



MOTOR DRIVE UNIT TYPE CMA7

Operating Instruction

HM 0.460.302



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1. General

Motor drive unit CMA7 is used for driving tap changer to realize tap change operation.

All necessary electrical and mechanical equipments are contained in housing of motor drive unit CMA7 which adopts step-by-step principle, namely, operate tap changer from its service position to the adjacent one. The motor drive unit is initiated by a single control signal and it will stop automatically as one tap change operation accomplishes.

End positions are prevented to be overrun by electrical and mechanical limits devices. The motor drive unit is designed to have different ratings of power and current for driving various tap changers.

The whole motor drive unit is fixed outside of transformer wall and is connected to tap changer by vertical and horizontal shaft, intermediate bevel gear box.

1.1 Scope of application

CMA7 can be used to drive all type of on-load tap changers as well as off-circuit tap changers.

1.2 Service condition

The storage ambient temperature of OLTC is from -25°C to 40°C . The storage humidity of the OLTC should be no more than 85 percent.

The service temperature of standard designed OLTC is -25°C to 40°C

If the temperature exceeds the range of above (-25°C to 40°C), please specify when ordering.

To meet the ordering requirements and comply with the operating environment, if the requested service temperature is out of the range of -25°C to 40°C , the material and accessories of the OLTC will be specially designed and selected.

The deviation of perpendicularity to ground can not exceed 5%.

The place for application should be free of serious dust, explosive and corrosive gases.



Fig.1 CMA 7 Motor Drive Unit

2. Technical data

Item	Rated motor power (kW)			
	0.75	1.1	2.2	
Rated voltage (V)	Three phase	380	380	380
	Single phase	220	220	220
Rated current (A)	Three phase	2.0	2,8	5.1
	Single phase	3.4	5	8.8
Rated frequency (Hz)		50,60	50,60	50,60
Revolution speed (rev/min)		1400	1400	1400
Rev. of drive shaft/ per switching operation		33		
Running time per switching operation		About 5 seconds		
Rated torque on drive shaft (N.m)		18	26	52
Max.number of operation positions		35 (107)*		
Voltage for control and heater (V)		220		
Power consumption of control circuit (W)	When energized	52		
	During running time	24		
Heater power (W)		50		
Power frequency withstand voltage to ground (without motor)		2 kV/1 min,50 Hz		
Ingress protection		IP56		
Mechanical life (operations)		800,000		
Weight (kg)		90		

* special design

3. Structure

CMA7 motor drive unit consists of housing, drive mechanism, position indication and electrical control components, etc, please refer to fig.1.

3.1 Housing

Housing consists of tank and cover, both of which are made of corrosion-proof aluminum alloy made in low-pressure casting process and are interlocked through door hinges that can be interchanged, making the door alternatively open either towards right or towards left side, swing-open direction is indicated in order specification, in addition, between the tank and cover is sealed by rubber ring, and the whole housing is coated with outdoor paint.

The arrangements of two labyrinthic vent holes in the rear of tank and all apertures for driving shaft, inspection window, hand crank and push-buttons are designed as sealing structure so that rain, dust and insects can be prevented from entering into the housing.

There are two cable entry holes, temporarily sealed by a complete rubber gasket before commissioning, under bottom of tank, remove rubber gasket, and insert cable through gland plates into housing.

3.2 Gearing system

Shown in fig.2, gear system comprises motor, pulley box, poly-V- driving belt, two end positions limits, transmission gear for manual operation. The poly-V-driving belt is installed inside cast aluminum alloy box, etc. Belt shaft and transmission gear shaft are structured as sleeve shaft and connected by mechanical clutch which is used for mechanical limit protection of motor drive unit, when the mechanical limit is actuated, then clutch acts, the motor will stop running.

3.3 Position indication mechanism

Position indication mechanism consists of cam disc, indication wheels, position indicator and position transmitter, etc.

The position indication and control mechanism is fixed on one side of transmission gear.

Tap change indication wheel 104 and cam disc perform one revolution for one tap change operation. The indication wheel 104 is divided into 33 sections on which green field represents stop position of cam switch.

Operation counter displays accumulated operation times of tap changer.

It is not necessary to open the motor drive to look into mechanical indicator and counter. Position signal from the position transmitter is transmitted into position indicator via terminals.

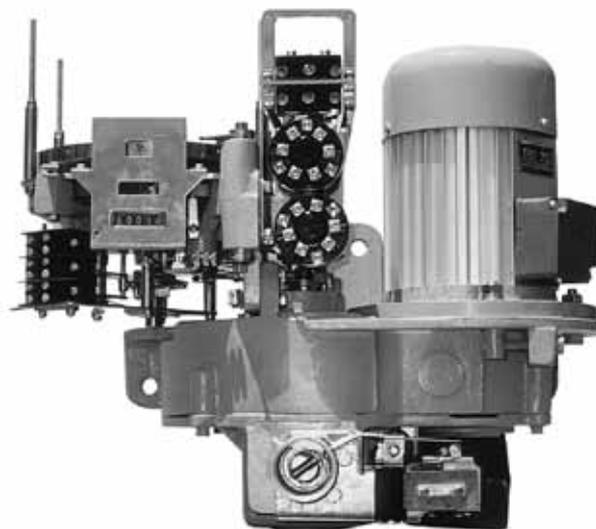


Fig.2 Driving mechanism

4. Operating principle

4.1 Mechanical operation principle (fig.4)

Normally the motor drive unit is operated electrically, but it might be operated manually during inspection or maintenance.

Motor drives big drive wheel 3 via small drive wheel 2, then force will be transmitted to drive shaft 4 through which the tap changer is operated.

Through cog wheel, turning force will be transmitted to gear 101 via cogs on drive shaft 4, which revolves tap change indication wheel 104 and planet gear 106, then position indication wheel 108 turns and displays present position. The position transmitter 121 will produce position signal at the different positions. Operation counter is controlled by indication wheel 104 and acts once after every tap change operation, operation times will be accumulated and displayed. 4 sections of green field appearing in the inspection window symbolizes that mechanical-operated cam switch is released. The contactor K3 is short-circuited to brake motor and finally one tap change operation finishes.

As the motor drive unit runs to limits of end position 1 or N, the position indication wheel 108 continues to rotate and makes limit block in wheel trough to push end position lever 115, then disconnect electrical limit switch corresponding to position 1 or N, finally preventing motor drive unit from overrunning position 1 or N, however, in the event of failure of electrical limit switches, the motor will continue to run towards mechanical limits, in this case, end position lever mechanism will push lock latch of mechanical clutch of gear mechanism to buckle the clutch, as a result, manual shaft 8 stops running, realizing a double protection for motor drive unit by electrical limit switch and mechanical limits.

Operation sequence of limits protection should be followed by

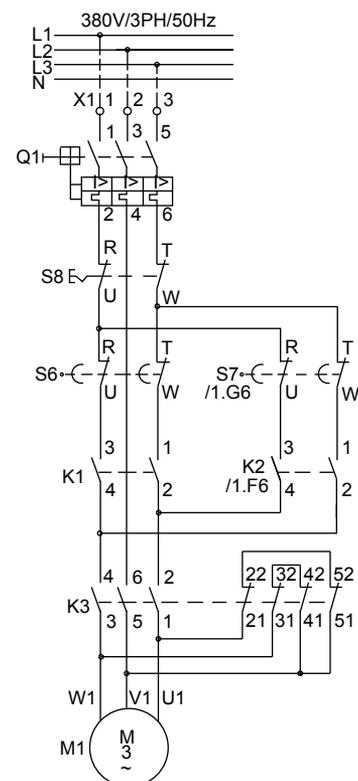
- A. Electrical limit switches (S16/S17) of control circuit acts
- B. Electrical limit switches (S6/S7) of motor circuit acts
- C. Lock latch of mechanical clutch

4.2 Electrical operation principles

This circuit is composed of motor circuit (main circuit), control circuit, protection circuit, indication circuit and heating circuit, for details please refers to appendix 5.

4.2.1 Motor circuit

Motor terminals U, V, W are connected to terminals X1/1, 2, 3 of power supply L1, L2, L3 via contactor K3, K1/K2; limit switch S6/S7, microswitch S8 and motor protective switch Q1.



4.2.1 Motor circuit

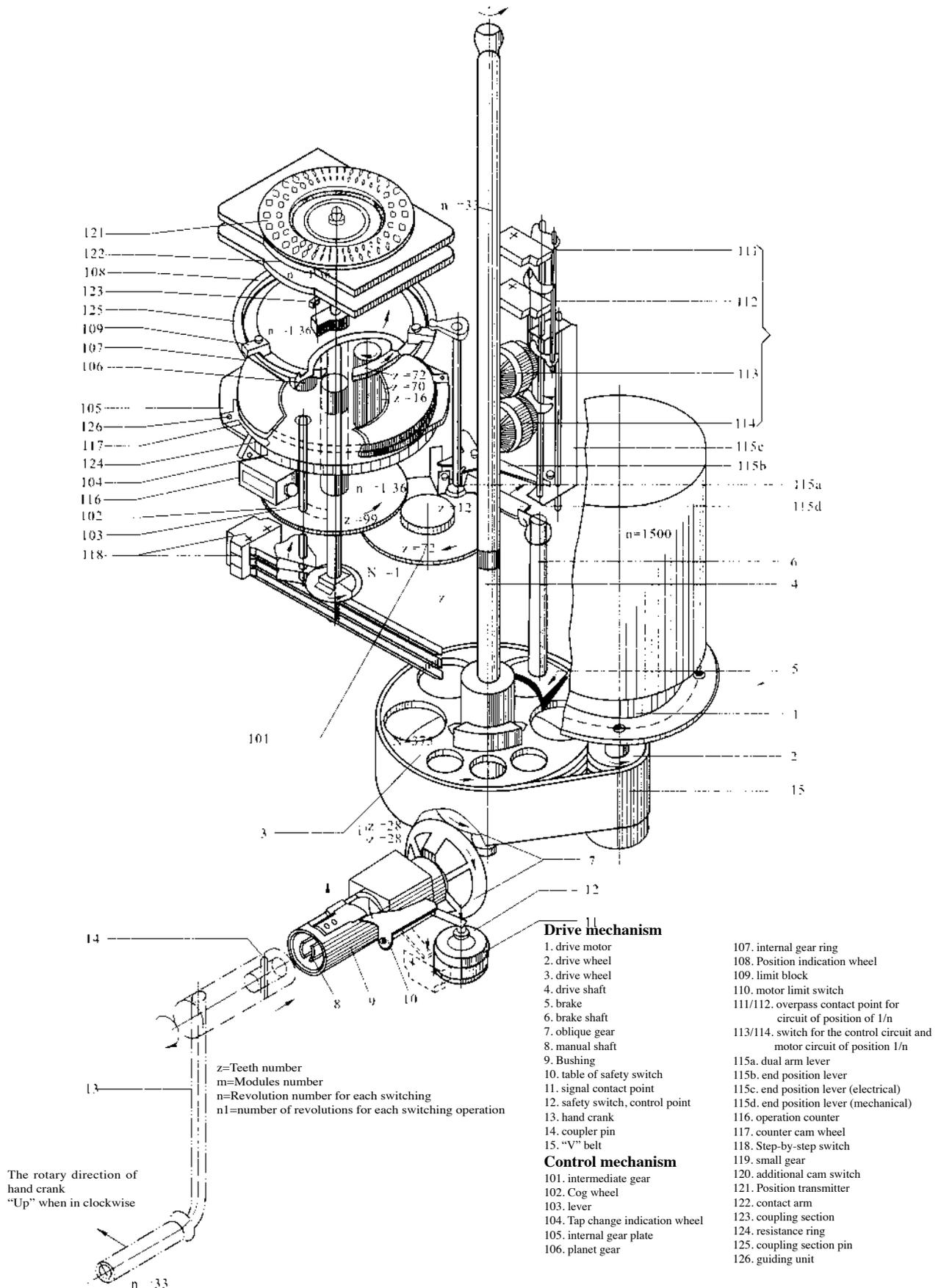


Fig.4 Mechanical principle diagram of Type CMA7 motor drive unit

4.2.2 Control circuit

Control circuit is connected to L1 and N via X1/6,7, Q1(13,14), S18(NC,C), S8(S,V), and control voltage will be interrupted once one of Q1,S18,S8 acts. Trip circuit of Q1 is interlocked with control circuit.

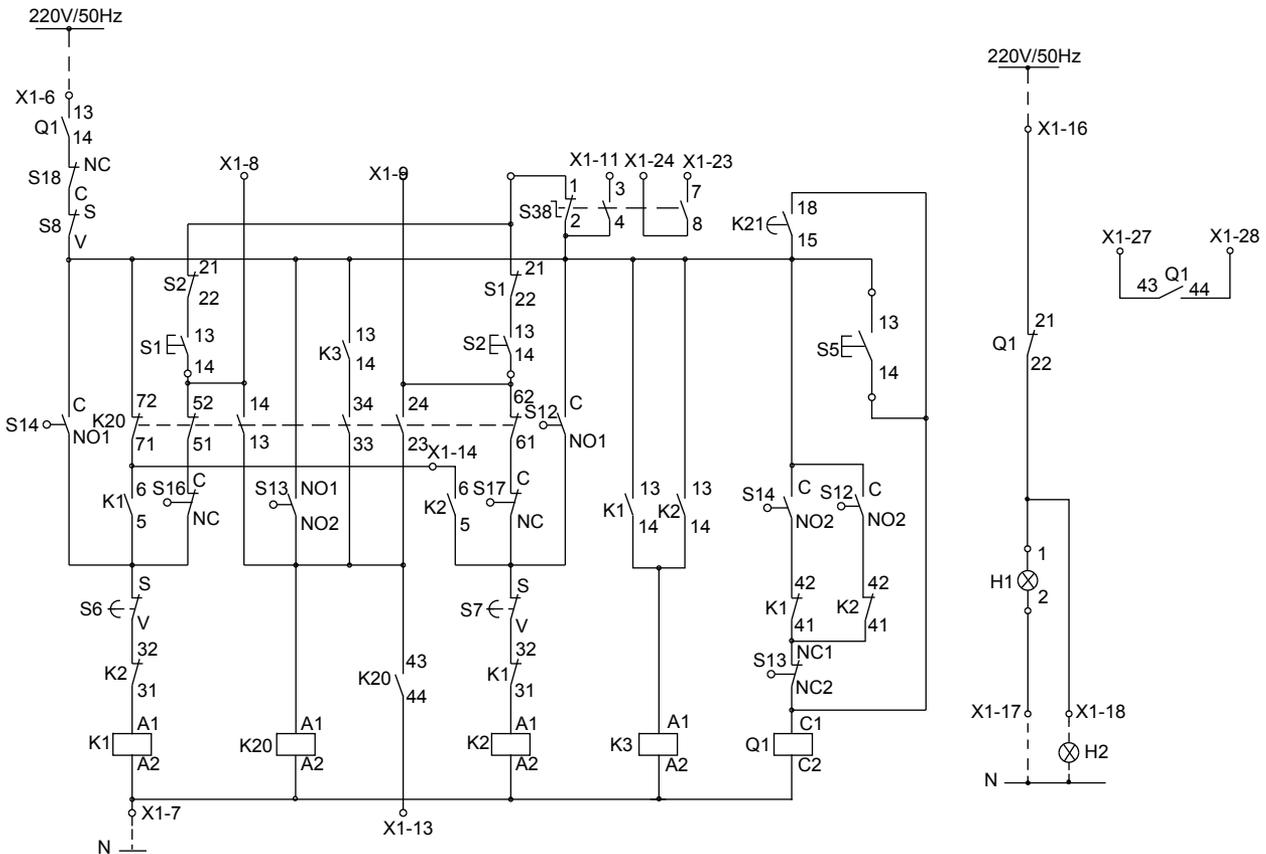
Motor protective switch Q1 equips with a trip coil which could be energized through push-button S5, safety circuit or protective circuit against run-through positions. Safety circuit is composed of cam switches S12, S13, S14 and auxiliary contacts of contactor K1, K2. One N/O contact of K21 is used for protection against runthrough positions.

4.2.3 Trip and indication circuit of motor protective switch Q1

This circuit is connected to Q1/22 and N via terminals X1/18 and 17. Signal lamp is installed in the pushbutton S5 of emergency stop. Auxiliary contacts Q1 (43, 44) are connected to X1/27, 28, and passive contact of Q1 are kept closed.

4.2.4 Indication circuit of motor running

V1,V2 of motor are connected to X1/ 19,20 which also serves as active terminals for operation signal lamp H3 (in control cabinet), and this circuit also offers one pair of passive contacts X1-25/26 for indication of motor running via K1 220V/50Hz (23,24) or K2(23,24).



4.2.2 Control circuit

4.2.3 Trip and indication circuit of Q1

4.2.5 Indication circuit of remote position

Digital remote position signal transmitter adopts code-dial sliding contacts which acts in way of break-before-make from one position to next one, together with position indicator to display position. The fixed contacts on position transmitter are connected to terminals on socket according to decimal system.

4.2.6 Heating circuit

Heating resistor is permanently connected to power supply L1 and N via terminal X1/4, 5.

4.3 Operation

4.3.1 Control

Motor control is achieved by using step-by-step principle, namely, once one tap change operation starts up, it will complete automatically and irrevocably regardless of whether the buttons S1-S4 are pressed down (except emergency stop) or not, next operation has to start from initial position where red mark, centered in green field on the indication wheel 104, stops at the center of the inspection window.

Essential conditions for operation:

The motor protective switch Q1 must be closed.

Line voltage applied on incoming line should be AC 380V, 3 phases, and phase voltage applied on L1, N should be 220V, 50 Hz.

Note!

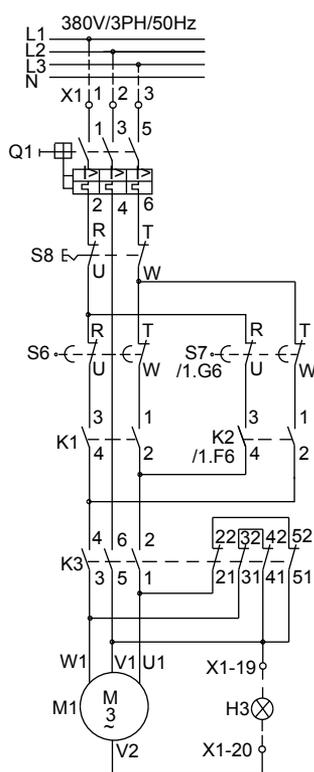
S38 must be in “local” position when S1 or S2 is operated, and also it must be in “remote” position when any one of S3, S4, or S9 is operated.

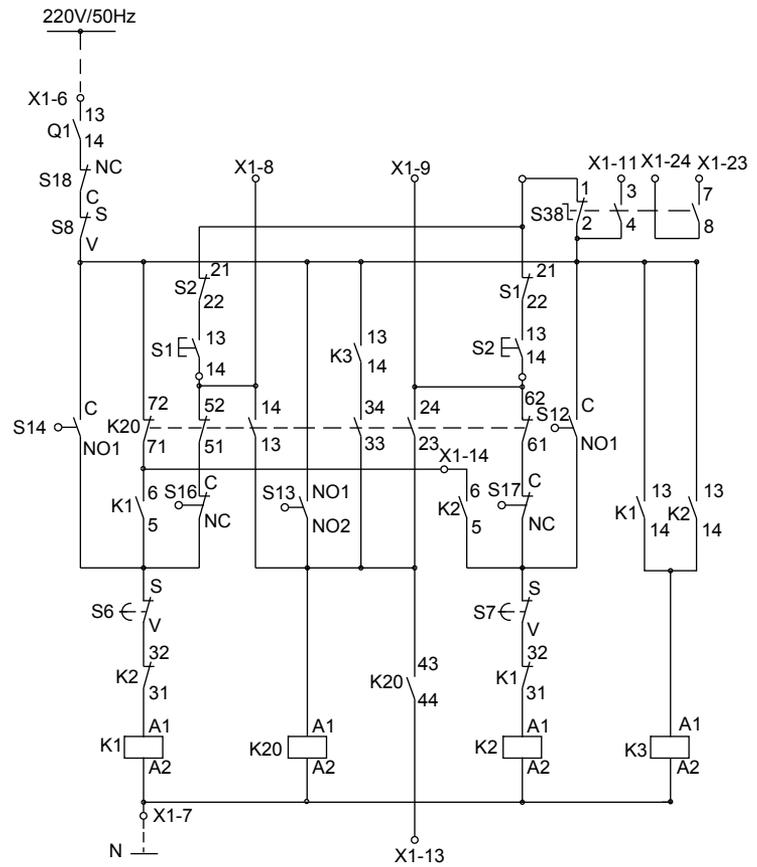
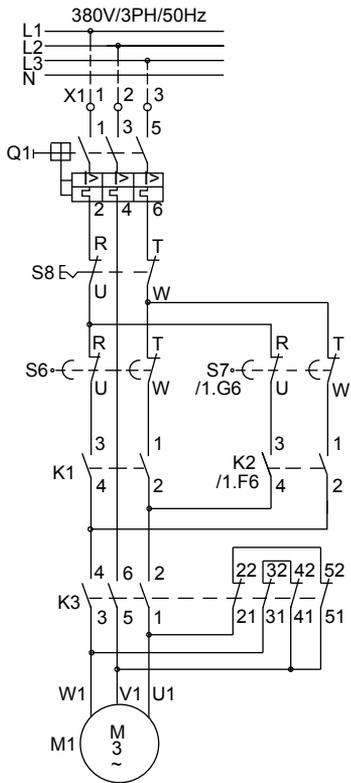
The operation goes towards “N” position.

4.3.1.1 Start-up

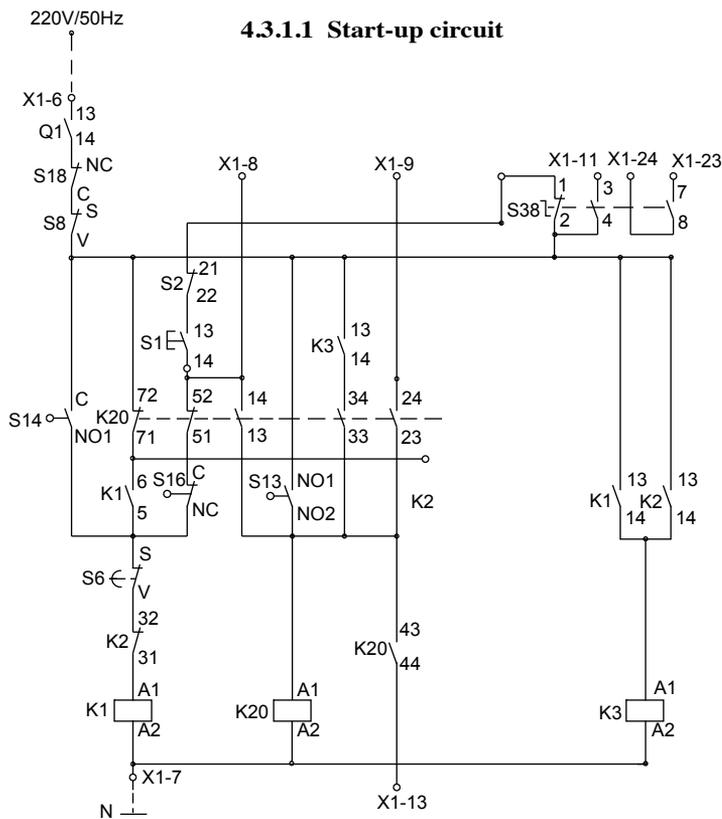
Press down button S1, N/O contact S1:13-14 closes and meanwhile S1:21-22 opens, then current flows through, Q1(13, 14), S8(S,V), S38(2,1), S2(21, 22), S1(13,14), K20(52,51), S16(C,NC), S6(S,V),

K2 (32, 31) via X1/6, exciting coil of contactor K1 is energized, which make auxiliary contact K1 (5, 6) closed, and then coil of K1 realizes self-locking via N/C contact K20 (72, 71).





4.3.1.1 Start-up circuit



4.3.1.2 Step-by-step control circuit

N/O contact of K1 (13, 14) close when K1 is energized, which make K3 energized, then the motor starts up, at the same time K21 (A1, A2) is energized to initiate time delay.

4.3.1.2 Step-by-step control

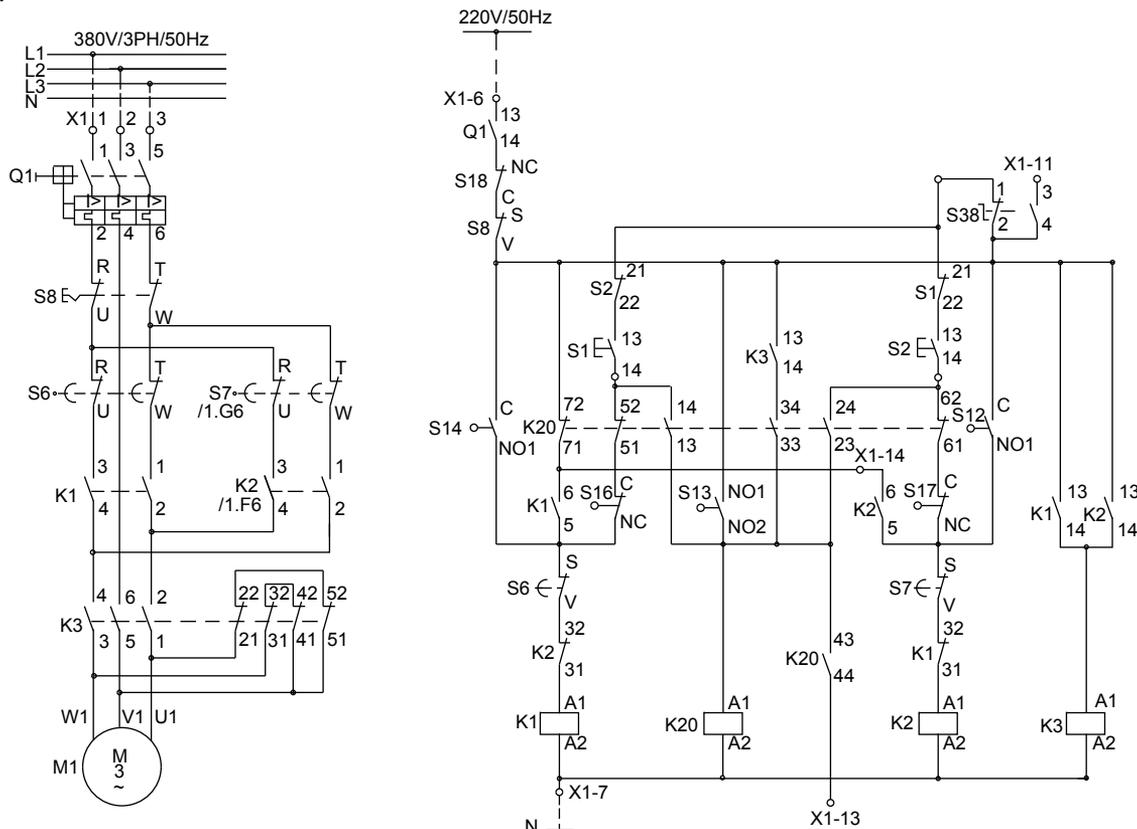
As the motor begins to run, the green field on the indication wheel 104 will turn out of inspection window, N/C contact of cam switch S14(C,NO1) close, by which simultaneously energizes the contactor K1(A1,A2).

When the indication wheel turns round one more section, cam switch S13 is actuated to close S13(NO1,NO2), followed by energizing K20 coil, then K20 (52,51),K20(72,71) open, and K20(14,13), K20(34,33) close, meanwhile S13 (NO1, NO2) opens and K20 will be still energized and kept closed via K3(13,!4),K20(34,33).

4.3.1.3 Stop

Cam switch S14 (C, NO1) will open when one tap change operation finishes, K1 is de-energized, and N/O contact K1 (13, 14) opens, then K3 is also de-energized, thus disconnecting main circuit, finally braking contacts K3 (21-22, 31- 32, 41-42, 51-52) are closed to stop motor M1 running.

Meanwhile K3 (13,14) is disconnected, causing K20 de-energized, however, if button S1(S2) is pressed down, K20 will be self-locked through its contact (13-14) or (23-24), which prevent K1 or K2 from being energized again via K20 (51-52) or K20(61-62), but if S1(S2) is not pressed down, then K20 coil will be de-energized.



4.3.1.3 Stop circuit

The operation goes towards “1” position.

Contactor K2 is energized

Motor runs reversely

Subsequent steps will be same as that of operation going towards “N” position.

Press push-button S2

Braking contactor K3 is energized

Cam switch S12 is actuated

The sequence of tap change operation from one position to adjacent one (equal to 33 sections on step-by-step indication wheel 104), operation status of each control element as follows

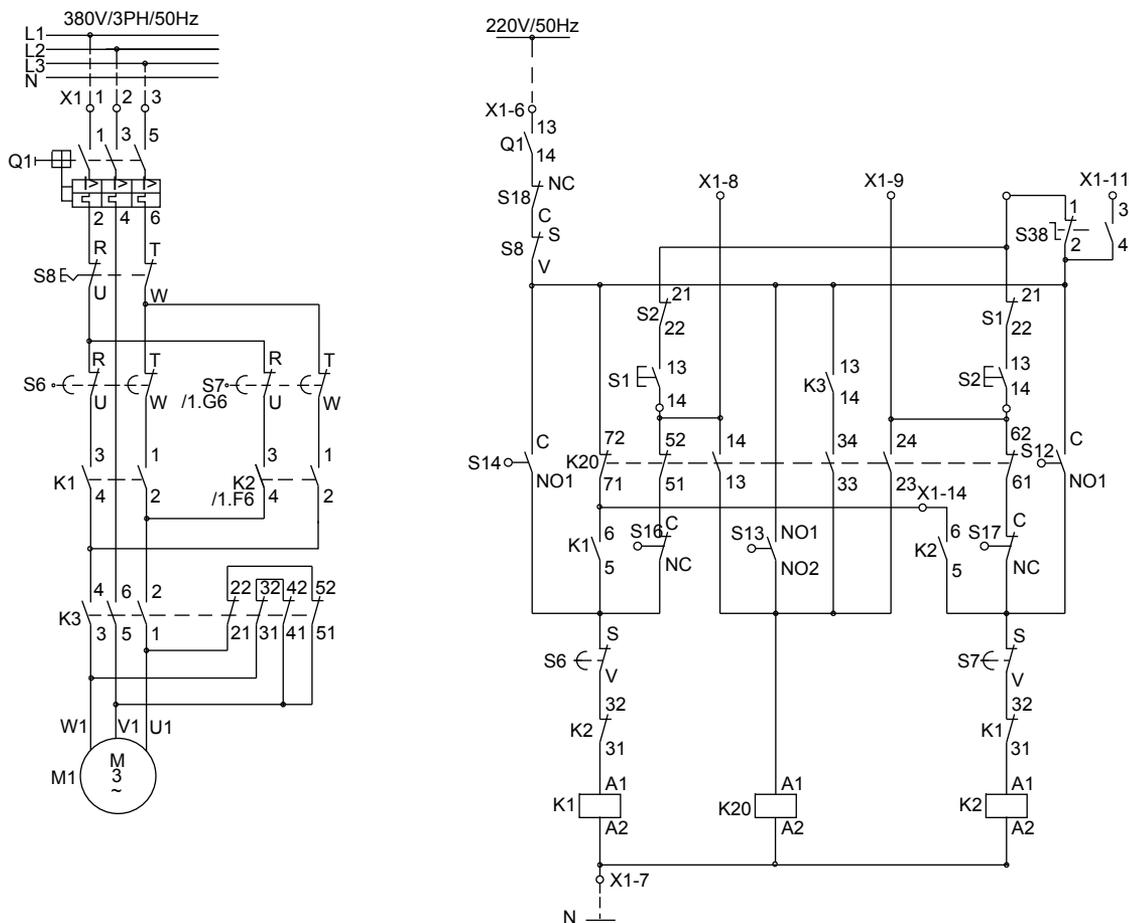
Closing sequence: S1 (S2), K1 (K2), K3

S14 (S12), S13, K20

4.3.2 Passage of positions for middle positions

Shown in appendix 5, the motor drive unit will run uninterruptedly when S37-1 and S37-2 are short-circuited, thus that motor drive unit requiring passage of positions for middle position can be achieved by a short-circuited contact point S37 which is acquired by using added contact point in remote position transmitter.

4.3.3 Safety protection



4.3.3.1 Protection circuit for end position

4.3.3.1 Protection for end position

N/C contact (C-NC) of limit switch S16 (at position N) or of S17 (at position 1) will open when driving mechanism runs to end position, therefore, contactor K1 or K2 can not be energized any more.

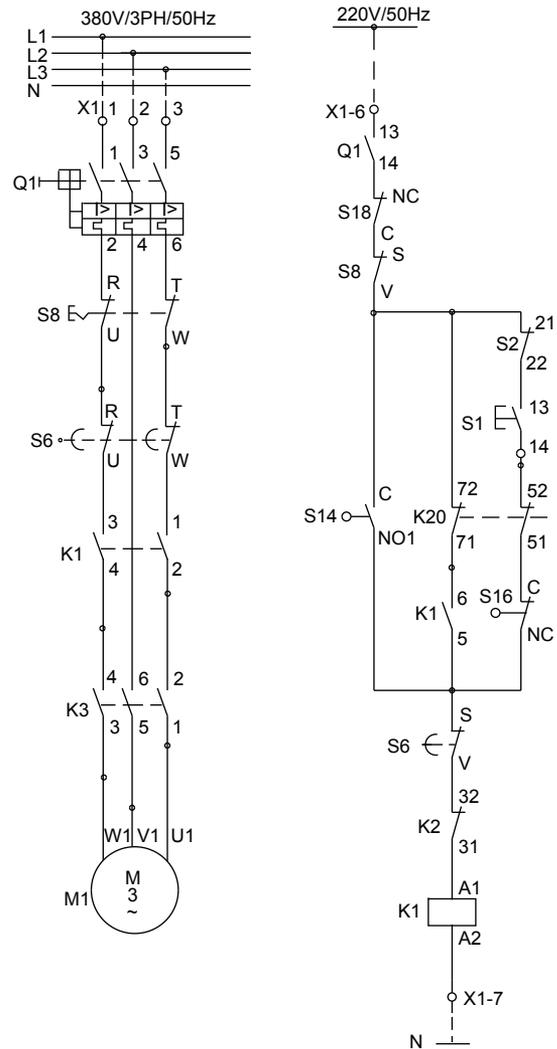
Limit switch S6 (S7) disconnect contacts R-U, T-W of main circuit when end position is overrun, which makes motor circuit de-energized and disconnects contactor K1 or K2 circuit via contact (S-V).

4.3.3.2 Protection for manual operation

Insert hand crank into bushing of shaft, microswitch for manual operation S8 is actuated to disconnect power supply for motor and control circuit; while taking out hand crank will close microswitch S8 again, however, the red mark on the indication wheel 104 must be turned back into the center of inspection window, that is rest position of mechanically-actuated cam switches, to avoid the motor re-start automatically after manual operation.

4.3.3.3 Protection for phase sequence

To ensure the motor run as pre-set direction, there are some requirements for phase sequence of motor. If connection of power supply L1,L2,L3 is incorrect, the motor protective switch Q1 will trip off via phase sequence protection circuit (refer to fig.5), namely, press down button S1 to energize K1, meanwhile K1(41,42) opens, however, the motor runs reversely, in addition, the driving mechanism will also run towards reverse direction accordingly, thus making S12(C,NO2) closed, trip coil of Q1 is energized via S1



4.3.3.2 Protection circuit for manual operation

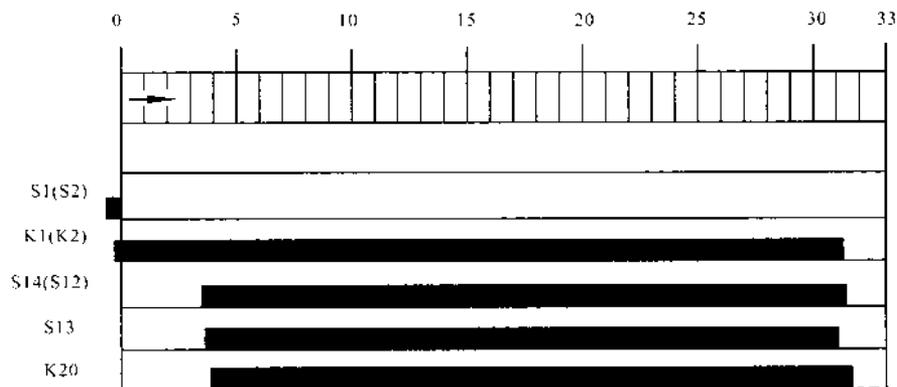


Fig.5 Status diagram of tap change operation

4.3.3.6 Protection against run-through positions

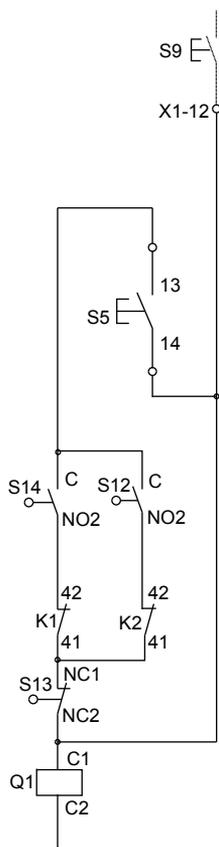
Delay time of time relay K21 is set at a certain value, if the driving mechanism runs through the positions continuously when losing control signal, time to energize K21 will exceed set value, causing K21 (6-8) closed, Q1 will trip power off.

4.4 External connection circuit

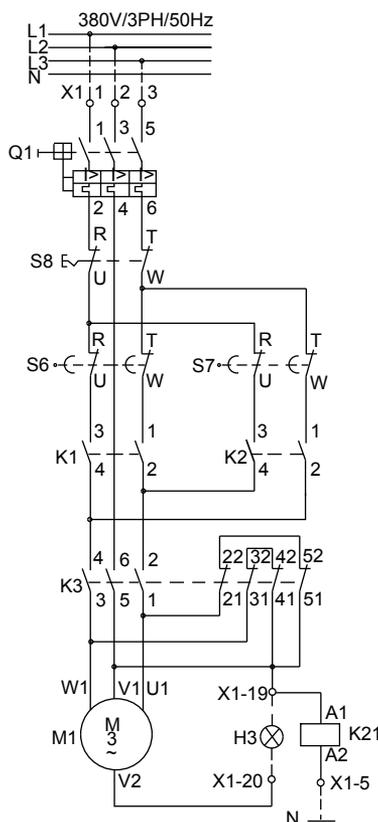
Inside the housing are terminal block X1 serving as terminals of power-in end, remote control and signal indication to realize functions like operation 1→N, N→1 and emergency stop, and also remote indication of operation state(X1-1,X1-2,X1-3,X1-5 for power-in end).

4.5 Passive contacts for position signal

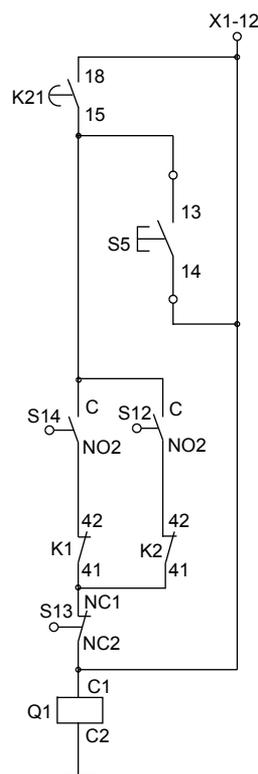
One rotatable contact arm with two sets of sliding contacts are sandwiched between the position transmitters in which fixed contacts are built to correspond to that of position indication circuit and to be linked with terminal block X3 in a sequence of 1→N. Common point connected with sliding contacts is also linked to X3. The two sets of sliding contacts moves from one position to next one in a way of break-before-make and keep synchronous in mechanical motion while independent in electrical action. Terminal block X3 provides one set of N/C passive contact for position signal.

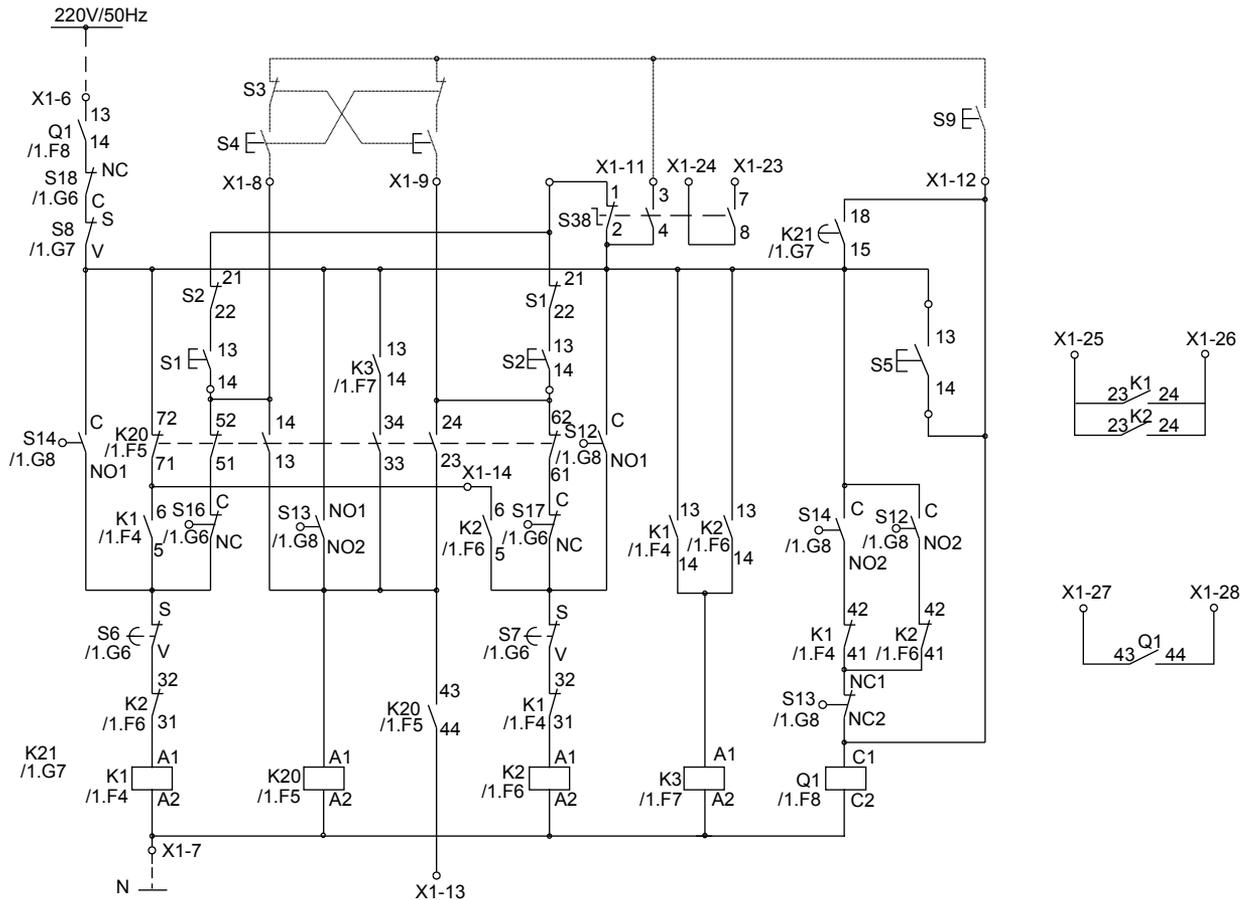


4.3.3.5 Emergency stop circuit



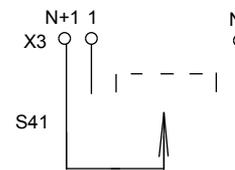
4.3.3.6 Passage of positions circuit





X1		K21-A2		K21-18		S37		K21-A1		K20-72		K3-13															
Q1-1	Q1-3	Q1-5	R1-1	R1-2	Q1-13	K1-A2	K20-52	K20-62	S38-3	S5-14	K20-44	K2-6	S37-1	Q1-21	H1-2	Q1-22	K3-51	M1-V2	S5-13	S13-NO1	S38-7	S38-8	K1-23	K1-24	Q1-43	Q1-44	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
L1	L2	L3	L1	N	L1	N								L1	N												

4.4 External connection circuit



X3			
S41	S41	S41	S41
1	2	-	N
			N+1

4.5 Passive contacts for position signal

5. Installation

5.1 Mount motor drive unit onto transformer tank (refer to appendix 1)

The motor drive unit should be mounted on a flat and straight surface or plate of external transformer tank by four studs, otherwise, it will be easily deformed and will cause difficulty in closing the cover, even affect normal operation. Please note that the motor drive unit should be mounted vertically and keep its output shaft aligned with shaft of bevel gear.

5.2 Mounting of drive shaft and bevel gear (fig.6)

NOTE! Vibration damping connector is recommended if sharp mechanical vibration arises.

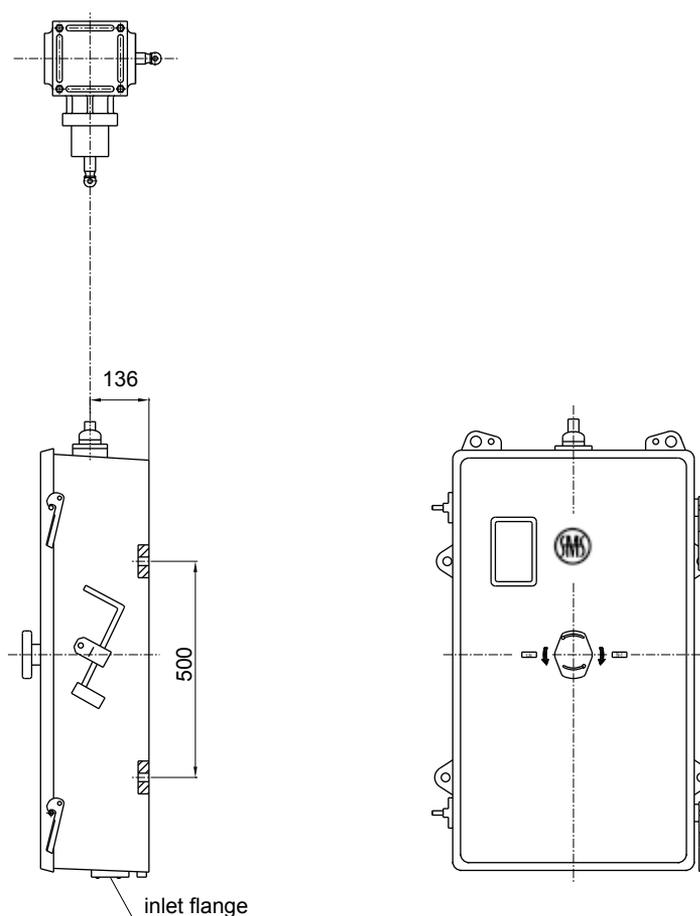


Fig. 6 Installation

5.3 Connect tap changer with motor drive unit

Tap change operation must be finished before motor drive unit stops, namely, tap change operation must finish 2 to 2.5 sections ahead of red mark arriving at the center of inspection window.

One tap change operation corresponds to one revolution of indication wheel 104 and 1 section means 1 rotation by hand crank.

For both direction $N \rightarrow 1$ and $1 \rightarrow N$, number differences of section that the indication wheel turns from the completion of tap change operation to where red mark get to the center of inspection window should be basically identical, a slight dissymmetry is permissible.

Connection should be done as follows

- a. Adjust it by hand crank;
- b. At each adjustment pay attention to that position indication reading of motor drive unit and tap changer must besame;
- c. Position of motor drive unit and tap changer must be at set position;
- d. Connect tap changer and motor drive unit;
- e. Turn towards one direction until tap change operation completes;
- f. Count the number of section that red mark deviates from the center of inspection window;
- g. Repeat the said operation in reverse direction;
- h. If recorded number of section is different for both directions, re-adjust connection of the motor drive unit and tap changer as per half of difference of two numbers.

For example (see fig.7)

- 1) Tap changer stops at position 10, turn towards position 11 using hand crank until diverter switch acts, record number of section that red mark gets to the center of window, for example it's 7 ;
- 2) Tap changer stops at position 11, turn towards position 10 using hand crank until diverter switch acts, record number of section when red mark gets to the center of window, for example, it's 1.5;
 $1/2 (7-1.5) = 2.75$ sections, choose 3 sections
- 3) Turn towards position 11 till red mark arrives at the center of window;
- 4) Uncouple the vertical shaft between motor drive unit and tap changer;
- 5) Continue to turn 3 sections towards position 12;
- 6) Connect them again;
- 7) Re-turn towards position 11 till diverter switch acts, then record the number of section that red mark gets to the center of window, the number of section is 4.5;
- 8) Repeat the said operation in reverse direction, the number of section is 4 section;

Finally the number difference of sections for both directions is basically symmetrical, remove the hand crank, and then motor drive unit should be switched to automatic operation mode.

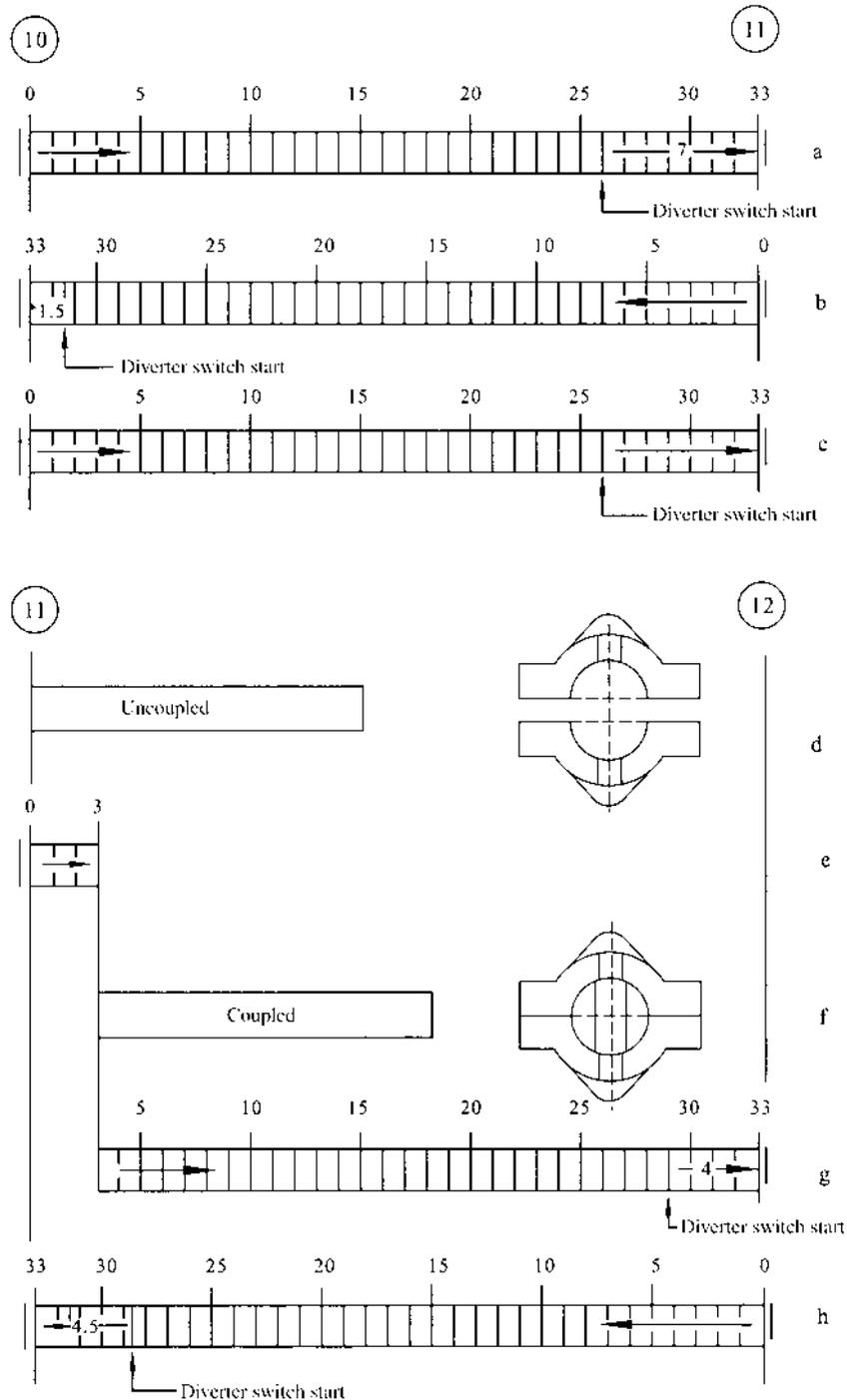
6. Commissioning

6.1 Operational tests

Before applying power supply on the motor circuit, control circuit and auxiliary circuit, check the voltage, current and signal output whether they are identical with required values.

6.1.1 Check step-by-step operation

Press down push-button S1 or S2, motor drive unit will stop automatically after one tap change operation.



- a, b: Count the number of section to the end for both direction separately, 7 sections for 1→N, 1.5 sections for N→1;
- c: Turn hand crank towards direction with more sections to end;
- d: Unfasten the coupling;
- e: Turn hand crank as per calculated sections;
- f: Connect the coupling again;
- g: Continue to turn to the end and check number of section;
- h: Check the reverse direction.

Fig.7 Coupling between motor drive unit and tap changer

6.1.2 Test for mechanical end stop device

Tap changer can move to last position within its tap change range, but can't approach its limit position, while motor drive unit can turn to its limit position by manual operation, about 2-3 revolutions before mechanical end stop is actuated. Turn hand crank reversely to release mechanical end stop device till red mark gets to the center of window, namely, it's the last position.

Repeat the said process in another limit position of motor drive unit.

6.1.3 Tests for electrical limit switch

As motor drive unit comes to one end position, further electrical operation can not make motor run towards same direction, while reverse operation can be done. Repeat the said process to check another electrical limit switch.

6.2 Transportation of transformer

If the motor drive unit is needed to dismount off transformer due to size when transformer is transported to commissioning site, tap changer and motor drive unit must be set at adjustment position.

For its re-installation, please refer to item 5

6.3 Put into operation at site

Before putting transformer into operation, operation tests for tap changer should be carried out according to item 6.

7. Maintenance

Because the transmission gear is a maintenance-free poly-V belt drive and ball bearings of motor are sufficiently supplied with grease, a regular maintenance is not necessary. It is recommended to inspect following items regularly:

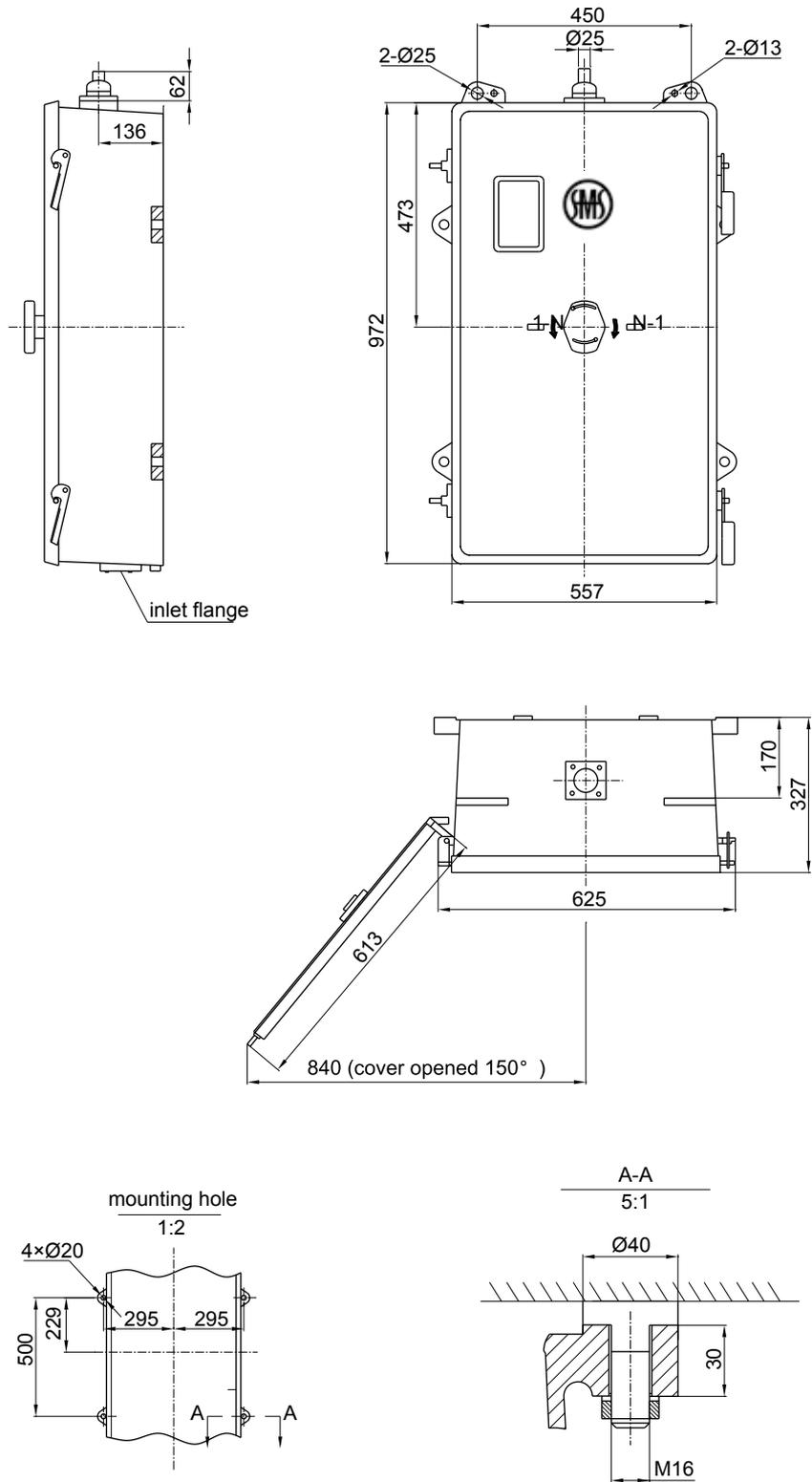
- Waterproof property of housing
- Performance of resistance heater (heater and thermostat)

When tap changer is maintained, besides inspections for motor drive unit, others inspections regulated in 6.1 also should be carried out.

NOTE!

- 1) The number of operation position should correspond to that of on-load tap changer.**
- 2) The auxiliary contacts of motor drive unit, motor protective switch are excluded from power frequency withstand voltage test.**

Appendix 1 Overall dimension diagram



Unit: mm

Appendix 2 Description of all functions of CMA 7 Motor Drive Unit

No.	Description	Remark
1	Manual operation	Standard
2	Electrical operation	
3	Remote operation	
4	Protection of limit position	
5	Protection of phase sequence	
6	Protection of manual operation	
7	Automatic re-start after temporary control voltage break-down	
8	Emergency stop	
9	Position indication	
10	Raise 1→N or Lower N→1	
11	One plug coded with decimal, specially connected with HMC-3C Position Indicator	
12	Step-by-step control	
13	Heater	
14	Operation counter	
15	One set of one-to-one corresponding passive contacts connected terminal block	
16	One set of terminals for remote control	
17	One pair of contacts for motor running connected terminal block	
18	Remote indication contacts of “Local/Remote” connected terminal block	
19	BCD code position signal outputted from Position Indicator	
20	N/O contact for Q1 tripping	
21	Add one pair of contacts for “Local/Remote” switch	
22	Add one set of one-to-one corresponding passive contacts connected terminal block	
23	Add one set of decimal position signal passive contacts connected terminal block	
24	Position indication signal directly to be connected terminal block without plug	
25	Add fuse protection for heater	
26	Add hygrostat and thermostat	

Appendix 3 Designation of terminals

X1 terminal number	Description
1,2,3,5	Power-in end, line voltage L1,L2,L3: 380V/50Hz;
8	Phase voltage L1 to N: 220V/50Hz
9	Input terminal for remote control "1→N"
10,11	Input terminal for remote control "N→1"
12	Common terminal for remote control
18	Input terminal for remote control "stop"
19,20	Output terminal for emergency stop (output 220/50Hz power signal)
23,24	Output terminal for motor running (output 220/50Hz power signal)
25,26	Output terminal for "remote" of "Local/Remote" switch (passive contact)
27,28	Output terminal for motor running (passive contact)
	Output terminal for "close" signal of Q1(passive contact)

NOTE!

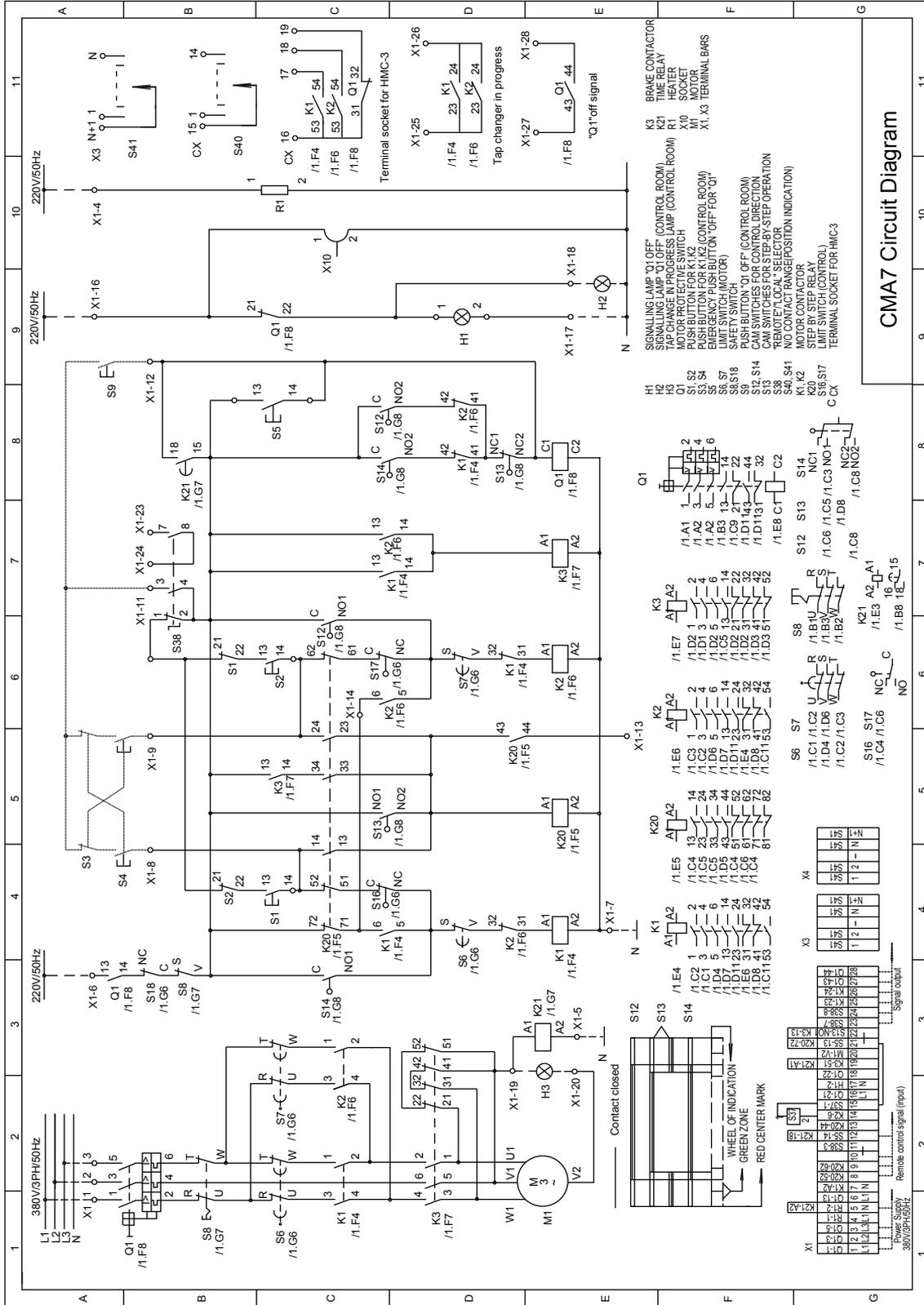
X3 terminal block is furnished with one set of one-to-one corresponding passive contacts, among them there is a "N+1" on X3 for common terminal and terminals 1→N on X3 correspond to position 1 to N of on-load tap changer.

Appendix 4 CX output decimal position signal

CX terminals output decimal position signal and is generally connected with HMC-3C Position Indicator.

CX Socket Number	Description
CX-1	Units digit of position signal "1"
CX-2	Units digit of position signal "2"
CX-3	Units digit of position signal "3"
CX-4	Units digit of position signal "4"
CX-5	Units digit of position signal "5"
CX-6	Units digit of position signal "6"
CX-7	Units digit of position signal "7"
CX-8	Units digit of position signal "8"
CX-9	Units digit of position signal "9"
CX-10	Units digit of position signal "0"
CX-11	Tens digit of position signal "0"
CX-12	Tens digit of position signal "1"
CX-13	Tens digit of position signal "2"
CX-14	Tens digit of position signal "3"
CX-15	"com" point of position signal
CX-16	Common terminal for indication lamp
CX-17	"1→N" indication
CX-18	"N→1" indication
CX-19	"stop" indication

Appendix 5 Electrical principle circuit



Note!

- 1. Please ensure that this operation instruction has been understood before operating this motor drive unit**
- 2. The concerned documents may be revised due to the modification of products**

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