KEB F5 Elevator Drives: Startup, Adjustment and Troubleshooting PM Applications

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Learning Objectives

After reading this article, you should have learned about:
◆ The basic start-up procedure of the KEB F5 elevator drive
◆ Familiarization of motor data and encoder position learn procedures
◆ How to adjust speed control for ride quality
◆ How to perform governor overspeed test
◆ How to recognize common troubleshooting solutions

Getting Started

Below is a quick overview of the steps for starting and adjusting the KEB F5 Elevator Drive:

1. Load configuration
2. Set input/output (I/O)
3. Enter control type
4. Enter and learn motor data
5. Enter machine data
6. Enter speeds and profiles
7. Learn motor pole/encoder position
8. Motor ready to run
   Adjust ride quality
       i. Adjust speed controller
       ii. Learn system inertia
       iii. Adjust synthetic pre-torque
9. Governor overspeed test
10. Additional tips and troubleshooting

Keypad Navigation

The majority of parameter adjustments during startup will be made in the LF parameter group. Other parameter groups may be needed for additional setup and adjustment, which include: US, Ld, do, di, ru, and LP.

A quick overview for navigating between parameters, parameter groups, viewing and saving parameter values is included. In particular, to view a parameter value, press the function key. To save the parameter setting, press the ENTER key. Otherwise, to exit the parameter without saving press the function key again. Some parameters, such as motor data, cannot be changed while the elevator is in operation. This is also true for all parameters with serial speed control. Figures 1-3 serve as a quick overview for navigating between parameters and parameter groups, and viewing and saving parameter values.
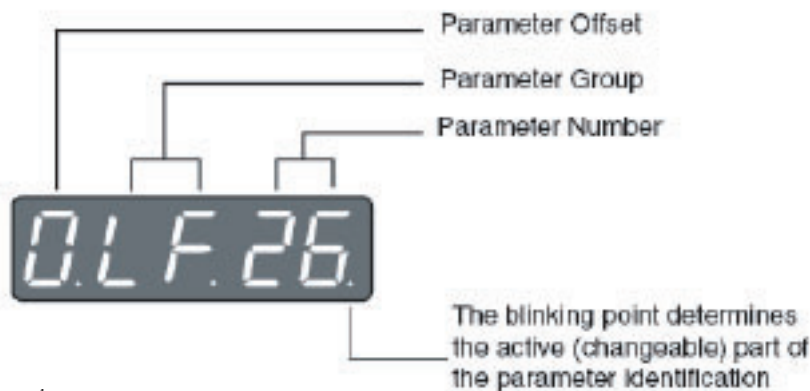
Parameter Offset
Parameter Group
Parameter Number

0.LF.26

The blinking point determines the active (changeable) part of the parameter identification

Figure 1

Value: 2 contact hours (0.2 CEU)

Approved by NAEC

Approved by NAESAI

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Initialization of the Drive

The KEB F5 elevator drive is an AC drive that supports both induction asynchronous and permanent-magnet (PM) synchronous motors. Additionally, the drive supports both standard high- and low-speed gearless resolutions.

The first step in setting up the drive is to select then load the proper motor and speed resolution configuration for the application. The selectable configurations are listed in parameter US.10: ICLSd (geared induction motor), IGLSS (gearless induction motor), PCLSd (PM synchronous geared motor) and PGLSS (PM gearless motor). Once the appropriate configuration has been selected, the next step is to load the configuration. Loading the configuration establishes the parameter for the selected motor type (i.e. induction and PM motors have different motor data parameters). This is done by setting parameter US.4 = 'Load,' then pressing ENTER on the keypad. If this has not previously been done, US.4 will display 'bdPAS.' When complete, the drive will display in the inverter status for normal operation, 'noP,' in parameter LF.99. After loading, the configuration can be verified through parameter LF.4. The same configuration code as that selected in US.10 will be displayed in LF.4. Also after a successful load, US.4 will display 'PASS'. Now the drive is ready for further programming.

Setting I/O

The digital inputs of the drive can either be set up for PNP (sourcing, +24V) or NPN (sinking, 0V) logic. This can be set in parameter di.0, according to the controller.

Additionally, the drive digital and relay output functions are selectable. These can be configured in parameters do.80 – do.83 according to the controller prints.

Setting the Speed Command Control

Next, the control mode must be established in parameter LF.2, according to the controller type. This will establish the drive inputs accordingly. Selections are displayed in Chart 1.

Figure 2

Figure 3

Entering Motor Data

As with any closed-loop system, correct motor data is essential to proper motor operation and control. Most essential motor data such as the rated speed and rated torque or power should be available from the motor nameplate. Items not commonly listed, such as the motor EMF constant, resistance and inductance can be measured by the drive.

Control Mode	Description	LF.2 Setting
Absolute Analog Speed Control	0... 10V = 0 ...Contract Speed	AbSPd
Digital Speed Selection	4 Discreet Digital Inputs, 5 Speeds	dSPd
Analog Torque Control	0... 10V = 0 ...Rated Torque	Ator
Serial Speed Control	Inputs and Speed Profile via Serial Comm.	SErSP
Binary Speed Selection	3 Discreet Digital Inputs, 7 Speeds	bnSPd

Chart 1

$$\text{Lb.-ft.} = \frac{\text{kW X 7051}}{\text{Rated motor speed (LF.11)}}$$

$$\text{Lb.-ft.} = \frac{\text{Nm}}{1.355}$$

$$\text{Lb.-ft.} = \frac{\text{HP X 5258}}{\text{Rated motor speed (LF.11)}}$$

Table 1

To start, LF.8 is a motor overload protection function. This is a UL overload curve to protect the motor from high rms current. To activate this, set LF.8 = 'on'.

LF.10 lists the rate motor horsepower. For PM applications, this parameter is a calculated read-only value based on the motor rated speed in LF.11 and motor rated torque in LF.17. The rest of the motor data can be entered in parameters LF.11--LF.19. If the value for the motor EMF constant is unknown, then the motor rated voltage can be entered in LF.14 in the meantime and can be learned by the drive later, as well as the motor resistance and inductance.

LF.11 = Motor rated speed (rpm)
LF.12 = Motor rated current (A)
LF.13 = Motor rated frequency (9Hz)
LF.14* = Motor rated voltage at rated speed (VAC rms)
LF.17 = Motor rated torque (lb.-ft.)
LF.18* = Motor rated resistance (Ohm)
LF.19* = Motor rated inductance (mH)
*These values can be learned by the drive.

The relationship between the motor rated speed, motor rated frequency and number of motor poles is of high importance. Unlike asynchronous induction motors with a slip speed, PM gearless motors are synchronous, and the following relationship must hold true:

Rated motor speed (LF11 = rpm) =
$$\frac{\text{Rated motor frequency (LF.13 = Hz) X 120}}{\text{Number of motor poles}}$$

This relationship should always be verified in case nameplate values are rounded off. Otherwise, the commutation angle will be incorrect, leading to higher current draw or stalling of the sheave. If the motor rated speed and frequency are given, then the number of motor poles will always be calculated to a whole even number. This relationship also helps if either the rpm or motor rated frequency is not listed. The number of motor poles may either be listed, or may be quickly attainable based on the motor manufacturer machine frame. Either unknown value can be calculated quickly by knowing the number of motor poles.

Regarding the torque, the units listed on motor nameplates may vary (including HP, kW and Nm). For reference, the following conversion to lb.-ft. is listed in Table 1:

When the rated torque is entered in LF.17, the peak torque in 0.LF.36 is automatically calculated to 1.5 X LF.17. This is to prevent excessive current to the motor during setup. It will be necessary to raise the peak current to 200–250% of the rated torque in LF.17 once commissioning is complete for full performance and overload testing.

Once motor data has been entered, the procedure for learning the unknown motor data can be performed. This procedure will learn the EMF constant of the motor (LF.14 = VAC rms), the motor phase-to-phase resistance (LF.18 = Ohm), the motor phase-to-phase inductance (LF.19 = mH), and also calibrate the drive power stage to the motor characteristics.

Auto-Tuning PM Motor Procedure

For best performance, the resistance and the inductance of the PM motor must be measured by the drive. Use the following steps to complete the measurement for PM synchronous motors.

Setup

Make sure the rated motor speed (LF.11), rated motor current (LF.12), rated motor frequency (LF.13), rated motor torque (LF.17) and contract speed (LF.20) are entered into the drive before beginning the setup. Remove one brake wire from the controller or reduce the brake pick voltage level, preventing it from picking. If the controller is providing the speed command via analog or serial command, set the inspection speed value to zero and the controller to zero. If the drive is providing the command, there is no need to change the inspection speed in the drive.

Learn Process

Auto Tune

1) Set LF.3 = S Lrn. This will start the learn process.
2) The display will change to StArt.
3) Press and hold inspection up. The motor contactor should pull in and the brake should not pick. Motor current will begin to flow, an audible noise in the motor will be heard and the drive display will change to LS103.
4) The drive will measure various parameters in the motor, as well as in the drive's own power stage. During each measurement, the display will change to signify

what is being measured. In the event of a problem during the measurement phase, the factory can use the codes to determine what is happening.

5) Continue holding the inspection switch ON until the drive display is done.

6) Release the inspection switch. The drive will finish by making several calculations, CALC, and updating the parameters values with the measured values.

NOTE: Return brake wire if removed!

Errors

In the event that the drive can not complete the measurement, the following error messages may occur.

FAIL: The measurement sequence was interrupted, i.e., the inspection switch was released prematurely, or the controller dropped the enabled signal to the drive. Verify if the controller is dropping the signal by first setting LF.3 to conF and try again. If the controller still drops the enable and the motor contactor, the problem lies in the controller.

Entering Machine Data

The purpose of the machine data in parameters LF.21–23 is to translate the linear elevator speed in fpm to rotation motor speed. For serial communication speed control, only the contract speed in LF.20 is needed, although entering machine data in parameters LF.21-–24 may be a useful reference.

LF.20 = contract speed (fpm)
LF.21 = sheave diameter (in.)
LF.22 = gear ratio (x:1)
LF.23 = roping ratio (x:1)

TIP: Based on the machine data in LF.21-–LF.23, the drive will display the calculated elevator speed in LF.90. If the drive is going too fast or too slow, look at the encoder speed in LF.88 and compare with the commanded speed in LF.89. If these two numbers are relatively close, then the drive is tracking the command speed as it should and the issue may be that the machine data is incorrect. Otherwise, refer to the tip listed under the speed settings.

Entering Speeds and Profiles

When the speed control mode is set for discreet digital inputs, the drive speed and S-curve profile pattern are generated by the drive from the following parameters:

LF.41 = leveling speed (fpm)
LF.42 = high speed (fpm)
LF.43 = inspection speed (fpm)
LF.44 = high leveling speed (fpm)
LF.45 = intermediate 1 speed (fpm)
LF.46 = intermediate 2 speed (fpm)
LF.47 = intermediate 3 speed (fpm)
LF.50 = start jerk (ft./sec^3)
LF.51 = acceleration (ft./sec^2)
LF.52 = acceleration Jerk (ft./sec^3)
LF.53 = deceleration Jerk (ft./sec^3)

LF.54 = deceleration (ft./sec^2)
LF.55 = flare jerk (ft./sec^3)
LF.56 = stop jerk (ft./sec^3)

For binary coded discreet digital input speed commands, profile parameters LF.50–LF.55 will have indexes 0, 1, 2.LF.50-LF.55 so the profile may be adjusted differently for different speed commands. Index 0 refers to high and intermediate speeds, index 1 refers to leveling, high leveling and inspection speed, and index 2 refers to emergency operation mode.
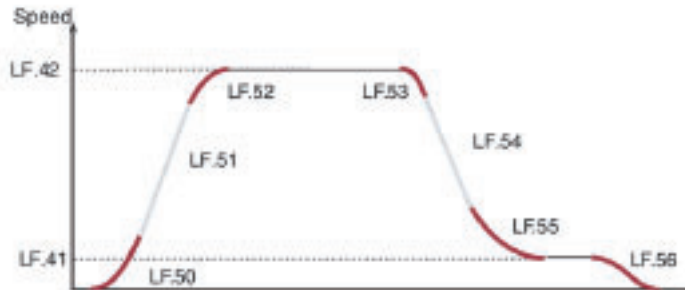

Figure 4

NOTE: For analog and serial speed control, profile parameters are set to off, and the drive will follow the controller command. If the acceleration/deceleration or jerk rate programmed on the drive is less than that from the controller, the drive will follow its internal S-curve pattern; this may be useful for troubleshooting.

NOTE: The jerk rates are limited to a minimum based on the corresponding acceleration/deceleration. This is to prevent discontinuity on the S-curve profile. Therefore, it may be necessary to lower the acceleration/deceleration rate if a desired jerk rate cannot be entered.

TIP: For discreet digital inputs, if the drive is going too fast or too slow, look at the encoder speed in LF.88 and compare with the commanded speed in LF.89. If these two numbers are relatively close, then the drive is tracking the command speed as it should, and the issue may be that speed setting is incorrect. Verify the input commands in LF.82 to determine if the correct speed is being signaled.

Entering Encoder Data
and Verifying Connection

With PM synchronous motors using an absolute encoder, it is necessary for the drive output phases to the motor to be correctly wired U–U, V-V and W-W. The encoder pulses per revolution (ppr) can be entered in LF.27. Then, the serial communication and position transfer between the encoder and drive can be verified by parameter 2.LF.26, which should display 'Conn' or scroll 'Serial Com Established'. If not, this parameter will display an error message for diagnosis.

TIP: If there is audible motor noise that cannot be rectified with lowered speed control gains, the cause may be

from noise on the encoder incremental signals, and the solution is to increase the encoder sample time in LF.29 from 4 ms to 8 ms or 16 ms to filter the noise.

Learning the Pole
Position of PM Motors

Now that all of the motor data have been entered and the speeds established, there is one last vital procedure before running a PM motor. That is to learn the position of the encoder relative to the motor pole. Since these are synchronous motors, the stator field must be commutated relative to a fixed rotor field with the encoder acting as an electrical commutator. Therefore, the position of the rotor via the encoder must be known to properly commutate the stator field.

The stationary pole identification (SPI) function allows the drive to learn the absolute encoder position for a PM machine under the brake without sheave movement. The SPI process can be done with the ropes on the brake set. This procedure can only be done with a PM. Before the drive can learn the absolute position, the motor data must be entered correctly, and the motor resistance and inductance must be measured by the drive.

Alignment Process

1) Set LF.3 = SPI and press ENTER. The display will confirm with StArt.
2) Press and hold the inspection switch up. The motor sheave should not turn, and the display will show 11 position values of the encoder.
3) Once complete, donE will be displayed on the keypad operator. Release the inspection switch and make note of the final position number in LF.77. This position number is valid only for this motor and encoder. If the encoder is physically removed from the motor, this process will need to be done again.
4) The display will show noP in LF.99, and LF.3 will automatically be set to run.
5) Verify that the encoder position is correct by running the car and monitoring the current in LF.93. If the current is excessive, the encoder rotation may be incorrect. In this case, change LF.28 from a value of 0 to 1 or from 1 to 0, else from 2 to 3 or from 3 to 2, and repeat the alignment process.
   NOTE: Return brake wire if removed!

Errors

In the event the drive cannot complete the measurement, the following error messages may occur:

FAILP: The drive is not able to begin measurements due to not entering and learning the correct motor data.

FAIL: The measurement sequence was interrupted, i.e., the inspection switch was released prematurely, or the controller dropped the enabled signal to the drive. Verify if the controller is dropping the signal by first setting LF.3 to

conFand try again. If the controller still drops the enable and the motor contactor, the problem lies in the controller.

FAILd: Excessive deviation between pole position samples. Set Ld.26 from value of 0 to 1 and retry the alignment procedure again.

Running the Motor

At this point, the drive should be ready to run the motor, although further ride quality adjustment may be needed. To run the motor, set LF.3 = 'run.'

If the motor runs in the wrong direction, the direction can be inverted with parameter LF.28, but setting from a value of 0 <-> 2 or 1 <-> 3. With synchronous motors, the output phases cannot be swapped to change the direction of rotation.

TIP: It may be necessary to reduce the speed gains in LF.31 –LF.33 to prevent vibration or erratic behavior if the running motor is unloaded. Good values are LF.31=300, LF.32=50 and LF.33=0. Otherwise, for a roped machine, good starting values are LF.31=1,200, LF.32=200 and LF.33=200.

TIP: With a loaded machine, it may also be necessary to raise the peak torque in 0.LF.36. By default, 0.LF.36 is set to 150% of the rated torque in LF.17 to prevent excessive current to the motor during setup. Under full load conditions, it may be necessary to raise the peak torque in 0.LF.36 to 200–250% of rated torque (LF.17).

Speed Gain Adjustment

When the FFTC is not being used, or when the gain of the FFTC must be kept lower, the speed control gains play a greater role in controlling the elevator. Always start the adjustment with the proportional gain LF.31 and then proceed on to the integral gains in LF.32 and LF.33. All of the gains are divided into three values, A for acceleration and contact run, d for deceleration, and P for pre-torque. The pre-torque values are for the pre-torque function only and are described later.

Proportional Gain

The proportional gain maintains general control and stability over the entire speed range. The proportional gain is split into two values – one for acceleration and constant speed (A.LF.31) and one for deceleration (d.LF.31). Additionally, the value can be automatically reduced as the speed transitions from slow to contract speed. LF.31 sets the overall gain. Lower values, less than 1000, may result in loose control and overshoot of the command speed as high speed is reached. Higher values can cause high-frequency oscillation or a buzzing sound in the motor. If tighter control is necessary during the start or stop, then the corresponding proportional gain can be raised accordingly in A.LF.31 or d.LF.31.

TIP: 3000 is a good number to start with for geared and high speed gearless applications. For lower- to

medium-speed gearless applications, 1500 is a good starting point.

TIP: For quick initial adjustment, raise/lower proportional gain in steps of 500–1000.

Examples of proportional gain adjustments:

LF.31=1000: Actual speed overshoots during transition into high speed. Raise in steps of 500 until overshoot is gone, 3000 is a good number.
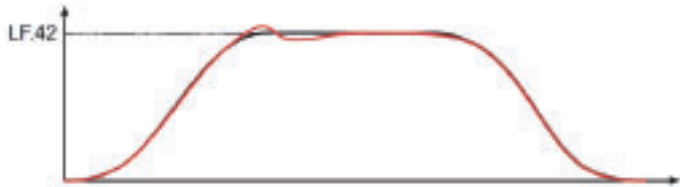

Figure 5

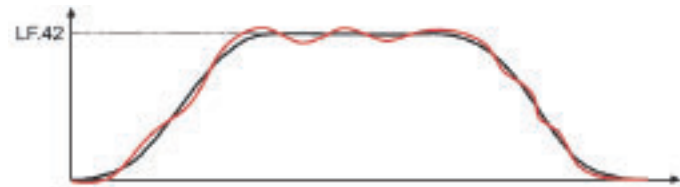*LF.31=500: Motor has poor control with strong oscillations. Raise in steps of 500 until better control is achieved.*

Figure 6

LF.31=5000: Loud audible noise or vibration from the motor; lower the value in steps of 500 until the noise/vibration stops.
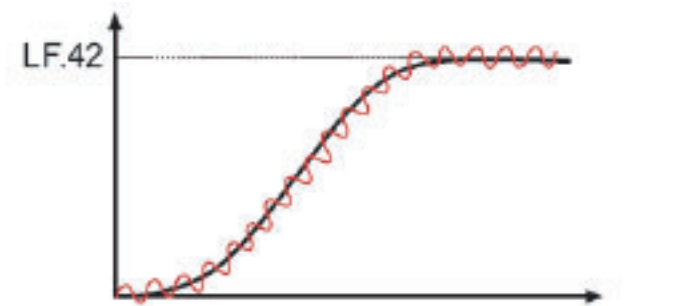
Figure 7

The gain can be reduced at high speed through US.22 and US.23. Turn the function on in US.22 and set US.23 to the lower value. This can help reduce jitter or vibration at high speed, while still maintaining control at lower speeds.
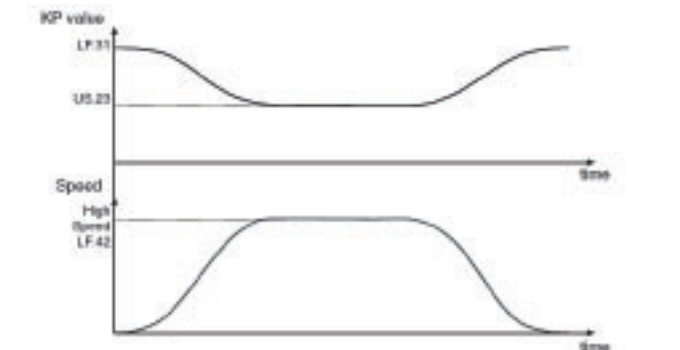
Figure 8

Integral Gain

The integral gain is responsible for correcting long-term average error in speed, as well as providing increased control and rigidity at lower speeds for starting and stopping. The integral gain is split into two values – one for acceleration and constant speed (A.LF.32). and one for deceleration (d.LF.32).

LF.32 provides an overall gain value for all speeds of operation. If this value becomes too high (greater than 600), it can result in torque pulsations during acceleration and deceleration. If the value becomes too low (less than 250), the tracking of the command speed will suffer and the system may not reach contract speed.

TIP: 200 is a good number to start with for gearless applications.

TIP: Typically, the integral gain needs very little adjustment. Instead, most adjustment will be made to the integral offset gain (amount added to LF.32 for low speeds) in LF.33.

Examples of integral gain adjustment:

LF.32=100: Speed lags the command, sometimes does not reach contract speed and/or undershoots the floor. Raise in steps of 100 until better control is achieved.

Figure 9

LF.32=1500: Acceleration is jerky, bunching or spotting occurs during deceleration. Lower LF.32 in steps of 200. A good range is 200-600.

Figure 10

Integral Offset

LF.33 provides an offset to the gain value at low speeds. Again, this parameter provides two adjustments; one for acceleration and one for deceleration. During starting and stopping, it is necessary to have higher gain values to overcome friction, as well as maintain good control. The total integral gain value is the sum of LF.32 and LF.33 at low speeds.

TIP: For quick initial adjustment, raise or lower integral gain in steps of 500.

US.20 and US.21 define the corner speeds where the gain begins to ramp up and reaches the maximum value.

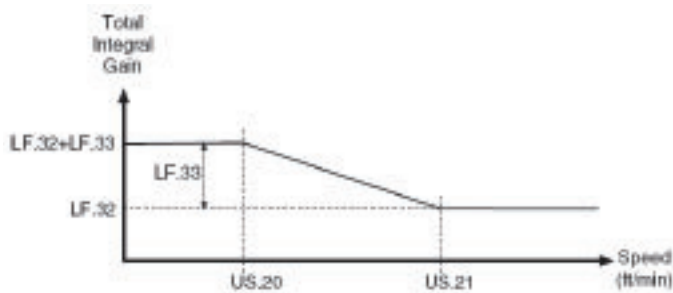For gearless applications it may be necessary to increase US.21 to around 100 fpm and decrease US.20 to 3 fpm

Figure 11

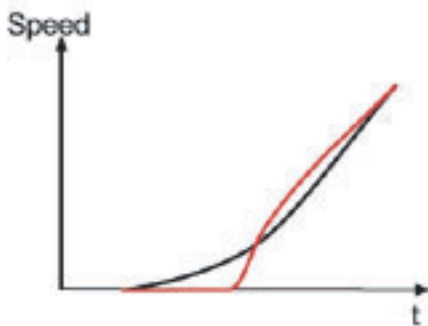Examples of common problems during starting and their solutions:

LF.33=1000:
Speed lags the command on takeoff. This is typical with worm-gear machines when trying to break free. The start feels very hard or abrupt. Raise in steps of 500.
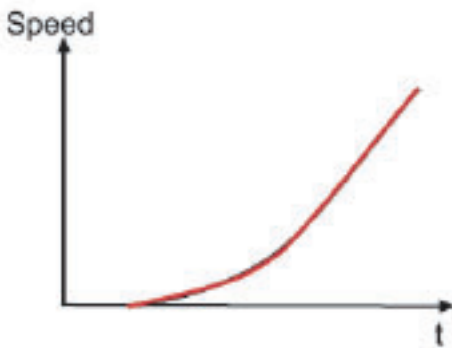
Figure 12

LF.33=3000:
Higher KI Offset value aids the torque build during starting. Helps to overcome break-away torque of machine. Actual speed tracks the command.
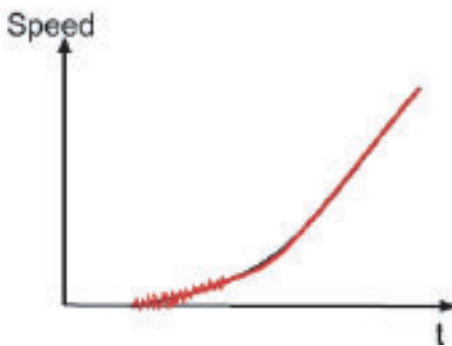
Figure 13

LF.33=6000:
High KI Offset value causing vibration or audible noise in the motor at take-off. Lower in steps of 500.

Figure 14

Examples of common problems during stopping and their solutions:

LF.33=500:
Speed lags during the final phase of decal, one slow oscillation just before stop; undershooting of floor. Raise in steps of 500.
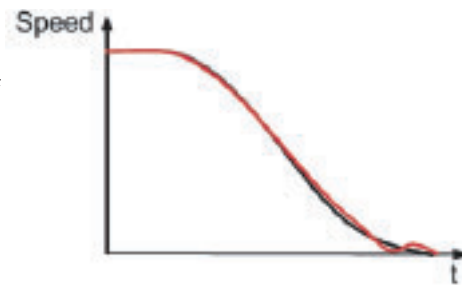

Figure 15

LF.33=3000:
Higher offset value leads to bunching or steps during final approach and/or faster oscillations; reduce value in steps of 500.
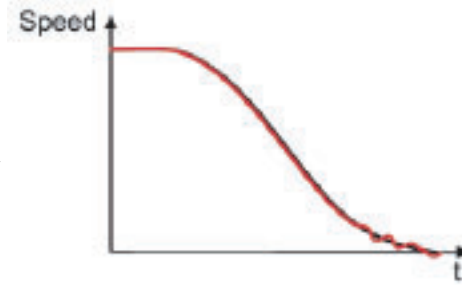

Figure 16
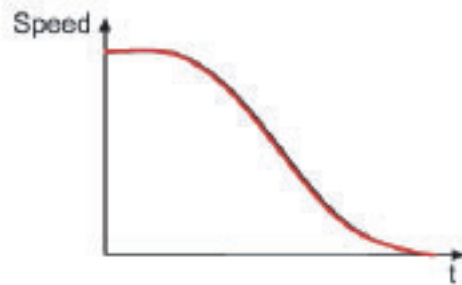
LF.33=1000:
Offset value OK.

Figure 17

LF.33=1000:
OK but corner speed US.21 too low. In this case the speed begins to lag during deceleration, but then recovers in the final approach. With gearless, it is often necessary to raise the corner speed of the start of the offset to a higher value. Raise US.21 from 24 feet per minute to 100 fpm.
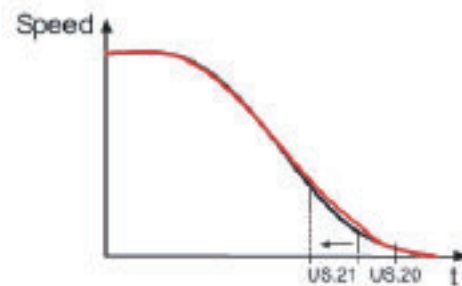

Figure 18

System Inertia Learn Procedure

For optimum control of the elevator, it is recommended to learn the system inertia and activate the feed forward torque controller. Feed forward control reduces the dependence on the speed feedback from the motor by predicting what the system will do and providing the required torque command based on that prediction.

The first step in learning the system inertia is to get the car running at contract speed over multiple floors. If the

auto tune process has not been completed, complete that first. The counterweight balance shall be adjusted and finalized. Additionally, if required, compensation chains or ropes shall be installed in their final state. Note: the best results are possible with compensation. The learn process is carried out by precisely balancing the car with weights inside the car. The procedure is outlined below.

1) Pick two floors and run the car only between the two. During the learn process, the rate of acceleration will be lower, so it might take two or more floors to reach contract speed.

2) Place balanced load in the car.

3) Display the actual motor torque in parameter ru.12.

4) Run the car up and down; note the value of ru.12 once the car is running at contract speed. When the car is balanced, the value will be near zero and about the same in each direction, although the value may be opposite in sign, i.e., +15 up and -15 down.

5) Add or subtract weight by a small amount at a time until the values in each direction are close. Excessive friction in the hoistway may result in higher torque values.

6) Once the car is balanced, adjust the speed (tach) following error in the controller to the maximum value, as during the learn process the actual motor speed will not track the controller's command.

7) Set parameter LF.3 to I Lrn and press ENTER. The display will confirm with StArt. Note: if at any point it is necessary to abort the learn process, press the Func key on the drive's keypad. Additionally, it is not allowed to navigate away from this parameter during the learn process.

8) Register a call. The display will change and show the torque value. Monitor the car speed on the controller and make sure the car is getting up to speed. If not, increase the number of floors the car is traveling.

9) Run the car up and down a few times. Note that during acceleration, the same value should be reached, then a much lower value during the constant speed portion of travel. Disregard the values during deceleration.

10) After having gotten a sense of the values, it will now be necessary to write down the values after each run. The values to note are the values during acceleration and at constant speed. It does not matter whether they are positive or negative. Write them all down as a positive value. Get values from approximately 10 runs.

11) Add all acceleration values together and divide by 10. Add all constant speed values together and divide by 10. Then subtract the constant speed value from the acceleration value. The result is the needed value.

12) With the car standing still, press the ENTER key on the keypad of the drive. The display will show 'VALuE'. Press the up arrow key and scroll up to the value from step 11.

13) Once the value is correct, press ENTER. This stores the acceleration torque value in parameter Ld.29. Additionally, this calculates the system inertia and sets up the feed forward control in parameters Ld.30...Ld.32.

14) At this point, the drive is back to a normal run mode. The car should accelerate normally. In the controller, readjust the speed (tach) following error to a more normal value.

Feed Forward Torque Control

With the inertia set, the feed forward torque control (FFTC) is active. The effectiveness of the control can be influenced by the gain value in parameter Ld.32. Ninety percent is the typical value and should give good results. However, if the value is lowered, the influence of the FFTC will be reduced; higher values will intensify the result. Values in the range of 50-150% can be typical. Setting this value to 0% turns off the FFTC. With the FFTC turned on, it is possible to reduce the values of A.LF.31, d.LF.31, A.LF.32, d.LF.32, although it is not always necessary. A.LF.33 and d.LF.33 should be reduced, i.e., by at least a factor of 10. Depending on the type of elevator, geared or gearless, more or less offset gain (LF.33) may be required.

Synthetic Pre-Torque

Synthetic pre-torque is a feature of the drive that can be used to minimize, if not totally eliminate, the roll back which normally occurs when the brake is lifted. The function is turned on in parameter LF.30 and adjusted in parameters US.17, US.18, P.LF.31 and P.LF.32. The following procedure will assist in the adjustment of the pre-torque.

NOTE: Adjust brake spring tension, brake voltage and brake timing first. It is often advantageous to use lower spring tension and lower brake voltage to provide a softer lifting of the brake. This allows for a smoother transition from brake to motor. It should be noted that any subsequent changes to the brake could require readjustment of the synthetic pre-torque.

1) Set the speed to zero in order to clearly see the rollback.

2) Run the car on inspection and note the rollback.

3) Turn on the synthetic pre-torque by setting LF.30=5. Also adjust US.17=0.2 sec. and US.18=0.2 seconds.

4) Run the car on inspection. If there is any vibration or audible noise at the start, lower the value of P.LF.32 by 2500 and try again.

5) Increase the value of US.17 by 0.05 seconds. If the rollback is reduced, proceed to step 6; otherwise, continue raising the value of US.17 again by 0.05 seconds until a difference in rollback is perceived.

6) Note the value of US.17 and raise it again by 0.05 seconds. If the roll back gets better, try raising it again. Keep raising US.17 until it gets worse again. Then lower the value by 0.05 seconds. Note that there may still be some rollback at this point. _Continued_

7) Increase the value of P.LF.32 in steps of 2000 and run the car. Roll back should be further reduced. Values as high as 20000 are normal. If there is vibration or audible noise at start, reduce P.LF.32. In some cases, it may help to raise the value of P.LF.31 to minimize vibration during the pre-torque phase. Adjust in steps of 1000. Finally, reduce US.18 by 0.05 seconds.

8) Return the pattern gain or inspection speed to the previous values.

9) Run the car on automatic.

The goal is to adjust timer US.17 so that the pre-torque ramp down phase occurs exactly when the brake releases and the roll back occurs.

NOTE: by monitoring LF.86 it is possible to see in which phase the drive is. A value of 4 is the ramp up phase US.17. A value of 3 is the ramp down phase and is controlled by US.18.
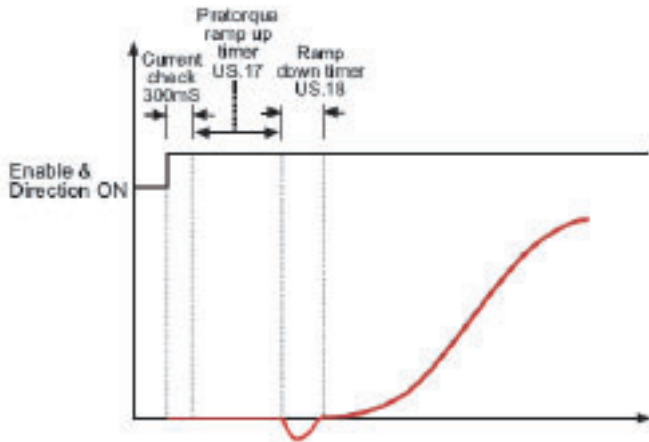

Figure 19

When adjusted properly, the brake should pick, the motor holds the load for a short period (about 1/4 second), and then acceleration begins.
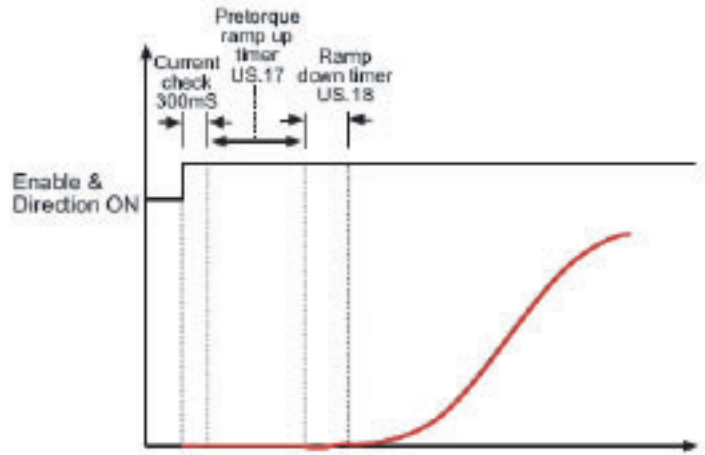

Figure 20

Governor Overspeed Test

One final step in turning over the elevator is to perform the governor overspeed test. On the drive, the output speed is limited to the contract speed in LF.20, and if 125% of the contract speed is reached, the drive will generate its own overspeed error, E.OS. So, to perform the governor overspeed test on the F5 elevator drive, the most common method is to increase the gear ratio in parameter LF.22. The gear ratio, along with the roping ratio and sheave diameter, are used to calculate a rotary speed (rpm) from a linear dimension (fpm). Increasing the gear ratio will linearly increase motor rpm to correspond to the calculated elevator speed. For example, if the gear ratio is typically set to 1.00 for a gearless machine, then setting LF.22 = 1.50 will cause the motor to run 150% faster. When the governor overspeed is complete, return the gear ratio in LF.22 to its nominal value and proceed as normal. ⊕

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Learning-Reinforcement Questions

Use the below learning-reinforcement questions to study for the Continuing Education Assessment Exam available online at www.elevatorbooks.com or on page 111 of this issue.

◆ How does one set up the KEB F5 elevator drive?
◆ What should be done after motor data is entered?
◆ How should resistance and inductance of the PM motor be measured?
◆ What should be done if the drive is going too fast or too slow?
◆ At what point is the drive ready to run the motor?
◆ What are the different types of speed adjustment?
◆ How is system inertia learned?
◆ What is synthetic pre-torque?
◆ What is the goal of synthetic pre-torque adjustment?
◆ What is the final step to perform before turning over the elevator?

Additional Tips and Troubleshooting

Problem	Cause	Solution
Machine does not rotate or only turns slightly. Machine stalls and draws high current.	Motor data incorrect	Verify correct motor data in LF.10 - LF.19. Verify correct correlation between rated speed, rated frequency and number of motor poles for PM machines: LF.11 = 120 x LF.13 / # poles
	Encoder position incorrect	Verify encoder mounting. Note value of LF.77, then relearn the encoder position for PM machines. If the re-learned value is different from the previous value by more than 2,000 then slippage may have occurred on the encoder.
Sheave rotates very fast and causes E.0S over-speed error.	Motor data incorrect	Verify correct motor data in LF.10 - LF.19. Verify correct correlation between rated speed, rated frequency and number of motor poles for PM machines: LF.11 = 120 x LF.13 / # poles
	Encoder position incorrect	Verify encoder mounting. Note value of LF.77, then relearn the encoder position for PM machines. If the re-learned value is different from the previous value by more than 2,000 then slippage may have occurred on the encoder.
Elevator fails to reach contract speed.	Torque limit reached	Increase torque limit in 0.LF.36
	Voltage limit reached	Monitor the modulation grade in ru.42. If the value reaches 100% or higher, then the voltage limit is being reached and more output voltage is required than what is being input. Verify input voltage is correct and not sagging
	Encoder position incorrect	Incorrect encoder position causes higher than normal current, causing higher than normal output voltage and the voltage limit is being reached. Relearn encoder position.
Cannot drive full load. Will not pick full load or car only moves in down direction with full load or up direction with empty car.	Torque limit being reached	Raise the torque limit 0.LF.36. Typicall is 200 – 250% of rated motor torque
	Motor data incorrect or Encoder position incorrect	The drive may also be reaching the torque limit if the motor data in LF.11 – LF.19 is incorrect or if the encoder position in LF.77 is encoder
	Speed gains too low	After the machine has been roped, the speed gains will need to be raised to control the motor. Typical starting values are A/d.LF.31 = 1200, A/d.LF.32 = 200, A/d.LF.33 = 300
Audible motor noise from physical vibration	Speed gains LF.31 – LF.33 are too high	After machine has been roped, start with low gain values and increase as needed. For example, LF.31 = 1,000, LF.32 = 200, LF.33 = 500. Start by decreasing proportional gain in LF.31.
	Encoder sample time to high	Increase LF.29 encoder sample time to 4ms or 8ms
	Incorrect motor data	Verify LF.11 – LF.19. Use LF.3 = S_Learn function to learn the resistance, inductance, and back EMF if unknown
E.EnC1 errors	Incorrect encoder rotation	Swap A and B encoder channels. Change LF.28 from a value of 0 to 1 or from 1 to 0 and relearn encoder position.
	Friction. Sheave unable to move freely	Verify brake is opening. If machine is unroped, the sheave should be movable by hand.
	Motor phasing incorrect	Verify output connections: U-U, V-V, W-W. For PM machines, phases cannot be swapped to invert motor rotation
E.EnCC errors	Determine fault displayed in 2.LF.26 before clearing error and correct as needed	2.LF.26 = PoSde (Position deviation). Verify encoder mounting, uncoil extra lengths of encoder cable and separate from noise sources, install ferrite rings
		2.LF.26 = bdCb (Bad Cable). Verify encoder connections, uncoil extra lenghts of encoder cable and separate from noise sources, such as high voltage or switching supplies.

Chart 2

ELEVATOR WORLD Continuing Education Assessment Examination Questions

Instructions:

◆ Read the article **"KEB F5 Elevator Drives: Startup, Adjustment and Troubleshooting PM Applications"** (page 63) and study the learning-reinforcement questions.

◆ To receive **two hours (0.2 CEU)** of continuing-education credit, answer the assessment examination questions found below online at www.elevatorbooks.com or fill out the ELEVATOR WORLD Continuing Education Reporting Form found overleaf and submit by mail with payment.

◆ Approved for Continuing Education by **NAEC for CET, NAESAI and QEI Services, Inc for QEI**.

1. The motor tachs out at an incorrect speed. What are the first things that should be checked?
   a. Whether the encoder speed matches the set speed.
   b. Whether the actual current is too high.
   c. Whether the contract speed is set correctly.
   d. Whether the motor rated speed is set correctly.

2. The motor does not move and draws high current. What is a likely cause?
   a. The encoder position is incorrect.
   b. The motor rated frequency is incorrect.
   c. The motor rated speed is incorrect.
   d. All of the above.

3. There is noise from physical vibration coming from the motor. What is the most likely cause?
   a. Proportional speed gain too high.
   b. Torque limit being reached.
   c. Voltage limit being reached.
   d. Motor phasing incorrect.

4. What adjustment can be used to increase the speed for the governor overspeed test?
   a. Increase the contract speed.
   b. Increase the gear ratio.
   c. Increase the motor rated speed.
   d. Decrease the encoder ppr.

5. When trying to learn the encoder position with SPI, "FailP" is displayed. What is the cause?
   a. Motor data learn procedure has not been performed.
   b. Encoder not connected.
   c. Encoder phasing incorrect.
   d. Encoder ppr incorrect.

6. When entering the motor data, the motor rated frequency is unknown. How can this value be determined?
   a. It is the same as the line frequency, 60Hz.
   b. Calculated from the motor rated speed and number of motor poles.
   c. This value can be learned by the drive.
   d. Calculated from the motor torque and horsepower.

7. After the encoder/rotor position is learned for the first time, the motor doesn't turn and draws high current. What should be done?
   a. Change encoder rotation on drive and relearn encoder position.
   b. Swap two motor phases.
   c. Relearn motor data.
   d. Invert motor direction and relearn encoder position.

8. There is motor noise from physical vibration that cannot be resolved with speed gains. What is the next adjustment step?
   a. Increase encoder sampling time.
   b. Increase peak torque.

   c. Relearn encoder position.
   d. Adjust motor slip.

9. The drive is following the set speed, but it is still not going the correct speed. What could be checked next?
   a. Whether machine data is correct (sheave diameter, roping ratio).
   b. Which set speed is being selected (digital inputs).
   c. Adjustment of the contract speed.
   d. A or B.

10. The motor resistance is not listed on the nameplate or datasheet. How should this be determined?
    a. Perform the motor data learn procedure with the drive.
    b. Calculate by dividing the motor rated voltage by the motor rated current.
    c. Run car up and down and adjust until current is minimum.

11. The car runs in the wrong direction each time. Which should NOT be done in an attempt to correct this?
    a. Change encoder rotation on drive.
    b. Swap two motor output phases.
    c. Verify inputs for Up and Down are correct.
    d. Verify command speed.

12. The acceleration jerk rate on the drive cannot be lowered to the desired value. How can this be achieved?
    a. First decrease the acceleration rate.
    b. Increase contract speed setting.
    c. Increase encoder sampling rate.
    d. Increase leveling speed setting.

13. Which step should be done before learning the system inertia?
    a. Balance the car by looking at the current in the up and down directions.
    b. Balance the car by looking at the torque in the up and down directions.
    c. Put the full load in the car.
    d. Take the full load out of the car.

14. During the motor data learn procedure, the drive displays "Fail". What would be a potential cause?
    a. Inspection command was accidentally dropped.
    b. Controller times out and drops input command to drive.
    c. The drive is unable to make a measurement.
    d. A or B.

15. The motor current seems to be limited to a low value. What is the potential cause?
    a. Maximum torque setting at default 150%.
    b. Motor data is incorrect.
    c. Proportional speed gain too low.
    d. Motor rated current set too low.

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4.	a	b	c	d	12.	a	b	c	d
5.	a	b	c	d	13.	a	b	c	d
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