL offers excellent control in both stable and dynamic motor operation, accurate speed control, and high speed stability without the additional cost and complexity of an encoder. Follow the steps below for ASCL motor control startup.

1. Set CP02 = 0 for ASCL.

2. Enter the basic motor information from the motor nameplate.
   - CP03 = Rated Power (kW), $P_{(kW)} = P_{(hp)} \times 0.746$.
   - CP04 = Rated Speed (rpm).
   - CP05 = Rated Current (A).
   - CP06 = Rated Frequency (Hz).
   - CP07 = Rated Voltage (V).
   - CP08 = Rated cos (phi) [Power Factor].*

   *Use 0.90 if unknown.

3. Load the motor data.
   - Set CP09 = 2 'Act.DC Voltage (F5-M/S)'.
   - Will display 'DONE!' and go back to 0 'done' when load complete.

4. Perform the motor learn.
   - Note! The drive will output current at zero speed, but may not generate enough torque to hold the load during the measurement. Set CP15 Inspection Speed to zero and prevent motor brake from picking during process (eg. Remove brake wire from controller).
   - Set CP10 = 7 'auto ident without move +1000 Hz'.
   - Navigate to CP01 Inverter Status. Press and hold Inspection Run Command.
   - When CP01 = 127 'Calculate Drive Data Ready'. Release Inspection Run Command.
   - Set CP10 = 0.

5. Set CP11 Electronic Motor Overload Protection.
   - For single motors, set the CP11 = 0 'Error, No Auto Retry'.
     - Set CP12 Electronic Motor Overload Protection Current = Motor Rated Current.
   - For parallel motors, set CP11 = 6 'Warning by Digital Output'.
     - CP12 is not used when CP11 = 6 'Warning by Digital Output'.

6. Set Speeds and Accel/Decel Times (See Section 7 for ACTUAL accel/decel time calculation).
   - CP13 = High Speed (rpm).
   - CP14 = Low Speed (rpm).
   - CP15 = Inspection Speed (rpm).
   - CP16 = Acceleration Time.**
   - CP17 = Deceleration Time.**

   **CP16 or 17 = 1000(Desired Accel or Decel Time - 5 sec.) / Command RPM

7. Motor Ready to Operate (See Section 8 for Drive faults and Section 9 for Operational Problems).

8. Adjust as necessary.
   - Speeds, CP13 - 15.
   - Accel/Decel Times CP16 - 17.
   - Speed Control Gains.
     - CP22 = Proportional.
     - CP23 = Integral.
     - CP24 = Integral Offset.

5. Open Loop, V/Hz Startup Steps

Open Loop, volts per hertz (V/Hz) control does not use feedback from an encoder for operation. Instead, it relies on a volts per hertz ratio that remains constant over a set speed (frequency) range. Open Loop, V/Hz allows for quick and easy setup and does not require motor data or an encoder to operate. Follow the steps below for Open Loop, V/Hz motor control startup.

1. Set CP02 = 1 for Open Loop, V/Hz.

2. Enter the basic motor information from the motor nameplate **(Optional, used for reference only)**.
   - CP03 = Rated Power (kW), $P_{(kW)} = P_{(hp)}$ x 0.746.
   - CP04 = Rated Speed (rpm).
   - CP05 = Rated Current (A).
   - CP06 = Rated Frequency (Hz).
   - CP07 = Rated Voltage (V).
   - CP08 = Rated cos (phi) [Power Factor].*

   *Use 0.90 if unknown.

3. Set CP11 Electronic Motor Overload Protection.
   - For single motors, set the CP11 = 0 'Error, No Auto Retry'.
     - Set CP12 Electronic Motor Overload Protection Current = Motor Rated Current.
   - For parallel motors, set CP11 = 6 'Warning by Digital Output'.
     - CP12 is not used when CP11 = 6 'Warning by Digital Output'.

4. Set Speeds and Accel/Decel Times (See Section 7 for ACTUAL accel/decel time calculation).
   - CP13 = High Speed (rpm).
   - CP14 = Low Speed (rpm).
   - CP15 = Inspection Speed (rpm).
   - CP16 = Acceleration Time.**
   - CP17 = Deceleration Time.**

   **CP16 or 17 = 1000(Desired Accel or Decel Time - 5 sec.) / Command RPM

5. Set CP18 = Motor Rated Frequency.

6. Motor Ready to Operate (See Section 8 for Drive faults and Section 9 for Operational Problems).

7. Adjust as necessary.
   - Speeds, CP13 - 15.
   - Accel/ Decel Times CP16 - 17.
   - Open Loop Low Speed Torque Boost, CP19.

6. Closed Loop Control Startup Steps

Closed Loop Control uses an encoder to provide feedback for precise motor control. Speed measurements are fed back to the drive real time and constantly compared against commanded values to be adjusted accordingly. Follow the steps below for Closed Loop motor control startup.

1. Set CP02 = 2 for Closed Loop Control.

2. Enter the basic motor information from the motor nameplate.
   - CP03 = Rated Power (kW), $P_{(kW)} = P_{(hp)}$ x 0.746.
   - CP04 = Rated Speed (rpm).
   - CP05 = Rated Current (A).
   - CP06 = Rated Frequency (Hz).
   - CP07 = Rated Voltage (V).
   - CP08 = Rated cos (phi) [Power Factor].*

   *Use 0.90 if unknown.

3. Load the motor data.
   - Set CP09 = 2 'Act.DC Voltage (F5-M/S)'.
   - Will display 'DONE!' and go back to 0 'done' when load complete.

4. Perform the motor learn.
   - Note! The drive will output current at zero speed, but may not generate enough torque to hold the load during the measurement. Set CP15 Inspection Speed to zero and prevent motor brake from picking during process (eg. Remove brake wire from controller).
   - Set CP10 = 7 'auto ident without move +1000 Hz'.
   - Navigate to CP01 Inverter Status. Press and hold Inspection Run Command.
   - When CP01 = 127 'Calculate Drive Data Ready'. Release Inspection Run Command.
   - Set CP10 = 0.

5. Set CP11 Electronic Motor Overload Protection.
   - For single motors, set the CP11 = 0 'Error, No Auto Retry'.
     - Set CP12 Electronic Motor Overload Protection Current = Motor Rated Current.
   - For parallel motors, set CP11 = 6 'Warning by Digital Output'.
     - CP12 is not used when CP11 = 6 'Warning by Digital Output'.

6. Set Speeds and Accel/Decel Times (See Section 7 for accel/decel time calculation)
   - CP13 = High Speed (rpm).
   - CP14 = Low Speed (rpm.)
   - CP15 = Inspection Speed (rpm).
   - CP16 = Acceleration Time.**
   - CP17 = Deceleration Time.**

   **CP16 or 17 = 1000(Desired Accel or Decel Time - 5 sec.) / Command RPM

7. Enter the encoder pulses per revolution (ppr) in CP20.

8. Motor Ready to Operate (See Section 8 for Drive faults and Section 9 for Operational Problems).

...continued on next page

6. Closed Loop Control Startup Steps (Continued)

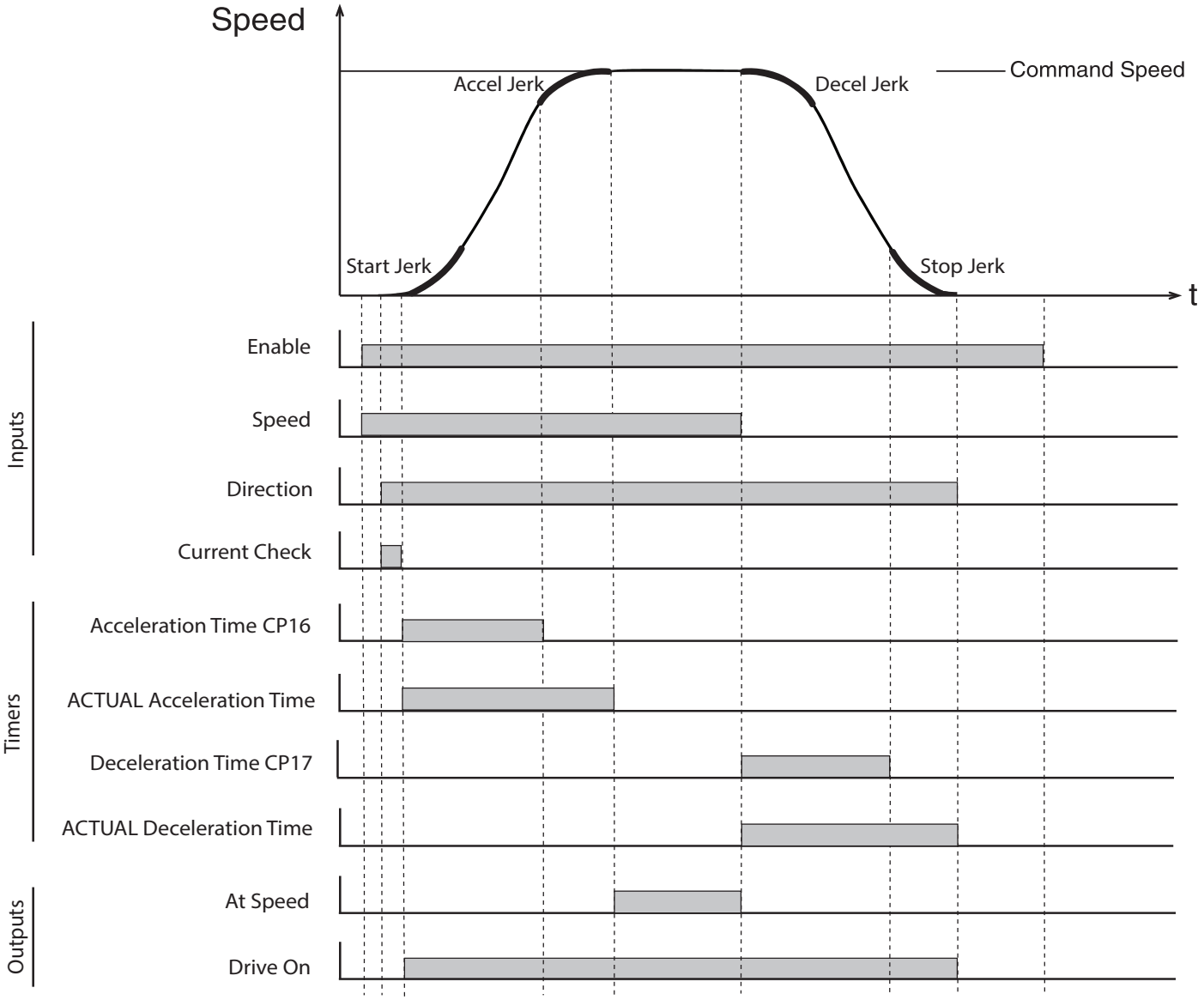
9. Adjust as necessary
    - CP21 Encoder phasing and direction.*** See table below for phasing information.

Setting:	Description:	NUM
Not Inverted	No changes are made to A/B or direction of rotation	0
A-B Swapped	Encoder channels A and B are swapped internally	1
Inverted Rotation	The direction of motor rotation is reversed	16
A-B Swap & Inverted Rotation	Encoder channels A and B are swapped internally and the direction of motor rotation is reversed	17
Default = Not Inverted (0)		

***If unsure of encoder phasing, run in Open Loop, V/Hz and monitor the Command Speed, CP27 and the Actual Motor Speed, CP28. They should have the same sign. If the motor runs in the wrong direction, only the rotation needs to be reversed. If the motor does not run, jerks, draws high current or vibrates excessivley, the encoder phasing may need to be changed.

- Speeds, CP13 - 15.
- Acceleration/Deceleration Times CP16 - 17.
- Speed Control Gains.
    - CP22 = Proportional.
    - CP23 = Integral.
    - CP24 = Integral Offset.

7. Speed Profile and Timing Chart



The acceleration and deceleration times (CP16 and CP17) only take into account one jerk time. Therefore, the ACTUAL accel/decel times must add an additional jerk time and are subject to a drive reference speed scalar. Default jerk times are set to 5.00 sec. See equation below.

ACTUAL Accel/Decel Time = [(Command RPM/1000) x (CP16 or CP17)] + 5.00 sec.

8. Drive Faults

Faults and error codes are listed alphabetically. Additional troubleshooting of Operational Problems are listed in Section 9. The last drive fault can be found in CP36. Fault history can be viewed in the Fault Log Screen, accessible through the Menu. After 50 errors the fault log will be written down to the memory of the keypad. These files can be retrieved with an SD card.

Error/Message	Alt. / (NUM)	Description	Cause/Solution/Troubleshoot
Error Encoder1	EEnC1 (32)	Loss of incremental encoder channel or differential pair are the same for TTL encoders. Closed loop only	For an incremental encoder interface, the recognition of encoder channel breakage or defective track triggers a fault if the voltage between two signal pairs (A+/A-, B+/B-, N+/N-) is smaller than 2V. That is, a signal pair cannot be at the same level. Channel pair voltages can be measured to confirm. If an incremental encoder does not have N+/N- (or Z+/Z-) tracks, then the corresponding inputs on the encoder interface card must be jumpered high/low. That is, jumper X3A.5 (N+) to X3B.7 (+5V) and X3A.6 (N-) to X3A.8 (0V Common). In any case, the N+/N- are not needed and these inputs could always be jumpered high/low. If performing a Motor Learn in open-loop, the incremental encoder interface card could be removed if an encoder is not connected. Verify the encoder power ratings & connections (e.g. Powering a 8-30VDC rated encoder with 5V)
Error Low Motor Current	Ebr (56)	Low current during initial current check	Possible causes for low motor current error during current check: One or more motor leads not connected Motor contactor not closing (in time) Motor contactor contacts are damaged Motor windings are damaged Check: Check/replace/bypass motor contactor Measure motor resistance

Error/Message	Alt. / (NUM)	Description	Cause/Solution/Troubleshoot
Error Over Current	EOC (4)	Occurs when the specified peak output current is exceeded or if there is a ground fault.	Current can be monitored in CP30. If the error occurs instantly at the start of each run, the issue may be: Damaged motor contactor Loose connection on power wiring Ground fault or motor failure Shorted output transistor in drive Incorrect grounding or noise Check: Drive output, contactor and motor connections Check/replace/bypass motor contactor Disconnect motor leads from drive and run in open loop (fault will occur instantly if shorted output transistor). Measure motor resistance
Error Overheat Power Module	EOH (8)	The heat sink temperature rises above the permissible limit.	The heatsink temperature can be viewed in the inverter parameter group, ru.38. The overheat limit is 90 degrees Celsius for most drives. Under normal operation, the heatsink temperature should usually be below 65 degrees Celsius. Causes of inverter heatsink overheat include: Insufficient cooling or ambient temperature too high Verify operation of fans. The fans are thermostatically controlled to come on at about 45 degrees Celsius. Make sure fans are not clogged. Increase airflow around inverter or add cabinet fans. Faulty temperature sensor. Power down the inverter or let it stand idle to allow for the heatsink temperature to cool. If the heatsink temperature read by the drive for the diagnostics seems unreasonably high or the heatsink is cool to the touch, then the heatsink temperature sensor may be faulty and would need to be repaired by KEB.

Error/Message	Alt. / (NUM)	Description	Cause/Solution/Troubleshoot
Error Motor Protection	EOH2 (30)	Electronic Motor Overload protection was activated	Current can be monitored in CP30. Possible causes: Incorrect motor data Incorrect encoder data (closed loop only) Torque boost too high or too low High mechanical load/issues (friction) Check: CP12 Electronic Motor Overload Protection Current (should match motor nameplate) Motor Data CP20 Encoder pulse number CP21 Swap Encoder Channels Mechanical load/issues (friction)
Error Overload	EOL (16)	Time dependant overload. Error cannot be reset until display shows E.nOL	Current can be monitored in CP30. Possible causes: Excessive current Incorrect motor data Incorrect encoder data (closed loop only) High mechanical load/issues (friction Torque boost too high or too low (low speed) Check: Motor data CP20 Encoder pulse number CP21 Swap Encoder Channels Mechanical load/issues (friction)

Error/Message	Alt. / (NUM)	Description	Cause/Solution/Troubleshoot
Error Over Voltage	EOP (1)	The DC bus voltage rises above the permissible value either during motor regenerative operation or as a result of line side voltage spikes. For 460V drives, the over voltage level is 840VDC and for 230V drives, the over voltage level is 400VDC. The over voltage level cannot be adjusted	The DC bus voltage can be monitored in CP32. When using a braking resistor to dissipate regenerated energy from overhauling or deceleration, the braking resistor should come on at the following levels: 460V = 760VDC 230V = 380VDC If a braking resistor is used: Ensure proper connection of the braking resistor to the to the braking transistor terminals PB, ++. Disconnect braking resistor and measure resistance to verify if correct. If a line regen unit is used: By default, the line regen unit will turn on at 103% of the idle DC bus voltage. Ensure proper connection between the drive and regen unit at the ++ and - - terminals at both units. Ensure the regen unit is regenerating properly and is in the regen status when it should be and there no faults on the regen unit preventing operation. If the over voltage is due to transient voltage spikes from the line: Install a 3-5% line reactor If the over voltage is due to high line voltage: Step-down down the line voltage with a transformer. If there is an issue with the DC bus voltage measurement circuit: ...continued on next page.

Error/Message	Alt. / (NUM)	Description	Cause/Solution/Troubleshoot
Error Over Voltage (continued)	EOP (1)		Measure DC bus directly and verify against DC bus voltage read from the CP32. The DC bus should be approximately 1.41xAC Input phase to phase If there is an issue due to high frequency noise: Verify proper mains grounding.
Error Under Voltage	EUP (2)	The DC bus voltage drops below the permissible value. For 460V drives, the under voltage level is 240VDC and for 230V drives, the under voltage level is 216VDC. The under voltage level cannot be adjusted.	Causes for under voltage include: Input voltage too low or unstable. Verify input voltage and wiring. The DC bus should measure approximately 1.41 x AC Input phase to phase and should match the DC bus measurement by the drive in CP32 One phase of the line input is missing. Line input phases are imbalanced. The phase-to-phase voltage measurement should not exceed 2%. Isolation transformer undersized or wired incorrectly. If there is an issue with the DC bus voltage measurement circuit: Measure DC bus directly and verify against DC bus voltage read from the Diagnostics screen. The DC bus should be approximately 1.41xAC phase to phase.

9. Operational Problems

Troubleshooting Operational Problems and potential solutions.

Problem	Cause/Solution/Troubleshoot
Motor Does Not Move	**Check the Motor Current. Refer to Motor Draws High Current for additional troubleshooting.** Make sure the brake is picking and/or not dragging. Make sure speeds are set correctly in CP13, CP14, and CP15. Check the Inverter Status, CP01, to determine whether there is indication a run command is being given (i.e. Up/Down Constant Speed/ Acceleration/Deceleration, etc.). Check Input Status, CP25 to determine whether the correct inputs are being signaled for a run command. Check the Command Speed, CP27, to determine what the dictated speed command is. Check to make sure the speed control gains (KP, KI Offset) are not set too low. For open loop induction motors, the Low Speed Torque Boost may need to be increased to lift the load or decreased if the Inverter Peak Current limit is reached.
Motor Draws High Current	Verify correct motor data. Perform a Motor Learn if this has not already been completed. For induction motors, set CP02, Control Mode to Open Loop V/Hz to determine if the issue is due to encoder, encoder settings or speed control settings. (Closed loop operation only) For open loop induction motors, the Low Speed Torque Boost may need to be decreased or increased. **Verify the brake picks and does not drag and that there are no other mechanical issues preventing the motor from rotating freely.**

Problem	Cause/Solution/Troubleshoot
Motor does not go the correct speed or cannot reach high speed.	**Check whether the Command Speed and Encoder Speed match (CP27 command speed and CP28 Encoder 1 speed) .** Check Input Status, CP25, to determine whether the correct inputs are being signaled for a run command. Check whether the (Voltage) Modulation Grade is reaching 100%. Refer to Voltage Modulation Grade limited reached for further troubleshooting. Check if the Inverter Peak Current limit is being reached. Check if the speed control gains (KP Proportional, KI Integral Offset) are set too low.
Cannot lift full load	**Check the motor current and whether the Inverter Peak Current limit is being reached. Refer to Motor Draws High Current for additional troubleshooting.** Check if the speed control gains (KP Proportional, KI Integral Offset) are set too low. For open loop induction motors, the Low Speed Torque Boost may need to be increased or decreased if reaching the Inverter Peak Current.
Unable to run induction motor in open loop.	Low Speed Torque Boost, CP19 may need to be decreased or increased. **Verify there are no mechanical issues preventing the motor from rotating freely.**
Motor only moves one direction; direction of weighting (e.g. full load escalator in down direction)	**Check the motor current. Refer to Motor Draws High Current for additional troubleshooting.** Check the Command Speed for dictated speed direction and whether it changes between directions.
Output current is limited (clamped)	Verify the current is not being limited by the Inverter Peak Current Limit. **Check if motor current is excessive. Refer to Motor Draws High Current for additional troubleshooting.**
Output current is limited (clamped)	Verify the current is not being limited by the Inverter Peak Current Limit. **Check if motor current is excessive. Refer to Motor Draws High Current for additional troubleshooting.**

10. Notes:

11. CP Parameter List

Cp.xx	Name	Units	Default Value	Description
00	Password	-	-	-
01	Inverter Status	-	Read Only	-
02	Control Setting	-	-	0 = ASCL, 1 = Open Loop V/Hz, 2 = Closed Loop
03	DASM Rated Power	kW	18.5 kW	Motor Nameplate
04	DASM Rated Speed	rpm	1170 rpm	Motor Nameplate
05	DASM Rated Current	A	35.0 A	Motor Nameplate
06	DASM Rated Frequency	Hz	60.0 Hz	Motor Nameplate
07	DASM Rated Voltage	V	460 V	Motor Nameplate
08	DASM Rated Cos(phi) [Power Factor]	-	0.90	Motor Nameplate
09	Load Motor Data	-	-	2 = Load Motor Data
10	Motor Learn	-	-	0 = Off, 7 = Motor Learn
11	Electronic Motor Overload Protection	-	-	0 = On (single motors; EOH2 active), 6 = Off (parallel motors)
12	Electronic Motor Overload Protection Current	A	35 A	Motor Nameplate
13	High Speed	rpm	1170 rpm	X2A.10
14	Low Speed	rpm	292 rpm	X2A.11
15	Inspection Speed	rpm	0.0 rpm	X2A.10 + X2A.11
16	Acceleration Time	secs	10.0 sec	Time required to accelerate to command speed
17	Deceleration Time	secs	10.0 sec	Time required to decelerate to command speed
18	Open Loop V/Hz Frequency	Hz	60 Hz	Motor Nameplate
19	Low Speed Torque Boost (Open Loop, V/Hz Only)	%	10.0%	-
20	Encoder Pulses Per Revolution (PPR)	inc/rev	1024 inc/rev	Encoder Pulse Number
21	Encoder Rotation Channel	-	0 = Not Inverted	0 = Not Inverted, 1 = AB Swapped 16 = Inverted Rotation, 17 = AB Swap & Inverted Rot.
22	KP Speed	-	1500	-
23	KI Speed	-	200	-
24	KI Offset	-	50	-
25	Input Status	coded	Read Only	See Section 3 for values
26	Output Status	coded	Read Only	See Section 3 for values
27	Command Speed	rpm	Read Only	-
28	Actual Motor Speed	rpm	Read Only	-
29	Output Frequency	Hz	Read Only	-
30	Output Current	A	Read Only	-
31	Peak Output Current	A	Read Only	-
32	DC Bus Voltage	V	Read Only	-
33	Output Voltage	V	Read Only	-
34	Modulation Grade	%	Read Only	-
35	Download Datecode	-	Read Only	-
36	Last Error	-	Read Only	-

KEB AMERICA INC.
5100 Valley Industrial Blvd.
Shakopee, MN 55379
Phone: 952-224-1400
www.kebamerica.com

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