



INSTALLATION, OPERATION AND INSTRUCTION MANUAL

TMU MOTORIZED TROLLEY

English

STD-R-KHA-F-CQD-ENG





CAUTION: Read the instructions supplied with the product before installation and commissioning.



CAUTION: Keep the instructions in a safe place for future reference.

Before proceeding with the operation or maintenance of the trolley, it is important that the operating and maintenance personnel read this bulletin carefully in order to ensure the safe and efficient use of the equipment.

Also, it is strongly recommended that the personnel responsible for the operation, inspection, and servicing of this trolley, read and follow the Safety Standard ASME B30.16-1998 (or current revised edition). This standard covers Overhead Trolleys (under-hung) as promulgated by the American National Standards Institute and is published by the American Society of Mechanical Engineers. Copies of this publication are available from the Society at United Engineering Center, 345 East 47th St., New York, NY 10017.

If any instructions are unclear, contact the manufacturer or distributor of the trolley before attempting to install or use the hoist.

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FOREWORD

This manual has been prepared to acquaint you of the procedures necessary for the installation, operation and maintenance of the equipment you have purchased.

Proper use is important to the ultimate performance of this equipment. Careful study of and adherence to the instructions will help ensure safe, dependable operation. It is also recommended that you keep this manual readily accessible to operators as well as maintenance and safety personnel.

Information in this manual is subject to change without notice.

Warranty

All sales are subject to the [R&M Materials Handling, Inc.](#) Standard Terms and Conditions of Sale (Revision 101707), a copy of which is available at www.rmhoist.com or upon request from [R&M Materials Handling, Inc.](#) customer service/sales representatives and the terms of which are incorporated as if fully rewritten herein.

How to Order Repair Parts Correctly

The Spare Parts section of this manual covers replacement parts required for [R&M Materials Handling, Inc.](#) equipment. To ensure prompt service, each repair parts order must contain the following information:

1. serial number (affixed to hoist and to trolley)
2. Capacity
3. Reference number from spare parts identification sheet
4. Quantity
5. Description
6. Voltage, phase, cycles
7. Correct shipping destination
8. Model numbers

The serial number of your trolley will be found on the nameplate affixed to the trolley. Without this serial number, we cannot be sure of sending you the correct parts, so always mention the serial number for parts, service, etc.

All verbal orders must be immediately followed up with a written confirmation since the company cannot assume responsibility for the accuracy of the verbal message.

Contact our Aftermarket – Parts Department should you desire the name and address of a parts distributor in your area.

Minimum Charges

All orders for repair parts are subject to a minimum charge.

Claims for Damage in Shipment

All shipments are carefully inspected and are delivered to the carrier in good order. Upon receipt of shipment caution should be exercised so that there is no loss or damage. If damage has occurred, refuse to accept the shipment until the carrier makes the proper notation to that effect. All claims for shipping damages must be filed with the carrier.

In the event of concealed loss or damage, notify the carrier immediately. By following these suggestions you will encounter less difficulty collecting your claim.



CAUTION: Read the instructions supplied with the product before installation and commissioning.



CAUTION: Keep the instructions in a safe place for future reference.

Table of contents

1	GENERAL	6
1.1	Installation of Trolley	6
1.2	Coupling Suspension	7
1.3	TROLLEY FLANGE SETTINGS TABLE	10
1.4	Operating Tests – TMU Variable Frequency Drive	12
1.5	Operating Tests – TMU Two-speed Motor	13
2	TECHNICAL CHARACTERISTICS	14
2.1	Specification and Minimum Radius Curve – TMU Variable Frequency Drive	14
2.2	Specification and Minimum Radius Curve – TMU Two-speed Motor	15
2.3	Environmental Data	15
3	TMU DRIVE	16
3.1	Motor	17
3.2	Description of the Gear Reducer	17
3.2.1	TMU VFD Gear Reducer	17
3.2.2	TMU Two-speed Motor Gear Reducer	17
3.3	Description of the Brakes	17
3.3.1	Compact Brake	17
3.3.2	D.C. Disc Brake	17
3.4	Mounting Position of Drive Unit	18
3.5	Mounting the Drive Unit	18
3.6	Removing the Drive Unit	18
3.7	Inspection and Service of the Drive Unit	18
3.8	Adjustment of Compact Brake Air Gap	19
3.9	Removal and Inspection of the Brake	19
3.9.1	Compact Brake	19
3.9.2	D.C. Disc Brake	19
3.10	Trouble Shooting – Brake	20
3.10.1	Compact Brake	20
3.10.2	D.C. Disc Brake	20
4	TMU VARIABLE FREQUENCY DRIVE	21
4.1	Description of the Inverter	21
4.1.1	Connections	22
	Technical Characteristics	23
4.1.2	Normal Operation for Trolley	23
4.1.3	LED Status Indicator	23
4.2	Programming Parameters	24
4.2.1	Speeds and Ramp Time Selections	25
4.2.2	Speed Control Mode	26
4.2.3	Motor Parameters	27
4.3	Fault Codes and Troubleshooting – TMU VFD	28
4.3.1	Troubleshooting Worksheet	29
4.4	Wiring Specification	30
4.4.1	Wiring Practices – TMU Variable Frequency Drive	30
4.4.2	Wiring Diagram – TMU Variable Frequency Drive	31
4.4.3	Wiring Diagram – TMU Two-speed	32
5	PREVENTATIVE MAINTENANCE	33
5.1	Maintenance table	33
5.2	Lubricants	33

5.3	Spare Part Replacement	33
5.4	Discarding the Trolley	33
6	SPARE PARTS	34
6.1	TMU Trolley	34
6.2	TMU Variable Frequency Drive	36
6.3	TMU VFD Transformer & Line Reactor	37
6.4	TMU Two-Speed Motor	38

1 GENERAL

- Service life of the trolley depends on the way in which it is installed.
- Any use contrary to our instructions may be dangerous.
- Before operating the equipment, read and follow the Installation, Operation and Maintenance Instruction manual.
- Always keep the Instruction manual close to the equipment, readily available to operator and person responsible for maintenance.
- Make sure that personnel safety rules are followed (harness, clearance of work area, posting of instructions to be followed in the work area, etc.).
- The crown tread profile of trolley wheel is compatible to flange profiles such as S or WF beam.
- Couple or hook on the hoist after installation of the trolley to the monorail or beam.



CAUTION: Check the width of beam flange and adjust the spacing of the flanges of the trolley as indicated in the trolley flange settings table.

Before installing make sure:

- Beam is secured as appropriate.
- Beam is suitable to the loads to be supported.
- Dimensions of beam flange are compatible with the trolley, which is being installed.
- Power supply voltage is compatible.
-

1.1 Installation of Trolley

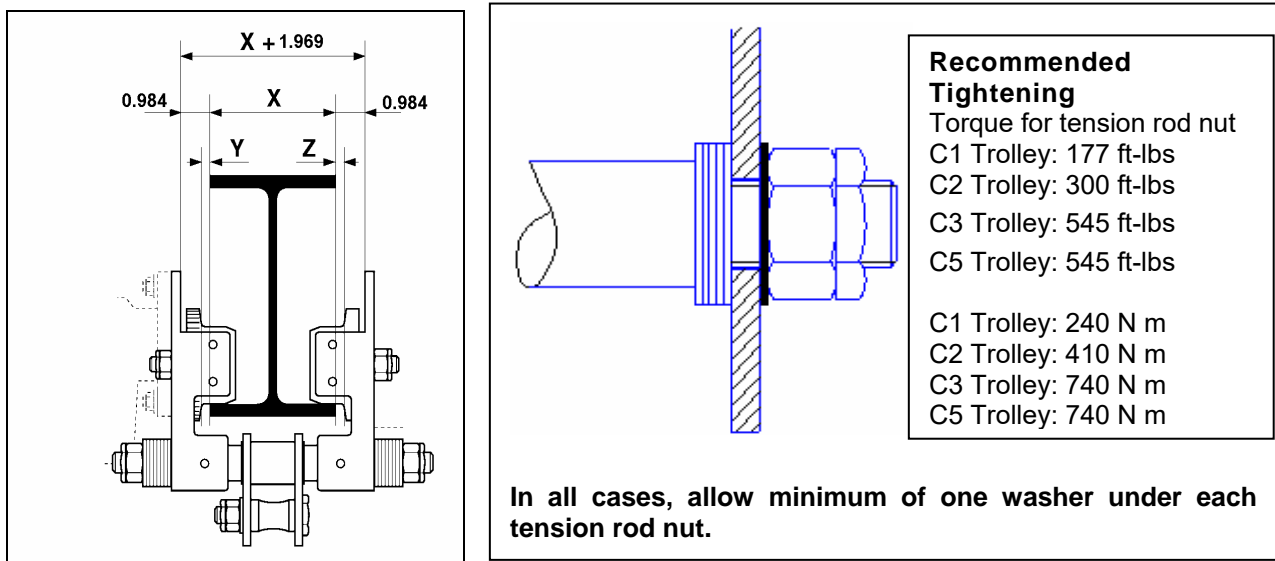
Method 1

1. Remove the trolley idler side plate assembly.
2. Position the trolley on the beam
3. Reinstall the idler side plate assembly.
4. Tighten the tension rod nuts. (see Recommended Tightening Torque chart below)
5. Connect the power cable plug to the hoist.
6. Grease the teeth of the drive pinion and the drive wheels. (see Section 5.2 Lubricants)

Method 2

1. Install the trolley as a complete assembly onto the beam from the end of the beam.
2. Install the trolley end stops at each beam end.
3. Check that all the tension rod nuts are properly tightened. (see Recommended Tightening Torque chart)
4. Connect the power cable plug to the hoist.
5. Grease the teeth of the drive pinion and the drive wheels. (see Section 5.2 Lubricants)

Figure 1. Trolley Installation and Recommended Torque Tensions

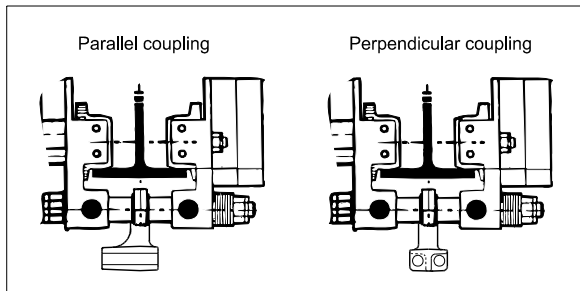


$Y + Z = 5/32" [4mm] \text{ MAX}$

The total play between wheel flange and the beam flange must not exceed 5/32" [4mm]. The distance between trolley side plates must be equal to the sum of the beam flange width + 1 15/16" [50mm].

1.2 Coupling Suspension

Figure 2. Parallel and Perpendicular Coupling Suspensions



When setting the hoist in position, check that the suspension hook or coupling is correctly positioned, depending on whether the chain hoist is a one-fall or two-fall design. This is necessary for proper balance of hoist when loaded.

Figure 3. Suspension (Perpendicular) with LM5 or LM10 Hoists

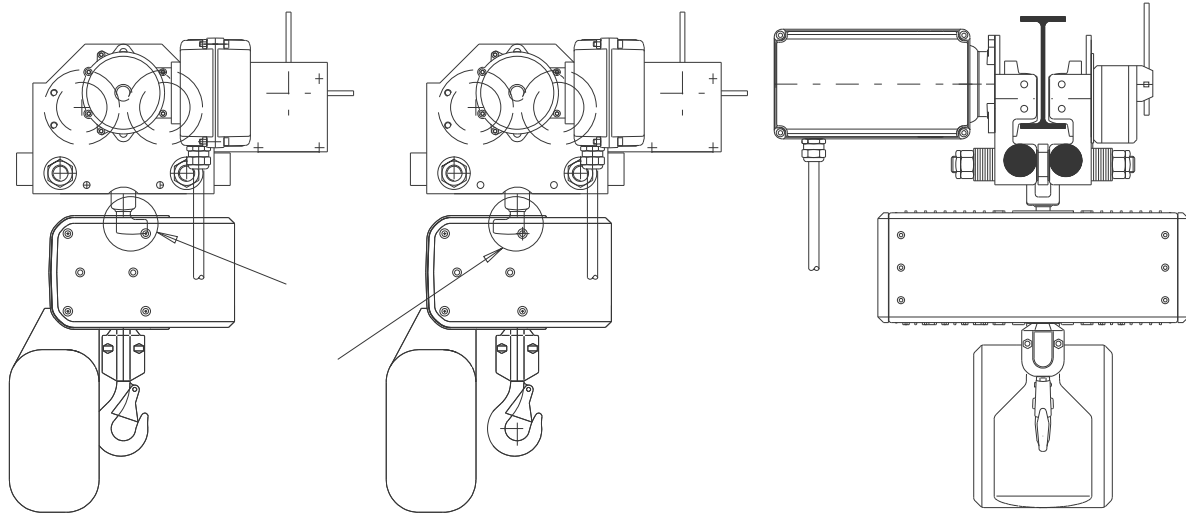


Figure 4. Suspension (Parallel) with LM5 or LM10 Hoists

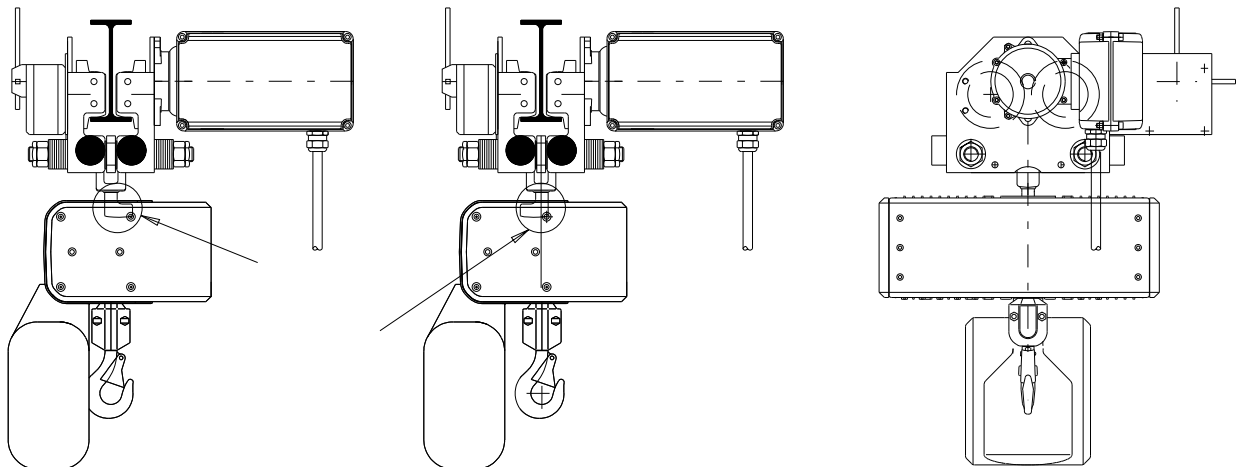
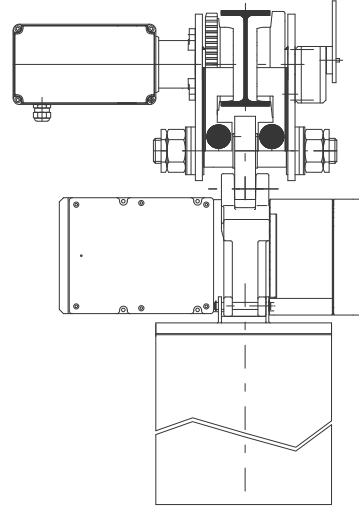
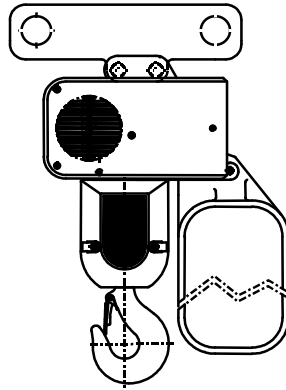
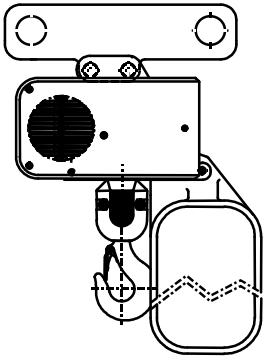


Figure 5. Suspension with LM16, LM20 or LM25 Hoists

















1 fall

2 falls



1.3 TROLLEY FLANGE SETTINGS TABLE

Table 1. Trolley Flange Settings

Flange Width In [mm]	C1 Trolley				C2 Trolley				C3 Trolley				C5 Trolley						
																			
2.52 [64]	225	4	0	2	260	0	0	0	305				309						
2.60 [66]		6	2	0		2	0	1											
2.83 [72]		14	4	1		8	2	0											
2.87 [73]		16	4	2		10	2	1											
2.91 [74]		18	6	0		10	2	1											
3.19 [81]		22	6	2		17	4	1											
3.23 [82]		24	8	0		17	4	1			3	0		1			6	1	0
3.50 [89]		30	8	3		25	6	1			8	2		0			12	2	0
3.54 [90]		30	10	0		25	6	1			11	2		1			14,5	2	1
3.58 [91]		32	10	1		28	6	2			11	2		1			14,5	2	1
3.86 [98]	36	12	0	34	8	1		19	4	1			20,5	3	1				
3.94 [100]	40	12	2	36	8	2		198	4	1			24	4	0				
4.17 [106]	270	0	0	0	325	42	10	1	355	27	6	1	381	30	5	0			
4.25 [108]		2	0	1		44	10	2		27	6	1				32,5	5	1	
4.33 [110]		3	1	0		46	10	3		30	6	2				35	5	2	
4.45 [113]		8	2	1		48	12	0		32	8	0				6	1	0	
4.65 [118]		9	3	0		54	12	3		38	8	2				12	2	0	
4.69 [119]		11	3	1		54	12	3		38	8	2				12	2	0	
4.72 [120]		12	4	0		56	14	0		40	10	0				14,5	2	1	
4.92 [125]		16	4	2		60	14	2		46	10	2				18	3	0	
4.96 [126]		18	4	3		62	14	3		46	10	2				20,5	3	1	
5.16 [131]		20	6	1		2	0	1		51	12	1				24	4	0	
5.24 [133]	22	6	2	6	0	3	54	12	2			26,5	4	1					
5.31 [135]	24	8	0	8	2	0	54	12	2			30	5	0					
5.39 [137]	26	8	1	8	2	0	56	14	0			30	5	0					
5.51 [140]	30	10	0	12	2	2	3	0	1			32,5	5	1					
5.63 [143]	32	10	1	14	2	3	6	0	2			36	6	0					
5.75 [146]	36	12	0	17	4	1	8	2	0			42	7	0					
5.79 [147]	38	12	1	20	4	2	8	2	0			42	7	0					
5.87 [149]	40	12	2	20	4	2	11	2	1			42	7	0					
5.91 [150]	46	12	3	22	4	3	11	2	1			44,5	7	1					
6.10 [155]	390				390	26	6	1	415	16	4	0	429	6	1	0			
6.22 [158]						30	6	3		19	4	1				8,5	1	1	
6.30 [160]						32	8	0		22	4	2				12	2	0	
6.53 [166]						38	8	3		227	6	1				17	2	2	
6.62 [168]						40	10	0		30	6	2				20,5	3	1	
6.69 [170]						42	10	1		32	8	0				20,5	3	1	
7.00 [178]						50	12	1		40	10	0				30	5	0	
7.08 [180]						52	12	2		43	10	1				32,5	5	1	
7.28 [185]						56	14	0		46	10	2				36	6	0	
7.32 [186]						58	14	1		48	12	0				38,5	6	1	
7.40 [188]				60	14	2	51	12	1			38,5	6	1					
7.48 [190]				62	14	3	51	12	1			42	7	0					
7.79 [198]				6	0	3	3	0	1			49,5	7	3					
7.87 [200]				8	2	0	3	0	1			50,5	8	1					
8.11 [206]				14	2	3	11	2	1			6	1	0					
8.26 [210]				17	4	1	14	2	2			12	2	0					
8.46 [215]				22	4	3	19	4	1			18	3	0					
8.58 [218]				26	6	1	22	4	2			20,5	3	1					
8.66 [220]				28	6	2	24	6	0			23	3	2					
8.90 [226]				34	8	1	30	6	2			30	5	0					
9.44 [240]				48	12	0	43	10	1			44,5	7	1					
9.76 [248]				56	14	0	51	12	1			52	7	4					
10.24 [260]				4	0	2	6	0	2			5	0	2					

10.55 [268]					12	2	2		14	2	2		12	2	0
11.02 [280]					24	6	0		27	6	1		24	4	0
11.34 [288]					32	8	0		35	8	1		32,5	5	1
11.81 [300]					44	10	2		46	10	2		44,5	7	1
11.89 [302]					46	10	3		48	12	0		47	7	2
11.93 [303]				460	48	12	0	480	48	12	0	488	47	7	2
11.97 [304]					48	12	0		51	12	1		48	8	0
12.00 [305]					50	12	1		51	12	1		50,5	8	1
12.05 [306]					50	12	1		51	12	1		50,5	8	1
12.09 [307]					52	12	2		54	12	2		53	8	2
12.13 [308]					52	12	2		54	12	2		53	8	2
12.13 [309]					54	12	3		54	12	2		53	8	2
12.20 [310]					54	12	3		56	14	0		54	9	0

1.4 Operating Tests – TMU Variable Frequency Drive



CAUTION: Always be ready to press the emergency stop button.

- Check that the electrical connections and mechanical assemblies are all correct.
- Check that the operating parameters are as required.
- Check for loose electrical connections.
- Close the control enclosure cover.
- Check that the movements of the trolley are free from obstruction and do not cause any danger.
- Read the voltage of the main power supply and check that the Autotransformer taps match the readings.
- Turn on the power supply.
- Verify a voltage of 440 to 460v is being supplied from the autotransformer to the inverter (L1, L2, L3). If needed, change taps on the autotransformer to obtain a voltage within this range.
- If the trolley moves to the wrong direction, interchange any two motor leads (U, V, or W). Changing input leads (L1, L2, or L3) will not affect the shaft rotation direction. Ensure that the motion is in the proper direction with respect to the push button being pressed.
- Operate at minimum speed for 5 to 10 seconds. Accelerate up to maximum speed and hold it for 5 to 10 seconds.
- Carry out the same operation in the opposite direction, first at minimum speed and then at maximum speed.
- Check the operations of the left and right trolley travel limit switches. Limit switch is an optional component.

1.5 Operating Tests – TMU Two-speed Motor



CAUTION: Always be ready to press the emergency stop button.

- Check that the electrical connections and mechanical assemblies are all correct.
- Check that the operating parameters are as required.
- Check for loose electrical connections.
- Close the control enclosure cover.
- Turn on the power supply.
- Check that the movements of the trolley are free from obstruction and do not cause any danger.
- Verify supply voltage matches the motor nameplate voltage.
- If the trolley moves to the wrong direction with respect to the push button pressed, interchange L1 and L2 leads on the contactor in the trolley control panel.
- Operate at minimum speed for 5 to 10 seconds. Accelerate up to maximum speed and hold it for 5 to 10 seconds.
- Carry out the same operation in the opposite direction, first at minimum speed and then at maximum speed.
- Check the operations of the left and right trolley travel limit switches. Limit switch is an optional component.

2 TECHNICAL CHARACTERISTICS



CAUTION: Never exceed the maximum load capacity that is indicated on the rating plate on the TMU unit.

2.1 Specification and Minimum Radius Curve – TMU Variable Frequency Drive

Table 2. Specification and Minimum Radius Curve - TMU Variable Frequency Drive

Trolley Type and Drive	Motor Type	Min. Radius Curve
C2 + TMU VFD less gear reducer	MF06MK200	6.56 ft [2m]
C2 + TMU VFD	MF06MK200	6.56 ft [2m]
C3 + TMU VFD	MF06MK200	6.56 ft [2m]
C5 + TMU VFD	MF06MK200	No radius Straight track only

The TMU variable frequency drive is available for power supply of 208, 230, 460 or 575v through the use of an autotransformer. In addition, a line reactor is used to protect the TMU VFD against voltage spikes. Both the autotransformer and the line reactor are mounted to the trolley idler side plate under a cover. For a power supply of 400v/50Hz, a transformer is not required. The VFD controls are totally enclosed, and the enclosure is mounted to the motor.

- Control Type: Variable Frequency Drive
- Main power supply: 208, 230, 400/50Hz, 460 or 575 VAC
- Control voltage: 115 VAC (48v optional; std. with 400v)
- Frequency: 50/60Hz
- Speed control method: 2 speed mode (default) or Infinitely variable
- Stopping method: Dynamic braking
- Brake Type: COMPACT Brake
- Acceleration/Deceleration: 2.50 seconds (default)
- Motor overload protection: Bimetal switch (option)
- Protection: IP-55 (NEMA 3R type enclosure)
- Approvals: CSA "C" and "US"

Gearless TMU Variable Frequency Drive (loads \leq 1 ton [1000 kg])

- Nominal output power of gearless TMU: 0.2 hp [0.15 kW]
- Travel speeds: 65/16 fpm [20/5 m/min]
- Motor frequency: 35 Hz
- Motor Type: MF06MK200 gearless
- Starting Current: 2.3A
- Nominal Current: 1.1A

Geared TMU Variable Frequency Drive (loads >1 ton [1000 kg]) at 460v-60Hz

- Nominal output power of geared TMU: 0.5 hp [0.37 kW]
- Travel speeds: 65/16 fpm [20/5 m/min]
- Motor frequency: 100 Hz
- Motor Type: MF06MK200
- Starting Current: 4.3A
- Nominal Current: 1.2A

The inverter can be programmed to achieve a wide range of minimum and maximum travel speeds. See Section 4.2.1 for more information regarding the travel speed settings.

2.2 Specification and Minimum Radius Curve – TMU Two-speed Motor

Table 3. Specifications and Minimum Radius Curve

Trolley Type and Drive	Motor Type	Min. Radius Curve
C1 + TMU Two-speed	MF06MK104	6.56 ft [2m]
C2 + TMU Two-speed	MF06MK104	6.56 ft [2m]
C3 + TMU Two-speed	MF06MK104	6.56 ft [2m]
C5 + TMU Two-speed	MF06MK104	No radius Straight track only



Note: The trolley control panel is mounted directly to the motor.

- Control Type: Contactor controls
- Main power supply: 208, 230, 400/50Hz, 460 or 575 VAC
- Control voltage: 115 VAC (48v optional; std. with 400v)
- Frequency: 50/60Hz
- Speed control: Two-speed
- Brake Type: D.C. Disc Brake
- Motor overload protection: Bimetal switch (option)
- Protection: IP-55 (NEMA 3R type enclosure)
- Approvals: CSA "C" and "US"

TMU Two-speed Motor

- Motor Type: MF06MK104 two-speed motor
- Motor frequency: 60 Hz 50Hz
- Nominal output power: 0.5/0.9 hp 0.3/0.05 kW
- Synchronous speed: 3600/900 rpm 3000/750 rpm
- Starting Current: 3.9/1.1 A 3.5/1.0 A
- Nominal Current: 0.9 A 1.0 A
- Travel Speed: 80/20 fpm 20/5 m/min

2.3 Environmental Data

- Ambient temperature: 14°F to +104°F [-10°C to +40°C]
- Humidity: 90%RH (no condensation)
- Vibration: 0.2g_n (2m/s²)
- Sound level: 70 dB at 3 feet [1m]

3 TMU DRIVE

Figure 6. TMU Variable Frequency Drive and TMU Two-Speed Motor

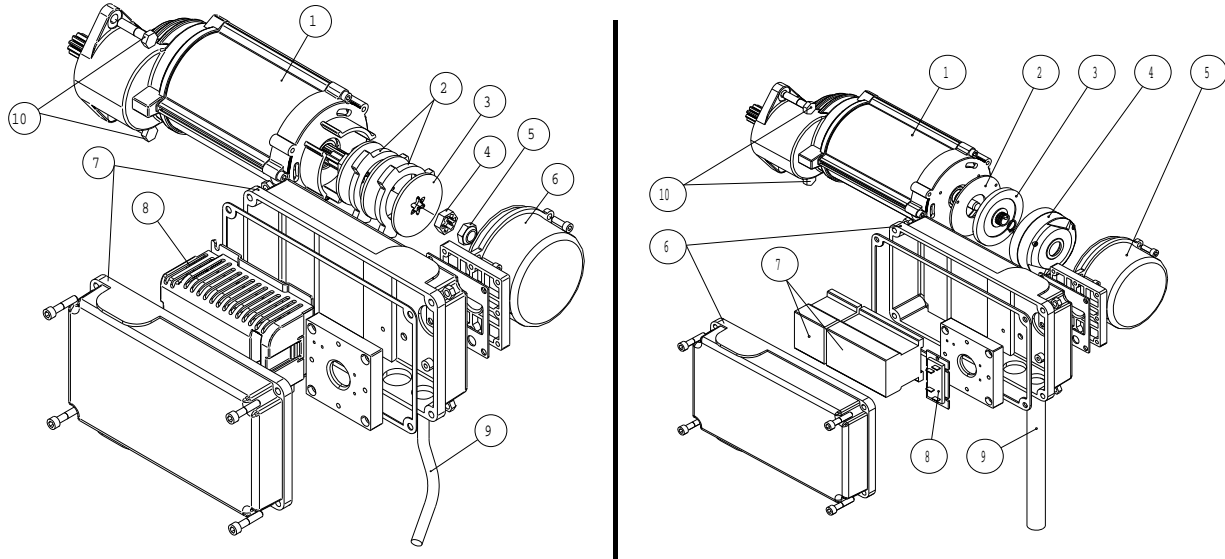


Table 4. Parts List for TMU Variable Frequency Drive and TMU Two-Speed Motor

TMU Variable Frequency Drive		TMU Two-speed Motor	
1. Gear/motor unit	6. Brake cover	1. Gear/motor unit	6. Control enclosure
2. Compact Brake	7. Control enclosure	2. Friction plate	7. Contactors
3. Brake disc	8. Variable frequency drive	3. Brake disc	8. Rectifier
4. Sleeve	9. Electrical cable	4. Brake	9. Electrical cable
5. Nut	10. Mounting screw	5. Brake cover	10. Mounting screws

* See Section 7 for Spare Part information

3.1 Motor

The motor insulation is class F and the degree of protection is IP55.

3.2 Description of the Gear Reducer

3.2.1 TMU VFD Gear Reducer

A single reduction gear reducer is used together with the 100/120 Hz inverter motor. Generally, this gear motor reducer is used when the capacity of the hoist is greater than 1 ton [1000 kg]. The output pinion is cut into the output shaft of the gearbox. Gears are lubricated with semi-fluid grease.

The 35 Hz inverter motor is used without a gear reducer. Generally, this gearless motor is used when the capacity of the hoist is 1 ton [1000 kg] or less. The trolley wheels are directly driven from the motor.

3.2.2 TMU Two-speed Motor Gear Reducer

A single reduction gear reducer is always used together with the two-speed motor regardless of load capacity. The output pinion is cut into the output shaft of the gearbox. Gears are lubricated with semi-fluid grease.

3.3 Description of the Brakes

3.3.1 Compact Brake

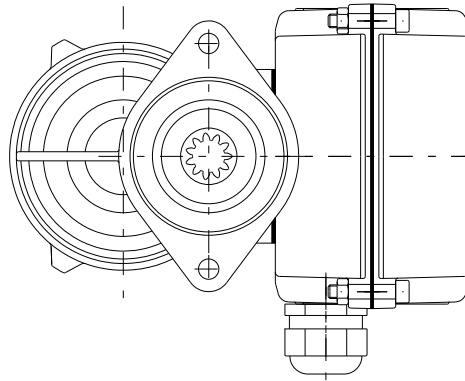
The Compact brake is integrated into the design of the MF06 inverter motor and is AC operated - without a separate coil for the brake. An electromagnetic force produced from the energized motor stator winding releases the brake. Since the MF06 inverter motor is always operated with a TMU VFD that provides dynamic braking, the compact brake is essentially a holding brake. The brake sets when the motor decelerates to zero and a spring applies a clamping force.

3.3.2 D.C. Disc Brake

The D.C. Disc brake is mounted to the two-speed motor and utilizes a D.C. coil. The coil releases the brake disc. Several springs apply the clamping force.

3.4 Mounting Position of Drive Unit

Figure 7. Positioning of the TMU Drive Unit



The TMU drive unit is to be positioned so that the control enclosure is located to the side of the motor, with the power cable outlet pointing down as shown above.

Other mounting positions of the drive are not recommended because they reduce the cooling effectiveness and may cause overheating of the controls.

3.5 Mounting the Drive Unit

- Be sure the main power supply is switched off - to avoid electrical hazard.
- Align the pinion teeth with the wheel gear teeth. Push the drive unit against the trolley side plate.
- Rotate the machinery to the proper mounting position. Note: the motor brake prevents the free rotation of the motor. So either release the brake or raise the drive wheels off the rail.
- Insert the mounting bolts. Use lock washers
- Tighten the mounting bolts by hand until snug.
- If the drive wheels are raised up, lower the wheels down before beginning the final tightening of the mounting bolts. Note: Wheels must lie on the track when tightening the mounting bolts to ensure that no excessive loads are directed toward the secondary shaft. Recommended tightening torque for M8 bolt is 18 ft-lbs [24 Nm].
- Connect the power cable plug to the hoist.

3.6 Removing the Drive Unit

- Disconnect power and lockout disconnecting means on the crane/hoist.
- Disconnect the power cable plug from the hoist.
- Loosen and remove the mounting bolts.
- Remove the drive unit from the trolley side plate.

3.7 Inspection and Service of the Drive Unit

- Check the tightness of the mounting bolts.
- Check the traveling motion: acceleration and deceleration.
- Check the brake for wear of the friction linings. If necessary, clean the brake and replace the friction linings.
- Check the air gap of the brake.
- Check that the inverter or contactors operate correctly.
- Gears are lubricated with semi-fluid grease. See Preventative Maintenance section for grease type.

3.8 Adjustment of Compact Brake Air Gap

- Disconnect power and lockout disconnecting means on the crane/hoist.
- Disconnect the power cable plug from the hoist.
- Remove brake and motor leads from enclosure.
- Remove the brake cover.
- Push the brake disk and measure the air gap between the adjustment nut and aluminum ring. The air gap must be 0.008 – 0.012 inches [0.2 - 0.3 mm]. Turn the adjustment nut, to adjust the air gap.
- Add the brake cover, install brake and motor leads, and connect the power supply plug to motor.

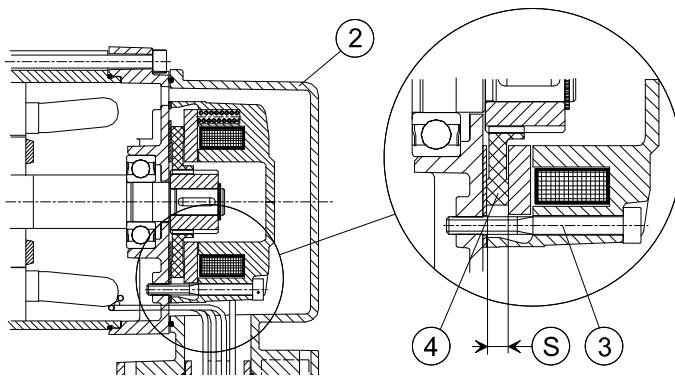
3.9 Removal and Inspection of the Brake

3.9.1 Compact Brake

- Disconnect power and lockout disconnecting means on the crane/hoist.
- Disconnect the power cable plug from the hoist.
- Remove the brake cover.
- Unscrew and remove the adjustment nut.
- Remove the brake parts. If the thickness of the friction disc is less than 0.197" [5 mm], replace brake discs and friction disc.
- Re-assemble in the reverse order.
- Adjust the brake air gap.

3.9.2 D.C. Disc Brake

Figure 8. D.C. Disc Brake and Parts List



- 2. Brake cover
- 3. Mounting screws
- 4. Friction disc
- S. Thickness of friction disc

Data below is for NM38710NR#, 2 Nm brake type and torque size

- Disconnect power and lockout disconnecting means on the crane/hoist.
- Disconnect the power cable plug from the hoist.
- Remove the brake cover.
- Unscrew the mounting screws.
- Remove the brake. If the thickness of the friction disc is less than 0.23" [5.8 mm], replace brake discs and friction disc.
- Re-assemble in the reverse order.
- Recommended tightening torque for mounting screws is 1.8 lb-ft [2.5 Nm]



Note: The air gap on the D.C. Brake is not adjustable.

3.10 Trouble Shooting – Brake

3.10.1 Compact Brake

The Compact brake is used on the MF06 inverter motor only.

Brake will not release:

- Air gap too large ⇒ adjust air gap
- Presence of foreign matter ⇒ clean brake
- Check Motor Parameter setting ⇒ consult Section 4.2.3

Insufficient braking torque:

- Grease on lining ⇒ replace lining
- Damaged lining ⇒ replace lining
- Air gap too large ⇒ adjust air gap
- Worn friction material ⇒ replace lining

3.10.2 D.C. Disc Brake

The D.C. Disc brake is used on the two-speed motor only.

Brake will not release:

- Presence of foreign matter ⇒ clean brake
- Bad rectifier ⇒ replace rectifier

Insufficient braking torque:

- Grease on lining ⇒ replace lining
- Damaged lining ⇒ replace lining
- Air gap too large ⇒ replace friction material
- Worn friction material ⇒ replace friction material

4 TMU VARIABLE FREQUENCY DRIVE

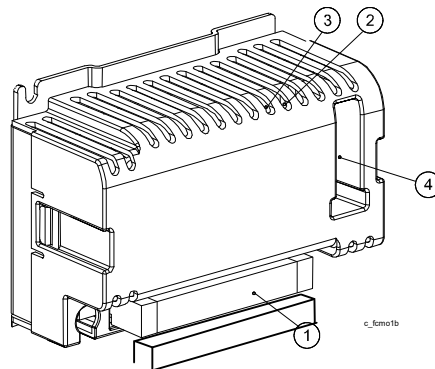
4.1 Description of the Inverter



WARNING: Do not touch any circuit components while the main AC power is on. High voltages are supplied to the inverter (including the programming switches). Wait for at least three minutes after the supply voltage has been switched off before performing any service on the unit. Failure to adhere to this warning can result in injury.

Figure 9. Inverter

1. Terminal X1
2. Red LED (fault)
3. Green LED (ok)
4. Programming switches
5. Capacitor



CAUTION: Inverter cooling is optimal when the air flows through the device from the bottom to the top. If the inverter is mounted sideways, the output current must be de-rated by 40%.

4.1.1 Connections

The required supply voltage for the inverter is 380v/50Hz to 480v/60Hz. For other available three-phase voltages including 460v, an autotransformer is provided to supply the proper voltage to the inverter. See Section 1.4, Operating Tests, with regards to the verification of the output voltage from the autotransformer to the inverter.

Power and control circuit connections are made to X1 terminal as follows:

Table 5. Power and Control Circuit Connections to the X1 Terminal

Number	Name	Description
1	PE	Ground
2	L1	Power phase 1. 380-480V 50/60Hz.
3	L2	Power phase 2. 380-480V 50/60Hz.
4	L3	Power phase 3. 380-480V 50/60Hz.
5	U	Motor phase 1.
6	V	Motor phase 2.
7	W	Motor phase 3.
8	S1	Drive command. Direction 1.
9	S2	Drive command. Direction 2.
10	SP2/AP	Speed 2 / Acceleration command.
11	ON	Control voltage, neutral.

A minimum of two collectors for each runway conductor shall be used with inverter use.

In addition, the use of a ground shall be utilized, either through the frame ground or a conductor ground.

Proper grounding is important with inverter use. A poor ground could cause damage to the inverter or could create a shock hazard to personnel.



WARNING: Failure to properly ground the hoist presents the danger of electric shock.



WARNING: An improper or insufficient ground connection creates an electrical shock hazard when touching any part of the hoist or trolley.

Technical Characteristics

Table 6. Technical Characteristics

Technical Characteristics	Description
Power range	0.75 kW
Supply voltage*	380 – 480 VAC \pm 10%
Nominal supply frequency	48 – 62 Hz
Nominal current	2.4 A
Digital control	S1, S2, DI3
Max output voltage	Equal to supply voltage
Control voltage range	48 or 115 VAC \pm 10%
Ambient temperature	-10 °C to 50 °C 14 °F to 120 °F
Humidity	95% N. C. (with dripping)
Degree of protection	Inverter + inverter cover IP20
Dimensions (W x H x D)	5.24 x 3.62 x 2.36 in. [133 x 92 x 60 mm]
Altitude	Output current must be reduced 1% for every 100 m over 1000 m. For heights over 3000 m, consult factory.
Pollution degree	Pollution degree 2 according to NEMA ICS-1, IEC664 and UL840
Vibration	IEC68-2-6
Shock	IEC68-2-27



Note: * A transformer is used to provide the proper supply voltage if the main power supply is different from the required supply voltage.

4.1.2 Normal Operation for Trolley

The inverter goes into Ready-to-Run within one second after power is applied to the inverter. During running, the inverter follows the user defined speed control mode.

The default speed control mode is the two-speed (MS-2).

The stopping method, which the user cannot change on TMU VFD, is programmed to decelerate to a stop using dynamic braking. As a result of this, the brake is used essentially as a holding brake and the wear on the brake is minimized. When the RUN Forward/Reverse command is removed, the inverter decelerates to zero according to its preset ramp time and then the brake sets. If a failure occurs or if the emergency stop button is pushed, dynamic braking is overridden and the brake closes immediately, bringing the motor and load to an immediate stop.

4.1.3 LED Status Indicator

TMU VFD indicates its operating status by two LEDs. A steady green LED indicates Ready-to-Run. A blinking green LED indicates that a fault condition had been activated, but the fault has since recovered. Normal operation is possible when the green LED is blinking. A blinking red LED indicates a severe fault condition and operation is inhibited. The blinking pattern tells the user the type of fault that has occurred.

4.2 Programming Parameters







CAUTION: Do not touch any circuit components while the main AC power is on. High voltages are supplied to the inverter (including the programming switches). Wait for at least three minutes after the supply voltage has been switched off before performing any service on the unit. Failure to adhere to this warning can result in injury.

Before shipping the unit to you, the parameters are set at the factory, which may be different from the default settings, to meet the performance requirements for your crane application. Changing parameters without full understanding of the inverter functions could cause damage to the equipment or create an unsafe condition.

The TMU VFD uses dip switches to program the features. The state of each switch is either OFF (0) or ON (1). There are five parameters that are possible to set by switches S1 through S4.

Table 7. TMU VFD Dip Switch Settings

<p>Switch S1 = Maximum speed, upper frequency output setting Switch S2 = Minimum speed, lower frequency output setting Switch S3 = Acceleration / Deceleration Ramp Time Switch S4 = Control Mode (S4-1) and Motor Parameters (S4-2-3-4)</p>	 S1  S2  S3  S4
---	---

4.2.1 Speeds and Ramp Time Selections

Frequency Output Selection (Set Switches S1 and S2)

The minimum and maximum speeds are selected by setting the minimum output frequency and the maximum output frequency. Switch S1 sets the maximum output frequency selection and Switch S2 sets the minimum frequency selection. Table “A” is used for the 35Hz gearless motor and table “B” for the 100Hz motor.


Table 8. Frequency Output Selection (Set Switches S1 and S2)

Switch S1 / S2				SPEED TABLE A MF06MK200 35 Hz Gearless Motor				SPEED TABLE B MF06MK200 100Hz Motor			
-1	-2	-3	-4	Minimum Speed		Maximum Speed		Minimum Speed		Maximum Speed	
				S2 switch	Trolley Speed fpm [m/min]	S1 switch	Trolley Speed fpm [m/min]	S2 switch	Trolley Speed fpm [m/min]	S1 switch	Trolley Speed fpm [m/min]
0	0	0	0	8 Hz	26 [8]	35 Hz	121 [37]	29 Hz	20 [6]	100 Hz	66 [20]
0	0	0	1	9 Hz	29.5 [9]	19 Hz	66 [20]	14 Hz	10 [3]	50 Hz	33 [10]
0	0	1	0	13 Hz	46 [14]	22 Hz	75 [23]	23 Hz	16 [5]	62 Hz	43 [13]
0	0	1	1	4 Hz	13 [4]	20 Hz	69 [21]	10 Hz	6.5 [2]	54 Hz	36 [11]
0	1	0	0	15 Hz	53 [16]	28 Hz	95 [29]	32 Hz	20 [6]	80 Hz	53 [16]
0	1	0	1	5 Hz	16 [5]	21 Hz	72 [22]	12 Hz	6.5 [2]	58 Hz	40 [12]
0	1	1	0	6 Hz	20 [6]	23 Hz	79 [24]	16 Hz	10 [3]	66 Hz	43 [13]
0	1	1	1	7 Hz	23 [7]	25 Hz	85 [26]	18 Hz	13 [4]	70 Hz	46 [14]
1	0	0	0	19 Hz	66 [20]	41 Hz	141 [43]	50 Hz	33 [10]	115 Hz	75 [23]**
1	0	0	1	10 Hz	33 [10]	26 Hz	89 [27]	20 Hz	13 [4]	75 Hz	49 [15]
1	0	1	0	11 Hz	40 [12]	30 Hz	102 [31]	26 Hz	16 [5]	85 Hz	56 [17]
1	0	1	1	12 Hz	43 [13]	32 Hz	112 [34]	35 Hz	23 [7]	90 Hz	59 [18]
1	1	0	0	14 Hz	49 [15]	33 Hz	115 [35]	38 Hz	26 [8]	95 Hz	62 [19]
1	1	0	1	16 Hz	56 [17]	37 Hz	128 [39]	41 Hz	26 [8]	105 Hz	69 [21]**
1	1	1	0	17 Hz	59 [18]	39 Hz	135 [41]	44 Hz	29.5 [9]	110 Hz	72 [22]**
1	1	1	1	18 Hz	62 [19]	42 Hz	144 [44]	47 Hz	33 [10]	120 Hz	79 [24]**



Note: ** TMU VFD connected to a 50Hz power supply cannot achieve these speeds. These speeds are available only from either 460v or 575v - 60Hz power supply.

Table 9. Example of Parameter Setting

<p>EXAMPLE OF PARAMETER SETTING: A 100Hz motor is connected to the inverter and 80Hz maximum speed is desired. That speed is found on the 5th row of speed table B. The corresponding setting for S1 switches is in the same row to the left: 0-1-0-0 (off-on-off-off).</p>	 <p>S1</p> <p>Max speed set to 80Hz.</p>
--	---

Acceleration and Deceleration Ramp Time

The acceleration and deceleration ramp times are set using switch S3 as follows:

Table 10. Acceleration and Deceleration Ramp Time Switch Settings

Switch S3				Acceleration/Deceleration ramp time
-1	-2	-3	-4	
0	0	0	0	2.5 sec (default)
0	0	0	1	3.5 sec
0	0	1	0	3.0 sec
0	0	1	1	5.0 sec
1	0	0	1	4.0 sec
1	0	1	1	6.5 sec
1	1	0	0	4.5 sec
1	1	0	1	6.0 sec
1	1	1	0	5.5 sec

The default setting for the acceleration and deceleration ramp time is 2.5 seconds. The acceleration ramp time always equals the deceleration ramp time. Do not reset ramp time below 2.5 seconds.

The TMU VFD stopping method is always the Deceleration to stop (dynamic braking) and extreme caution should be used taking into consideration the value of switch S3. If the deceleration time is too long, crane/hoist can crash into the end stops, causing damage to equipment or injury to personnel.

4.2.2 Speed Control Mode

The TMU VFD provides the user with the flexibility of selecting either Two-step Multi-Speed Control (MS-2) or a Two-step Infinitely Variable (EP-2) mode. Switch S4-1 sets the speed control mode.

Multi-Speed Control Mode (MS-2) (S4-1 = OFF)

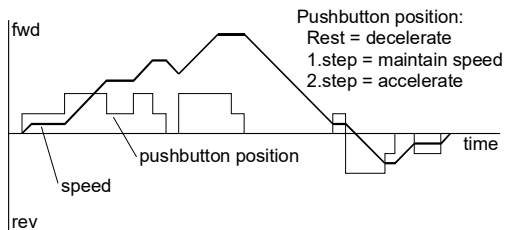
The TMU VFD features 2-step Multi-Speed Control Mode and Decelerate to Stop using dynamic braking stopping method.

- S1 input is RUN Forward. Frequency output increases to frequency set by DIP switch S2. Operation continues at this frequency (minimum speed).
- S2 input is RUN Reverse. Frequency output increases to frequency set by DIP switch S2. Operation continues at this frequency (minimum speed).
- SP2 input/second speed command. Frequency (speed) output increases to frequency set by DIP switch S1. Operation continues at this frequency (maximum speed).
- Upon removal of SP2 input/second speed command, the frequency (speed) output decreases to frequency set by DIP switch S2. Operation continues at this frequency (minimum speed).
- Upon removal of S1 input and S2 input (Run Forward/Reverse), the stopping method is Decelerate to Stop. Output frequency decreases and the inverter decelerates to zero. Then the brake sets.

Two-step Infinitely Variable Speed Control (EP-2) (S4-1 = ON)

The TMU VFD features Two-step Infinitely Variable Speed Control and Decelerate to Stop using dynamic braking.

Figure 10. TMU VFD Two-Step Infinitely Variable Speed Control and Decelerate



- S1 input is RUN Forward. Frequency output increases to frequency set by DIP switch S2. Operation continues at this frequency (minimum speed).
- S2 input is RUN Reverse. Frequency output increases to frequency set by DIP switch S2. Operation continues at this frequency (minimum speed).
- AP input is acceleration. Frequency (speed) output increases. The longer this contact is closed, the higher the speed output becomes. Limited only by the setting if DIP switch S2.
- During running S1 input and S2 input are Hold speed. Frequency output remains constant.
- Upon removal of S1 input and S2 input (RUN Forward/Reverse), the stopping method is Decelerate to STOP. Output frequency decreases and the inverter decelerates to zero. Then the brake sets.

4.2.3 Motor Parameters

The motor parameters are selected by setting switches S4-2, S4-3 and S4-4. The motor parameters must correspond to the motor type being used. The motor parameters are selected as follows:


Table 11. Motor Parameter Switch Settings

Switch S4			Motor type	Nominal frequency	Nominal Motor power
-2	-3	-4			
0	0	0	MF06MK200	100Hz	0.37kW [0.5 hp]
1	0	1	MF06MK200 gearless	35Hz	0.15kW [0.2 hp]











Note: Incorrect motor parameter setting may damage the controls or the motor.


4.3 Fault Codes and Troubleshooting – TMU VFD

 **WARNING:** Do not touch any circuit components while the main AC power is on. High voltages are supplied to the inverter (including the programming switches). Wait for at least three minutes after the supply voltage has been switched off before performing any service on the unit. Failure to adhere to this warning can result in injury.

If the TMU VFD malfunctions, a fault lamp blinks on and off. The blinking pattern continues until a new fault occurs or until power is switched off. The fault codes are explained in the table below.

Table 12. TMU VFD Fault Code Troubleshooting Guide

LED Color, Blinking Pattern	Possible cause.	What to do.
GREEN 	Over voltage. Supply voltage exceeds the specification allows.	Lower input voltage.
GREEN 	Deceleration ramp time is too short.	Extend Deceleration time.
GREEN 	Stall supervision / over current. Brake does not open properly or an obstacle is on the track. Incorrect motor dependent parameter setup.	Adjust air gap. Repair/replace brake. Check that the motor parameter settings (switch S4) match the motor(s) supplied.
GREEN 	Deceleration ramp supervision. Deceleration ramp has not been followed. Supply voltage greater than specification allows.	Reset to longer Deceleration ramp time. Check voltage of all supply phases at terminal X1.
GREEN 	Inverter over temperature. Motor current is too high (bearing problem, obstacle on the track, brake does not open properly). Ambient temperature is too high.	Repair bearing problem. Remove obstacle. Adjust air gap or repair or replace brake. Use a larger rated inverter.
GREEN 	Under voltage. Supply voltage < specification allows	Correct the input power supply problem. Check for single-phase problem.
RED 	Short circuit. Break down in motor cable insulation. Break down in motor winding insulation.	Switch main power off. Replace the motor cables. Check motor resistance. Replace the motor. Replace inverter.
RED 	Inverter transistor failure. Microprocessor fault. Due to high electrical noise environment.	Switch power off for 10 seconds, then back on.

 **Note:** The latest active fault is always removed from the memory when power is switched off.

Drive will not run even though inverter is not in a fault condition:

- Motor will not start if DC-bus voltage too high (above 745V), this occurs if any line-to-line voltage exceeds 480V+5% = 504V. If line voltage cannot be reduced, install step-down transformer in inverter branch circuit.
- Check the supply voltage phases at terminal X1.
- Check the control signals at terminal X1.
- Check that the control voltage is correct. Rating plate is located on the left side of the inverter.
- Check all parameter selections, especially the motor parameters (switch S4).
- Check that the selected motor parameters (switch S4) correspond to the appropriate motor type.
- Check that the microprocessor starts running. Both the green and red indicator LEDs blink once as the inverter is powered up. After the one second initializing time, only the green LED should be lit.
- Check that the brake opens and closes properly. Check the brake air gap.
- Check plug connection for intermittent operations.

4.3.1 Troubleshooting Worksheet

Table 13. Measure and Record Information

Main hoist power leads L1-L2	Main hoist power leads L2-L3	Main hoist power leads L1-L3
Main hoist power leads L1-Gnd	Main hoist power leads L2-Gnd	Main hoist power leads L3-Gnd

Inverter Input power leads L1-L2	Inverter Input power leads L2-L3	Inverter Input power leads L1-L3
Inverter Input power leads L1-Gnd	Inverter Input power leads L2-Gnd	Inverter Input power leads L3-Gnd

Indicate Grounding system:

- 4th conductor of main power
- Frame ground
- Connected to hardware
- None

Indicate Collector System:

- Double shoe on each runway conductor
- Single shoe on each runway conductor

Indicate Control Transformer Voltage: _____ VAC

Indicate Power Supply Size to the equipment:

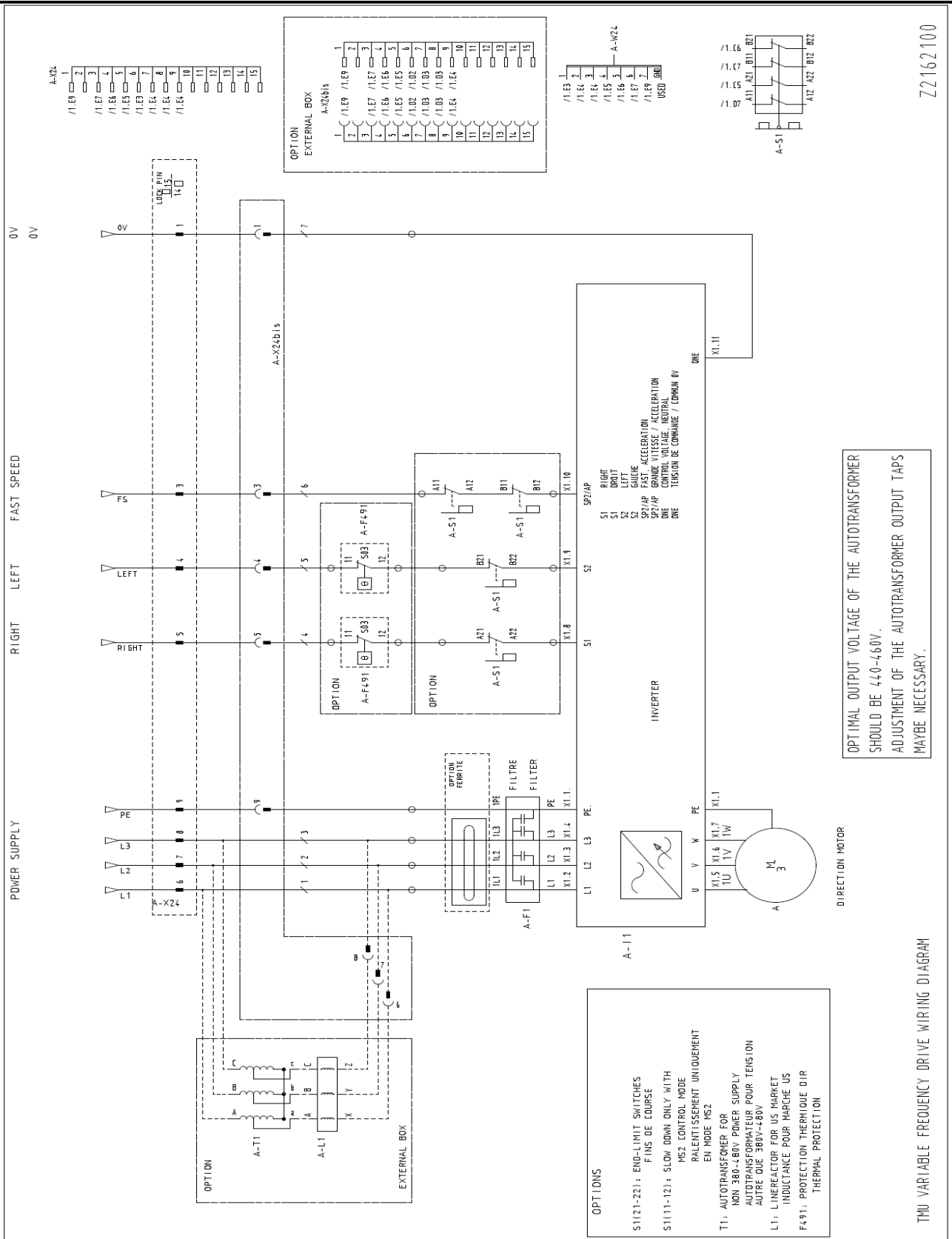
- ≤ 500 KVA
- > 500 KVA

4.4 Wiring Specification

4.4.1 Wiring Practices – TMU Variable Frequency Drive

- Do not connect incoming three-phase AC power to the drive output terminals U, V or W.
- Do not ground the inverter together with any high-current machines.
- Before using welders or high-current machines near the crane, disconnect all line and ground wiring.
- Do not use output contactors between the inverter and the motor.
- Do not connect power factor correction capacitors to the drive input or output.
- Before turning on the inverter, check the output circuit (U, V, and W) for possible short circuits and ground faults.
- When using more than one transformer for the inverter's power, properly phase each transformer.
- To reverse the direction of rotation, interchange any two motor leads (U, V, or W). Changing input leads (L1, L2, or L3) will not affect the shaft rotation direction. Ensure that the motion is in the proper direction with respect to the push button being pressed.
- Inverter line voltage inputs (L1, L2 and L3) are voltage specific. Do not connect the wrong voltage to the unit.
- A minimum of two collectors for each runway conductor shall be used when an inverter is used. Also, the use of a ground conductor is recommended.
- Always mount the inverter in its proper vertical orientation so that the air can flow from bottom to top.
- Keep the inverter heatsink clear of any obstructions (components on panel) to ensure proper cooling airflow.
- Do not connect the power supply directly to the inverter motor – always run the inverter motor from the inverter.

4.4.2 Wiring Diagram – TMU Variable Frequency Drive

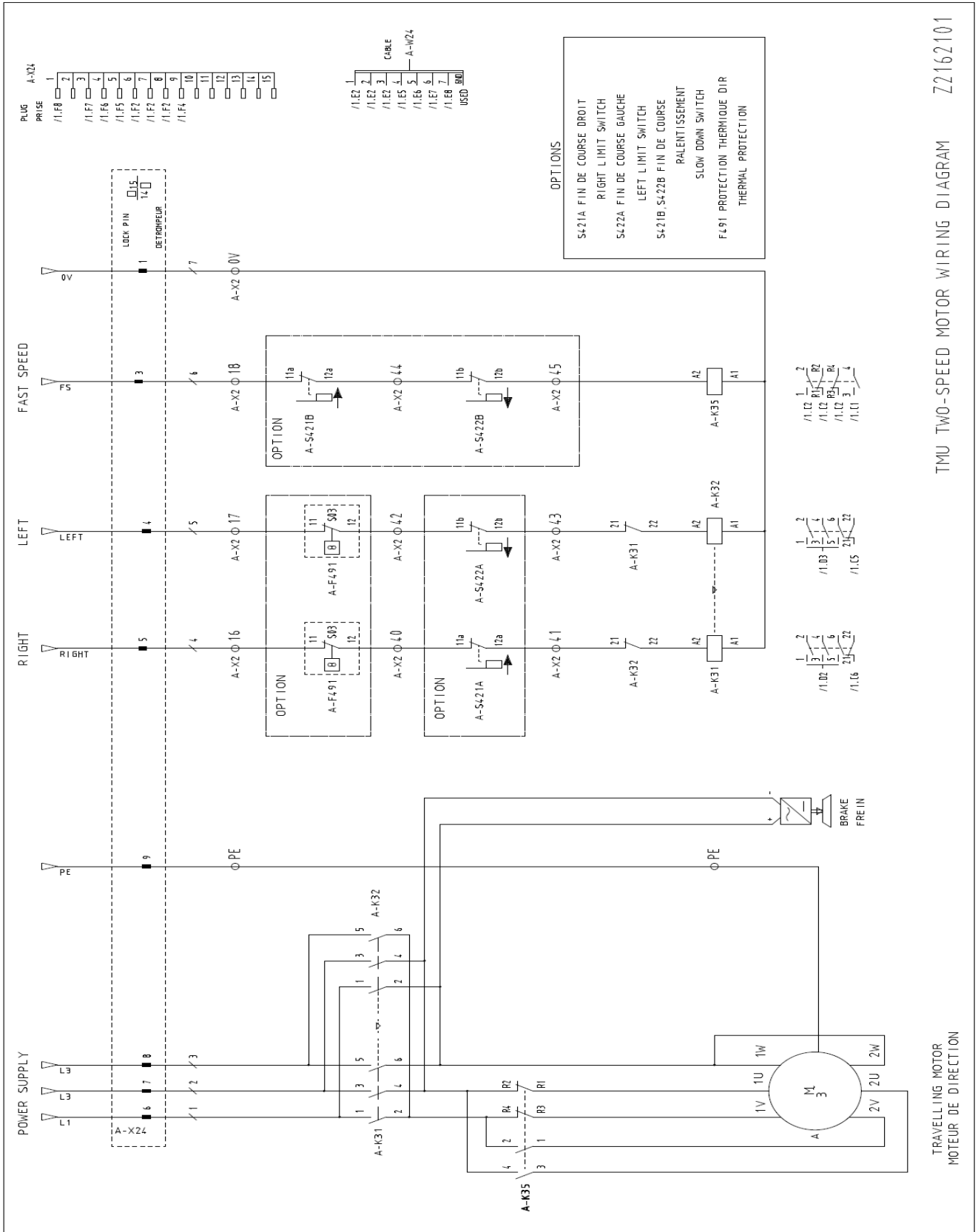


OPTIMAL OUTPUT VOLTAGE OF THE AUTOTRANSFORMER SHOULD BE 440-460V. ADJUSTMENT OF THE AUTOTRANSFORMER OUTPUT TAPS MAYBE NECESSARY.

TMU VARIABLE FREQUENCY DRIVE WIRING DIAGRAM

Z2162100

4.4.3 Wiring Diagram – TMU Two-speed



TMU TWO-SPEED MOTOR WIRING DIAGRAM Z2162101

TRAVELLING MOTOR
MOTEUR DE DIRECTION

5 PREVENTATIVE MAINTENANCE

The service life of the TMU depends on the demands placed on it such as the average operating time, and the number of start/stops and its maintenance.

5.1 Maintenance table

Table 14. Maintenance Schedule

Check	Interval	Qualification of personnel
Brake operation	Daily	Operator
For loose screws and signs of corrosion	Annually	Qualified mechanic
Condition of the brake air gap	Quarterly	Qualified mechanic
Condition of the drive pinion	Annually	Operator
Measurement of the wheel tread diameter	Annually	Operator
Lubrication of open gear	Quarterly	Operator



CAUTION: These intervals should be shortened if TMU is used daily for eight hours in 24 hour period, if it is used with maximum loads or in difficult ambient conditions.

5.2 Lubricants

Table 15. Lubricant Specifications

Lubrication point	Specifications	Possible brands	Quantity
Roller drive pinion	KP 0 K grease (DIN 51502) Soap-based lithium + MoS 2 Approx. melting point + 356°F Worked penetration 671 - 725°F Operating temperature	Tribol: Molub Alloy multi-purpose grease Aral: Aral P 64037 grease Aralub PMD0 BP: Multi-purpose grease L 21 M Esso: Multi-purpose grease M Mobil: Mobilgrease Special Shell: Shell Retimax AM Texaco: Molytex grease EP 2 Fuchs: Renolit FLM0	As necessary
Bearing (*)	- 22°F to + 266°F		(*) 0.02 L
Gear reducer		Mobilux EP00	

5.3 Spare Part Replacement

After a long period of non-use or during a routine check, check the operation and adjustment of the safety items (brake, end stops...). If there is a possibly defective element, deformation or abnormal wear, the parts must be changed.



CAUTION: Disconnect the power supply before replacing any parts.

If a part has been replaced, check the operation of the equipment before the equipment is returned to service.

5.4 Discarding the Trolley

Remove all grease from the trolley and gear reducer before discarding the unit to the recycle center.

6 SPARE PARTS

6.1 TMU Trolley

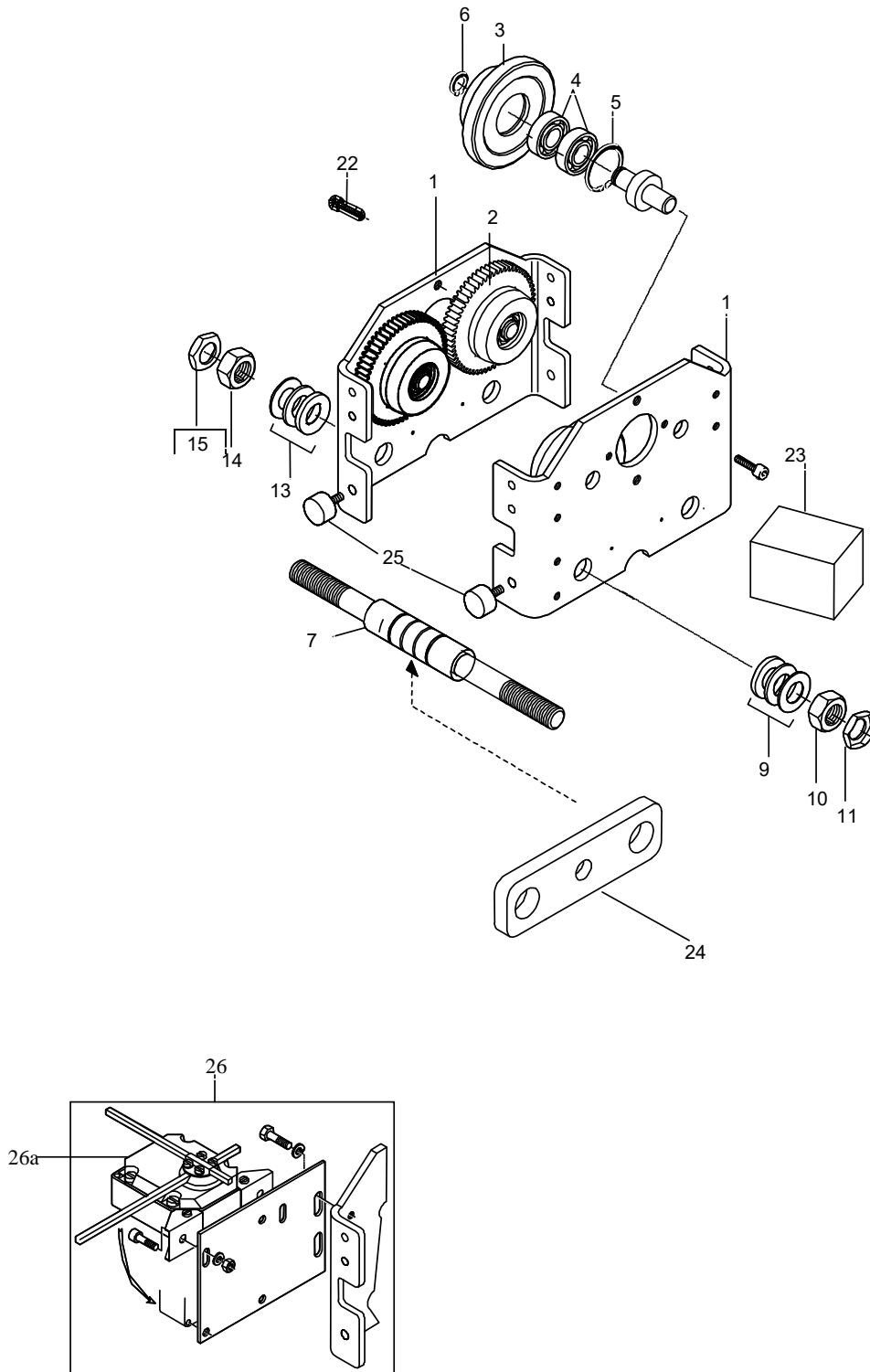


Table 16. TMU Trolley

Item	Qty.	C1 ≤1000kg	C2 ≤2000kg	C3 ≤3200kg	C5 ≤5000kg	Description
1+3+4+5+6	1	52329486	52329491	52329494	52329496	Side plate assembly - idler
1+2+4+5+6	1	52329489	52329493	52329495	52300010	Side plate assembly - drive
7+9+10+11+24	1	52329498	-	-	-	Cross head assembly = 2.28-3.94 in. 55-100 mm
7+9+10+11+24	1	52329499	-	-	-	Cross head assembly = 4.17-5.90 in. 106-150 mm
7+9+10+11+24	1	52329501	-	-	-	Cross head assembly = 6.10-7.87 in. 155-200 mm
7+9+10+11+24	1	52329502	-	-	-	Cross head assembly = 8.11-9.76 in. 206-248 mm
7+9+10+11+24	1	52329503	-	-	-	Cross head assembly = 10.23-12.09 in. 260-307 mm
7+9+10+11+24	1	-	52329506	-	-	Cross head assembly = 2.54-4.96 in. 64-126 mm
7+9+10+11+24	1	-	52329507	-	-	Cross head assembly = 5.16-7.48 in. 131-190 mm
7+9+10+11+24	1	-	52329508	-	-	Cross head assembly = 7.80-9.76 in. 198-248mm
7+9+10+11+24	1	-	52329510	-	-	Cross head assembly = 10.24-12.2 in. 260-310 mm
7+9+10+11+24	1	-	-	52329512	-	Cross head assembly = 3.28-5.39 in. 82-137 mm
7+9+10+11+24	1	-	-	52329513	-	Cross head assembly = 5.51-7.48 in. 140-190 mm
7+9+10+11+24	1	-	-	52329514	-	Cross head assembly = 7.80-9.76 in. 198-248 mm
7+9+10+11+24	1	-	-	52329516	-	Cross head assembly = 10.24-12.2 in. 260-310 mm
7+9+10+11+24	1	-	-	-	52329517	Cross head assembly = 3.23-4.33 in. 82-110 mm
7+9+10+11+24	1	-	-	-	52329518	Cross head assembly = 4.45-5.91 in. 113-150 mm
7+9+10+11+24	1	-	-	-	52329519	Cross head assembly = 6.10-7.87 in. 155-200 mm
7+9+10+11+24	1	-	-	-	52329520	Cross head assembly = 8.11-9.76 in. 206-248 mm
7+9+10+11+24	1	-	-	-	52329521	Cross head assembly = 10.24-12. In. 260-310 mm

Item	Qty.	C1 ≤1000kg	C2 ≤2000kg	C3 ≤3200kg	C5 ≤5000kg	Description
1	2	-	-	-	-	Side plate
2	2	558909	558919	558929	558949	Driving wheel with bearings 2+4+5
2a	2	2309781002	2309782002	2309783002	2309784002	Patented track drive wheel assy
3	2	558908	558918	558928	558948	Idle wheel with bearings 3+4+5
3a	2	2309781001	2309782001	2309783001	2309784001	Patented track idler wheel assy
6	4	-	-	-	-	Circlips external
7	2	-	-	-	-	Tension rod
9	-	-	-	-	-	Washers
10	4	831523	831540	831530	8004234	Nut
11	4	831575	831576	831577	8004208	PAL
22	2	830203	830203	830203	830203	CHC Screw (for drive)
23	2	558868	-	-	-	Counterweight
24	1	2222002	2222003	2277020	2182000	Adapter (perpendicular)
25	4	558993	558993	558993	558993	Bumper
26	1	2104205001	2104205001	2104205001	2104205001	Complete limit switch
26a	1	50004910	50004910	50004910	50004910	Limit switch
26b	1	558995	558995	558995	558995	Bracket – limit switch

6.2 TMU Variable Frequency Drive

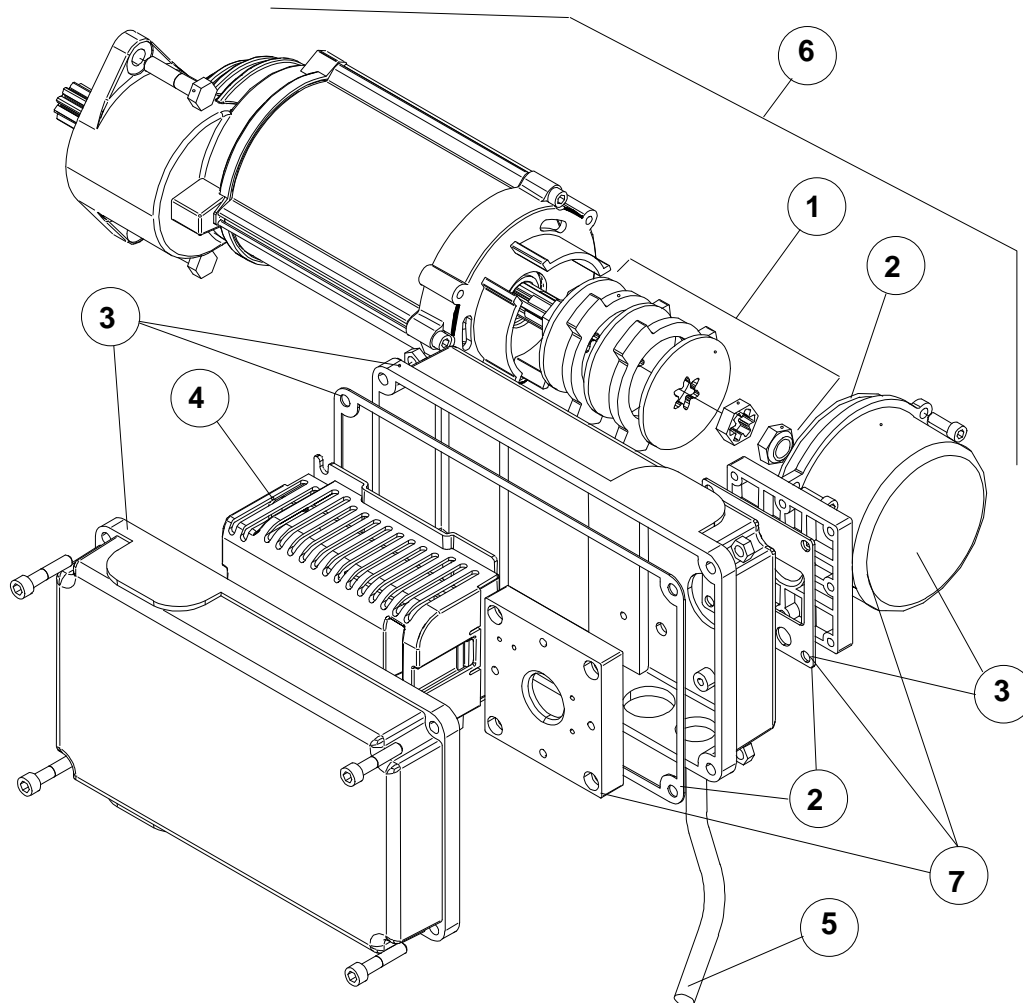


Table 17. TMU Variable Frequency Drive

Item	Part Number	Description	Specification
1	52296293	Brake repair kit	M06-001V
2	52300292	Gasket set	M06-008V
3	52300291	Enclosure	M06-007V
4	52300287	Inverter + filter 48v control	M06-003V
4	52300288	Inverter + filter 115v control	M06-004V
5	52297959	Electrical cable + plug + cable gland + nut	CCGCELCP-04
6	52299087	Complete gear motor drive + VFD – 48v control	
6	52299088	Complete gear motor drive + VFD – 115v control	
6	52299089	Complete gearless motor drive + VFD – 48v control	
6	52299090	Complete gearless motor drive + VFD – 115v control	
7		Brake cover kit with gasket	

6.3 TMU VFD Transformer & Line Reactor

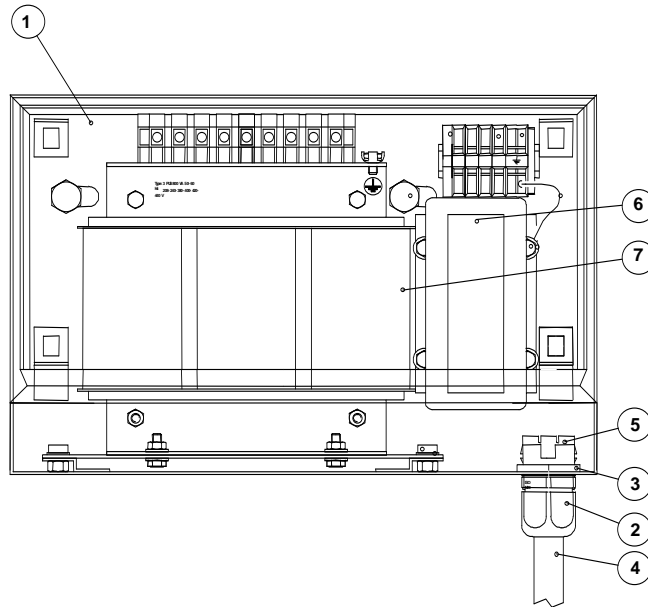


Table 18. TMU VFD Transformer & Line Reactor

Item	Qty	Part Number	Description
1	1	52303806	Complete transformer/reactor package – 208 or 230v (2+3+4+5+6+7)
1	1	52303807	Complete transformer/reactor package – 460v (2+3+4+5+6+7)
1	1	52303308	Complete transformer/reactor package – 575v (2+3+4+5+6+7)
2+3+4+5	1	52297959	Electrical cable + plug + cable gland + nut
6	1	52298738	Line reactor
7	1	52299489	Transformer 208/230v – 440v
7	1	52299494	Transformer 460v – 440v
7	1	52299491	Transformer 575v – 440v

6.4 TMU Two-Speed Motor

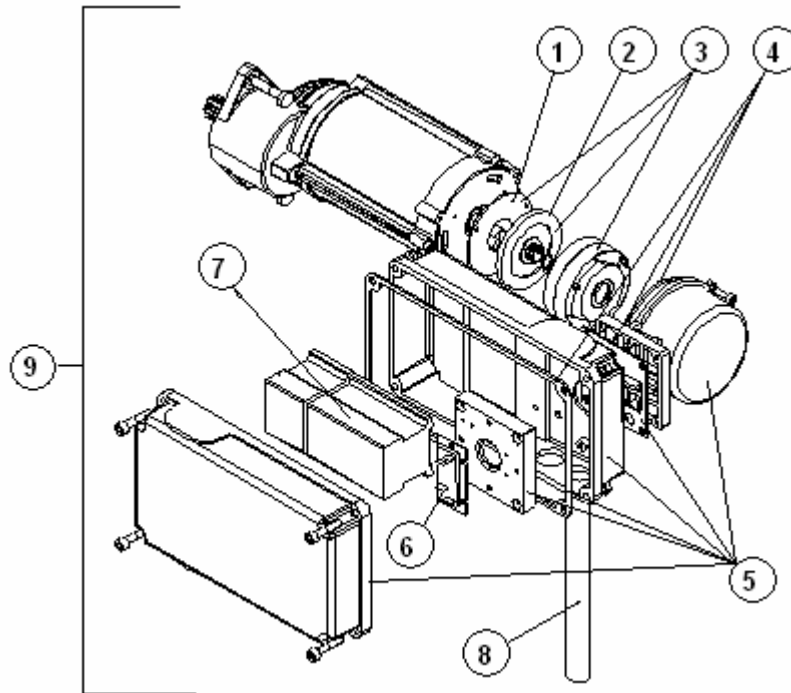


Table 19. TMU Two-Speed Motor

Item	Part Number	Description	Specification
1	52269590	Friction wear plate	NM38710KLV
2	52269587	Friction disc	NM38710JPV
3	52269582	Complete brake 180 vdc coil (208, 230, 400, 460vac)	NM38710NR2V
3	52269583	Complete brake 240 vdc coil (575vac)	NM38710NR3V
4	52300292	Gasket set	M06-008V
5	52300291	Brake cover kit with gasket	M06-007V
6	60010152	Rectifier – Full wave (208, 230vac)	NM181NR2V
6	60003169	Rectifier – Half wave (400, 460, 575vac)	NM181NR4V
7	1123052	Reversing Contactors – 115v	
8	52297959	Electrical cable + plug + cable gland + nut	CCGCELCP-04
9	52306026	Complete drive – 460v	
9	52306027	Complete drive – 575v	
9	52306028	Complete drive – 208/230v	
10	1123050	Selector Contactor – 115v Control	