ELECTRONIC CONTROL

Kelvin Martins

THE 20 MOTOR STARTERS EVERY ELECTRICIAN SHOULD KNOW

MASTER IT, IT WORKS

BAND OF ONE

INTRODUCTION

Mastering Electric Motor Starters: A Guide for Electricians

How many times have you been called for a technical visit or an electrical service, only to find yourself unsure of how to assemble a motor starter? Searching for solutions without knowing where to find them can be frustrating. With that in mind, I created this e-book, which covers the essential electric motor starters that every electrician should master. Through this guide, you will learn how to read, interpret, and assemble motor starters with confidence. Developing this skill will set you apart as a professional, opening doors to better opportunities, higher earnings, and greater profitability. Although it may seem complex at first, I will walk you through the fundamental principles that apply to most businesses and commercial establishments, such as stores and condominiums. This material presents everything in a clear and straightforward manner, ensuring that your clients trust your expertise. Inside, you will find wiring diagrams, a list of required materials, assembly layouts, proper sizing techniques, and additional resources tailored for you. The key to success is persistence and commitment to learning. Are you ready to take your skills to the next level? Let’s get started!

CHAPTER 1 - ELECTRIC MOTORS: THEORY AND PRACTICAL INSIGHTS

Chapter 2 – Electrical Device Testing: Ensuring Proper Operation

CHAPTER 3 - POWER SUPPLY SYSTEMS: UNDERSTANDING VOLTAGE AND NETWORKS

CHAPTER 6 - ELECTRIC MOTOR STARTERS: DESIGNS, LAYOUTS, AND DIAGRAMS

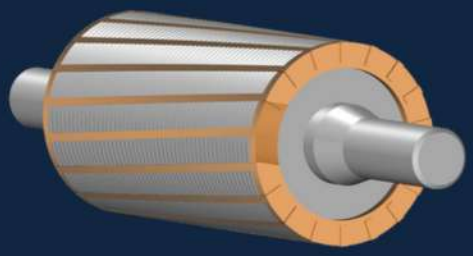
CHAPTER 8 - TEST YOUR KNOWLEDGE

Bonus Content

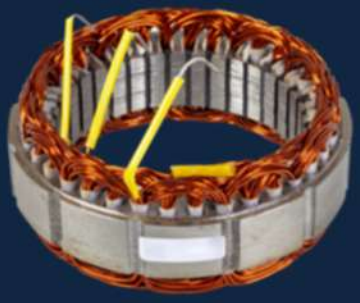
ELECTRIC MOTOR

AN ELECTRIC MOTOR IS A DEVICE DESIGNED TO CONVERT ELECTRICAL ENERGY INTO MECHANICAL ENERGY, OPERATING THROUGH THE PRINCIPLE OF THE ELECTROMAGNETIC EFFECT.

Key Components of an Engine



ROTOR



STATOR

ROTOR

THE ROTOR IS THE ROTATING COMPONENT OF THE MOTOR. THE STATOR REMAINS FIXED WITHIN THE CASING AND SERVES THE PURPOSE OF GUIDING THE MAGNETIC FLUX TO CONVERT THE KINETIC ENERGY INDUCED.

Single-Phase Auxiliary Phase Motor

SINGLE-PHASE MOTORS ARE THOSE DESIGNED FOR CONNECTION TO 'PHASE AND NEUTRAL' OR 'PHASE AND PHASE' CIRCUITS. AMONG SINGLE-PHASE MOTORS, AUXILIARY PHASE MOTORS ARE THE MOST WIDELY USED. THEY FIND APPLICATIONS IN COMPRESSORS, WASHING MACHINES, WATER PUMPS, AND MORE.

This type of motor has two windings: a main and an auxiliary winding. Based on the arrangement of the auxiliary winding, the single-phase motor can be classified as:

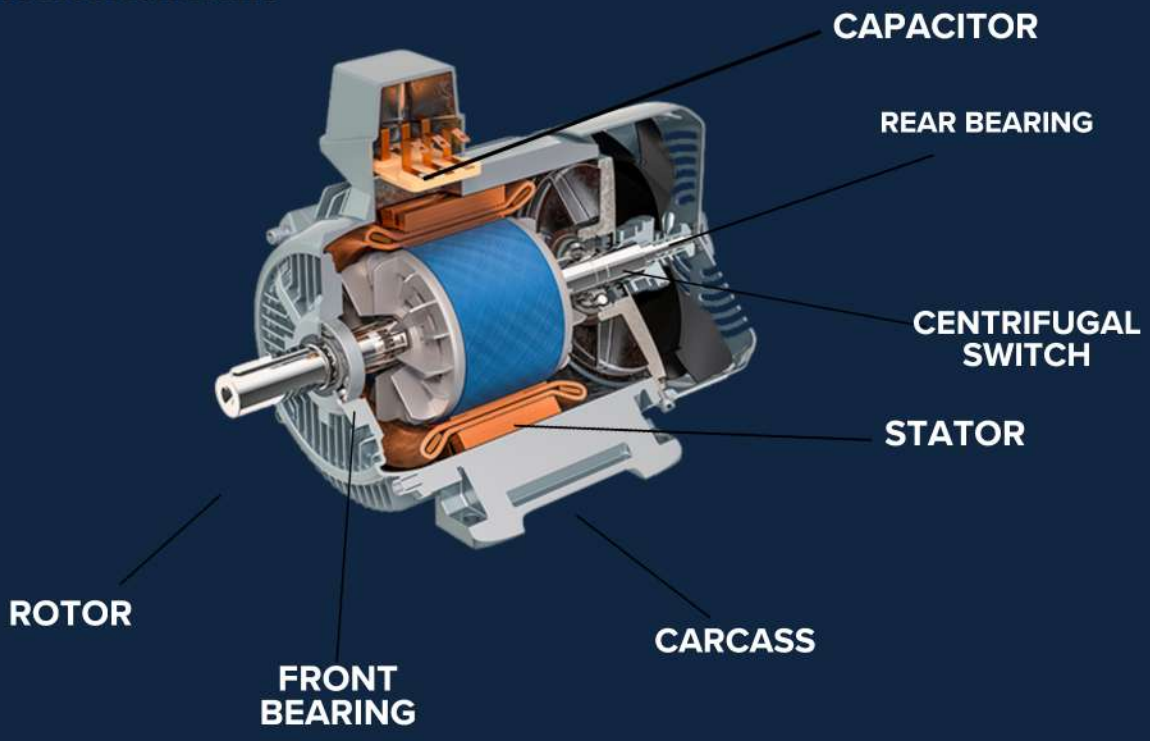
1) Split Phase Motor (MOTOR DE FASE SPLIT)

2) Capacitor Start Motor (MOTOR COM CAPACITOR - INÍCIO)

3) Permanent Split Capacitor Motor (1RC VP E=R M73A6NEWNTE)

4) Two-Capacitor Fixed-Value Motor

CONSTRUCTION PARTS



OPERATING PRINCIPLE OF A SINGLE-PHASE MOTOR WITH CAPACITOR START

IN THE STATOR, TWO WINDINGS ARE PRESENT: THE PRIMARY OR OPERATING WINDING (WITH A THICKER WIRE) AND THE SECONDARY OR STARTING WINDING (WITH A THINNER WIRE).

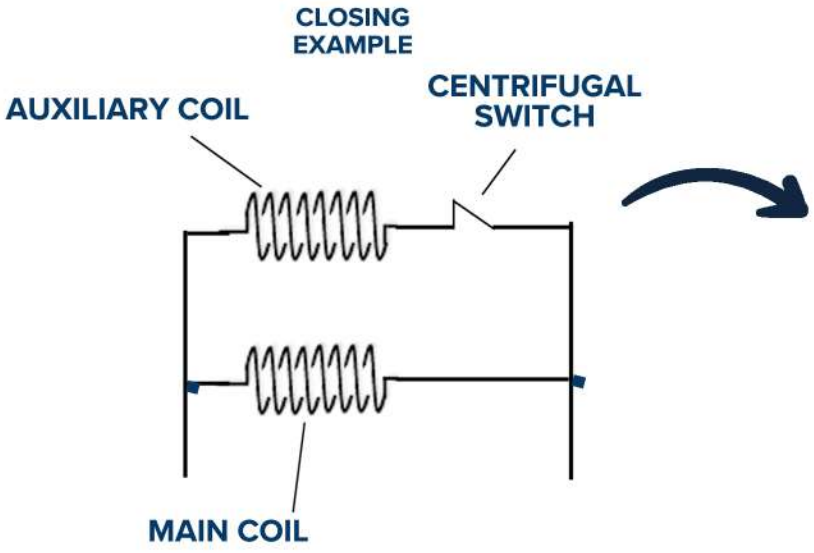
The primary winding remains active throughout the motor's operation, while the secondary winding is only engaged during the startup phase.

To stop the motor, it is equipped with an automatic mechanism (centrifugal switch), typically located on the rear cover of the motor.

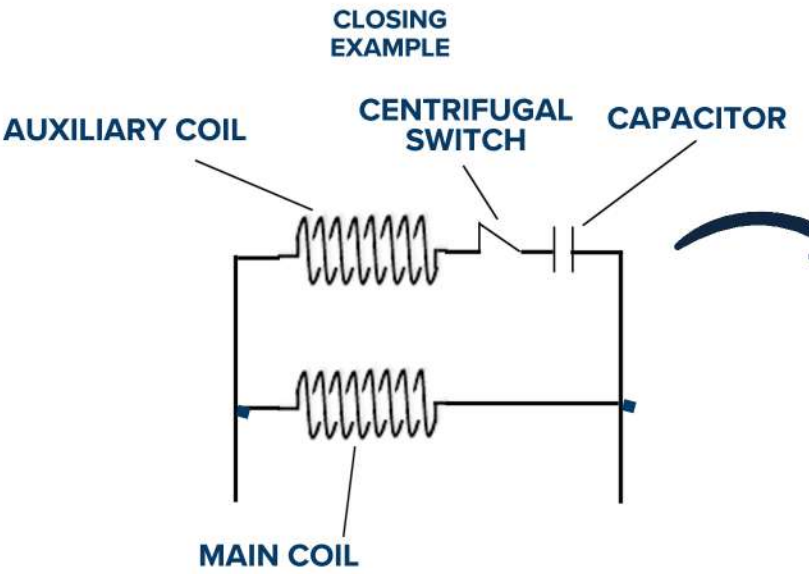
WHEN THE MOTOR REACHES APPROXIMATELY 80% OF ITS RATED SPEED, THE CENTRIFUGAL SWITCH, ALSO KNOWN AS THE AUTOMATIC SWITCH, DISCONNECTS THE AUXILIARY WINDING. FROM THAT POINT ON, THE MOTOR OPERATES USING ONLY THE MAIN WINDING.

Auxiliary phase motors can be found with or without a capacitor. The use of a capacitor enhances the precision of the starting process.

This capacitor is connected in series with the auxiliary winding and the automatic shut-off mechanism (centrifugal switch).



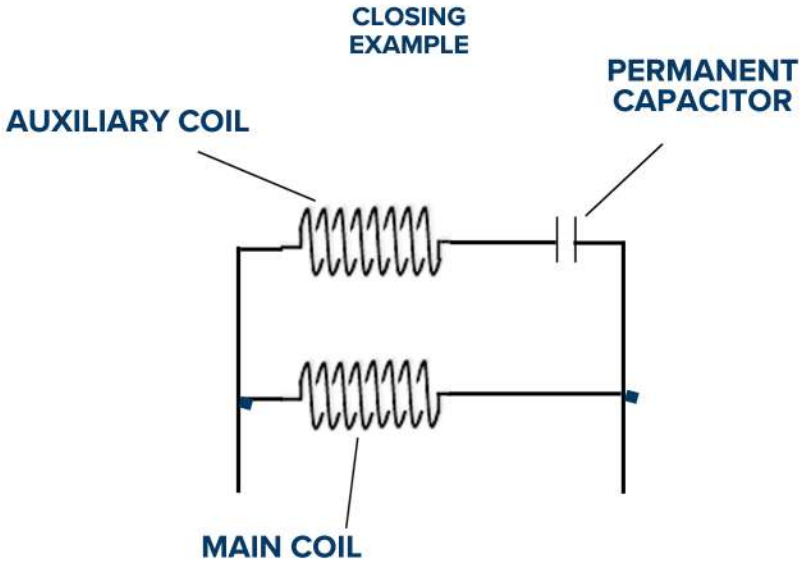
SINGLE-PHASE MOTOR WITHOUT CAPACITOR (Split Phase)



SINGLE-PHASE MOTOR WITH STARTING CAPACITOR

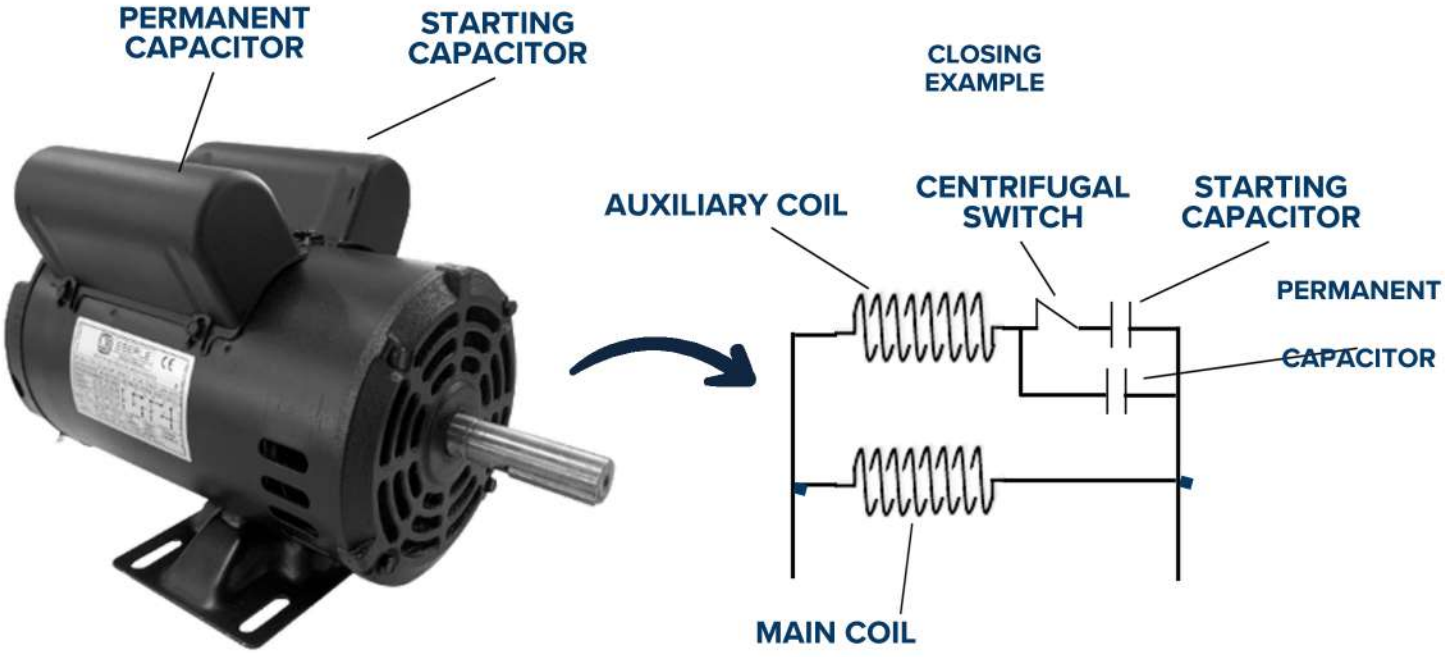
SINGLE-PHASE PERMANENT CAPACITOR MOTOR

AUXILIARY PHASE MOTORS WITH PERMANENT CAPACITOR DO NOT HAVE A CENTRIFUGAL SWITCH. DURING THE ENTIRE PERIOD OF MOTOR OPERATION, THE AUXILIARY CIRCUIT WITH THE CAPACITOR REMAINS CONNECTED TO THE POWER SUPPLY CIRCUIT.



SINGLE-PHASE MOTOR WITH TWO CAPACITORS

AUXILIARY PHASE MOTORS WITH TWO CAPACITORS USE THE ADVANTAGES OF MOTORS WITH STARTING CAPACITORS AND PERMANENT CAPACITORS. THEY OFFER EXCELLENT PERFORMANCE AT STARTING AND DURING RUNNING AND ARE NORMALLY MANUFACTURED WITH POWER ABOVE 1HP.



NUMBER AND CLOSURE OF SINGLE-PHASE MOTOR

THERE ARE AUXILIARY PHASE MOTORS WITH: TWO TERMINALS; FOUR TERMINALS AND SIX TERMINALS

2 TERMINALS

TWO-TERMINAL MOTORS WORK ON ONLY ONE VOLTAGE (127V OR 220V) AND DO NOT ALLOW ROTATION INVERSION.

FOR 127V

1HCAVDO = I
N73TE6RWNAMENTE,

IN THIS CASE THE ENGINE ALREADY COME FEC

JUST CONNECT IT DIRECTLY TO THE 127V POWER SUPPLY

FOR 220V

1HCAVDO = I
N73TE6RWNAMENTE,

IN THIS CASE THE ENGINE ALREADY COME FEC

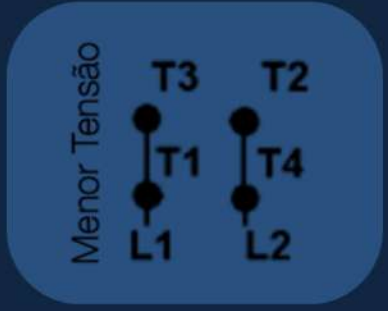
JUST CONNECT IT DIRECTLY TO THE 220V POWER SUPPLY

NOTE: IN MOST CITIES IN BRAZIL WE FIND 220V BETWEEN PHASE AND PHASE (LINE VOLTAGE) AND 127V BETWEEN PHASE AND NEUTRAL (PHASE VOLTAGE); HOWEVER, THERE ARE REGIONS WHERE WE FIND 380V BETWEEN PHASE AND PHASE AND 220V BETWEEN PHASE AND NEUTRAL. WE CAN ALSO FIND CITIES THAT DO NOT HAVE A NEUTRAL CONDUCTOR, OFFERING ONLY 220V BETWEEN PHASE AND PHASE.

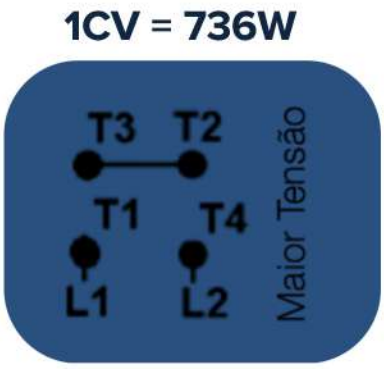
4 TERMINALS

FOUR-TERMINAL MOTORS WORK WITH TWO VOLTAGES (EX: 127V AND 220V), THERE ARE OTHER MODELS OF 4-TERMINAL MOTORS THAT RECEIVE A SINGLE VOLTAGE AND IT IS POSSIBLE TO REVERSE THE ROTATION.

CLOSING FOR 127V



1CV = 736W



THERE ARE OTHER 4-TERMINAL MOTOR MODELS THAT RECEIVE A SINGLE VOLTAGE AND CAN REVERSE THE ROTATION. IT IS EXTREMELY IMPORTANT TO PAY ATTENTION TO THE CHOICE OF MOTOR AND ITS IDENTIFICATION PLATE. IT IS POSSIBLE TO ANALYZE THESE DETAILS BY CHECKING MANUFACTURERS' CATALOGS, SUCH AS WEG.

6 TERMINALS

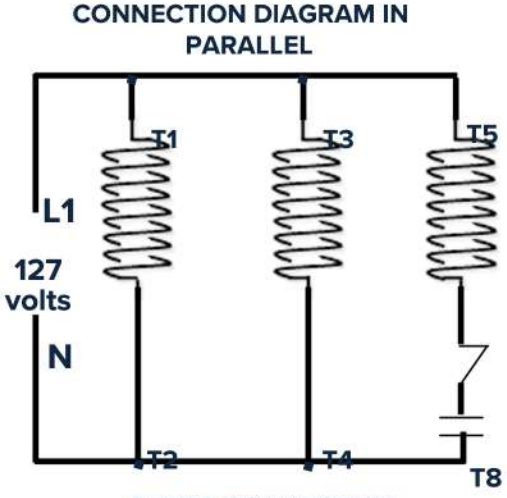
THE SINGLE-PHASE SIX-TERMINAL MOTOR HAS THREE COILS, TWO OF WHICH ARE MAIN AND ONE AUXILIARY.

THE FIRST COIL RECEIVES THE NUMBERINGS “T1” AND “T3”, THE SECOND COIL RECEIVES THE NUMBERINGS “T2” AND “T4” THE THIRD COIL, BEING THE AUXILIARY COIL, RECEIVES THE NUMBERINGS “T5” AND “T6”.

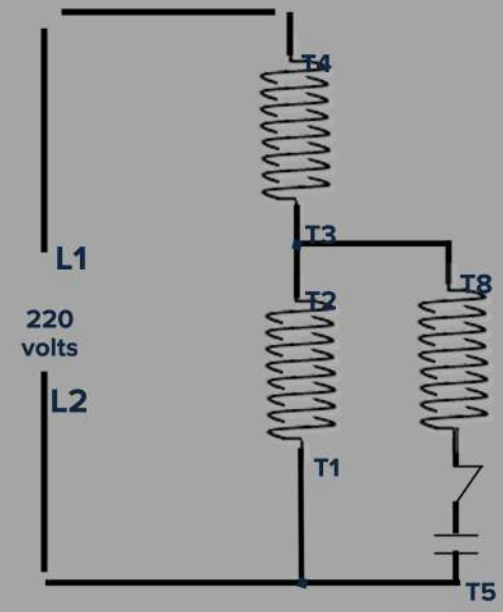
THESE MOTORS CAN OPERATE AT TWO VOLTAGES (127V AND 220V) AND ALLOW ROTATION TO BE REVERSED.

FOR CLOSING AT 127V, WE INTERCONNECT THE T1, T3 AND T5 TERMINALS TO EACH OTHER AND CONNECT THEM TO THE PHASE AND WE INTERCONNECT THE T2, T4 AND T8 TERMINALS TO EACH OTHER AND CONNECT THEM TO THE NEUTRAL.

CLOSING



SERIES CONNECTION DIAGRAM



TO REVERSE THE MOTOR ROTATION, JUST CHANGE THE T5 TERMINAL FOR THE T8 TERMINAL

CLOSING FOR 127V

CLOCKWISE

CLOSING FOR 127V

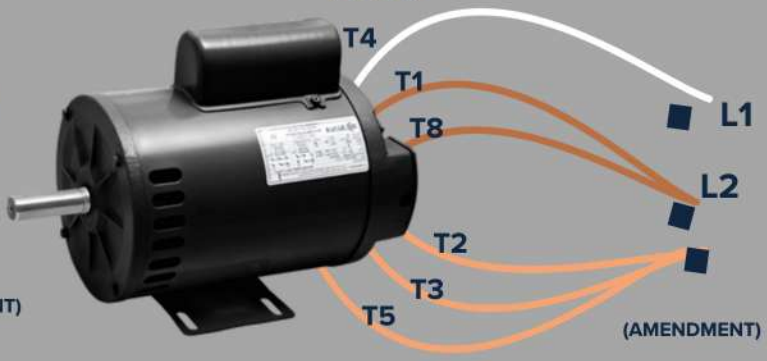
COUNTERCLOCKWISE

CHANGING THE T5 TERMINAL FOR THE T8

CLOSING FOR 220V

CLOCKWISE

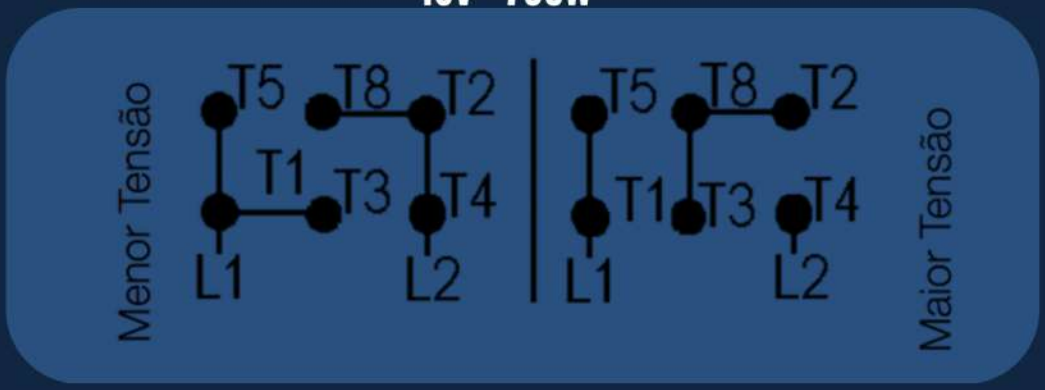
CLOSING FOR 220V



COUNTERCLOCKWISE

CHANGING THE T5 TERMINAL FOR THE T8

1CV = 736W



THE MOTOR CLOSURES REFERENCED IN THIS MATERIAL ARE BASED ON WEG MOTORS, AND THE SPECIFIC MANUFACTURERS OF EACH INSTALLATION MUST BE OBSERVED.

THREE-PHASE INDUCTION MOTOR

THREE-PHASE INDUCTION ELECTRIC MOTORS ARE WIDELY USED IN MACHINES AND INDUSTRIAL PROCESSES, DUE TO THEIR EFFICIENCY, SIMPLICITY, ROBUSTNESS AND LOW MAINTENANCE.

THREE-PHASE MOTORS, UNLIKE SINGLE-PHASE MOTORS, CAN HAVE HIGH POWER, ALLOW ROTATION INVERSION DURING OPERATION, AND SPEED CONTROL BY ELECTRONIC EQUIPMENT (FREQUENCY INVERTER, FOR EXAMPLE)

THREE-PHASE INDUCTION MOTORS, AS THEIR NAME SUGGESTS, ARE MANUFACTURED TO BE CONNECTED TO 3-PHASE ELECTRICAL SYSTEMS, NAMED AS: R, S AND T OR L1, L2 AND L3

THREE-PHASE INDUCTION MOTOR

THE MAIN MOTORS USED ARE: ASYNCHRONOUS MOTOR WITH SHORT-CIRCUIT ROTOR ASYNCHRONOUS MOTOR WITH WOUND ROTOR

THE STATOR OF THESE MOTORS HAVE AT LEAST 3 COILS (ONE FOR EACH PHASE) INTERCONNECTED IN A WAY THAT WHEN POWERING THESE COILS, DUE TO THE EFFECT OF THE THREE-PHASE CURRENT, A "ROTATIONAL MAGNETIC FIELD" IS CREATED, WHICH DRAGS THE ROTOR, MAKING IT SPIN.

SHORT CIRCUIT ROTOR

WOUND ROTOR

SHORT-CIRCUIT ROTOR THE SHORT-CIRCUIT ROTOR, ALSO KNOWN AS A "SQUIRREL CAGE", IS SIMILAR TO A SINGLE-PHASE MOTOR. THIS TYPE OF ROTOR IS NOT ELECTRICALLY CONNECTED TO THE COILS OR ANY OTHER DEVICE.

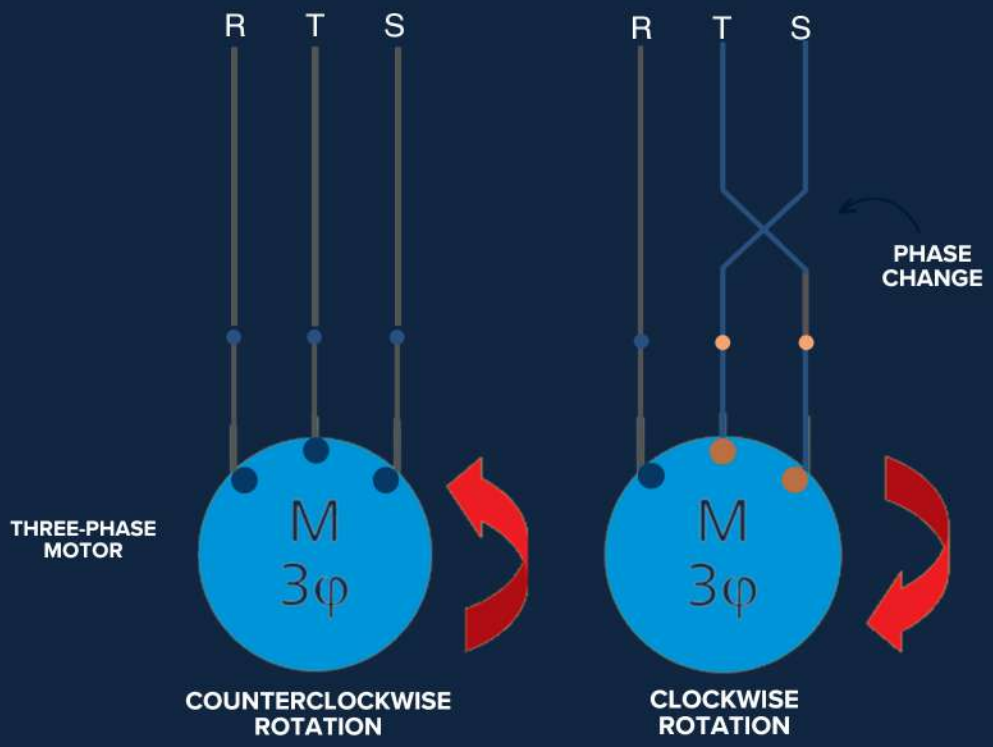
WOUND ROTOR

THE WOUND ROTOR OF THE ASYNCHRONOUS MOTOR MUST BE CONNECTED TO A RHeostat or a bank of resistors, enabling the regulation of the current that flows through the rotor, allowing a smoother start or varying the speed of the motor.

CHARACTERISTICS OF THREE-PHASE MOTOR TYPES

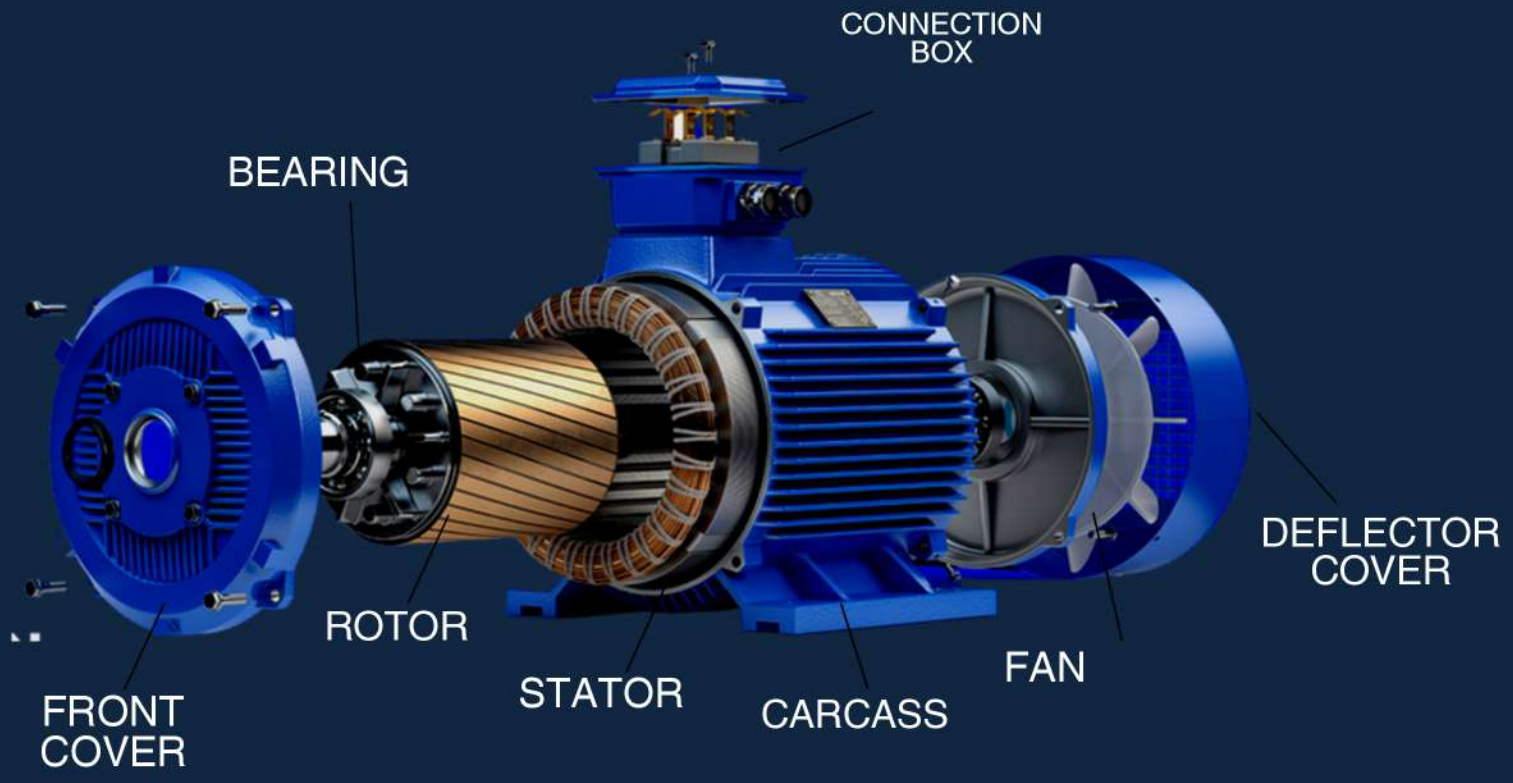
THREE-PHASE MOTOR	SPEED CONTROL	START	APPLICATION
SHORT CIRCUIT ROTOR	CONTROL THROUGH FREQUENCY INVERTER CONTROL THROUGH	LOW OR MEDIUM	STARTING SMALL AND LARGE MACHINES REDUCE CURRENT PEAKS,
WOUND ROTOR	OF RESISTANCES	HIGH	AND PERFORM SPEED CONTROL

HOW TO REVERSE THE ROTATION OF A THREE-PHASE INDUCTION MOTOR?

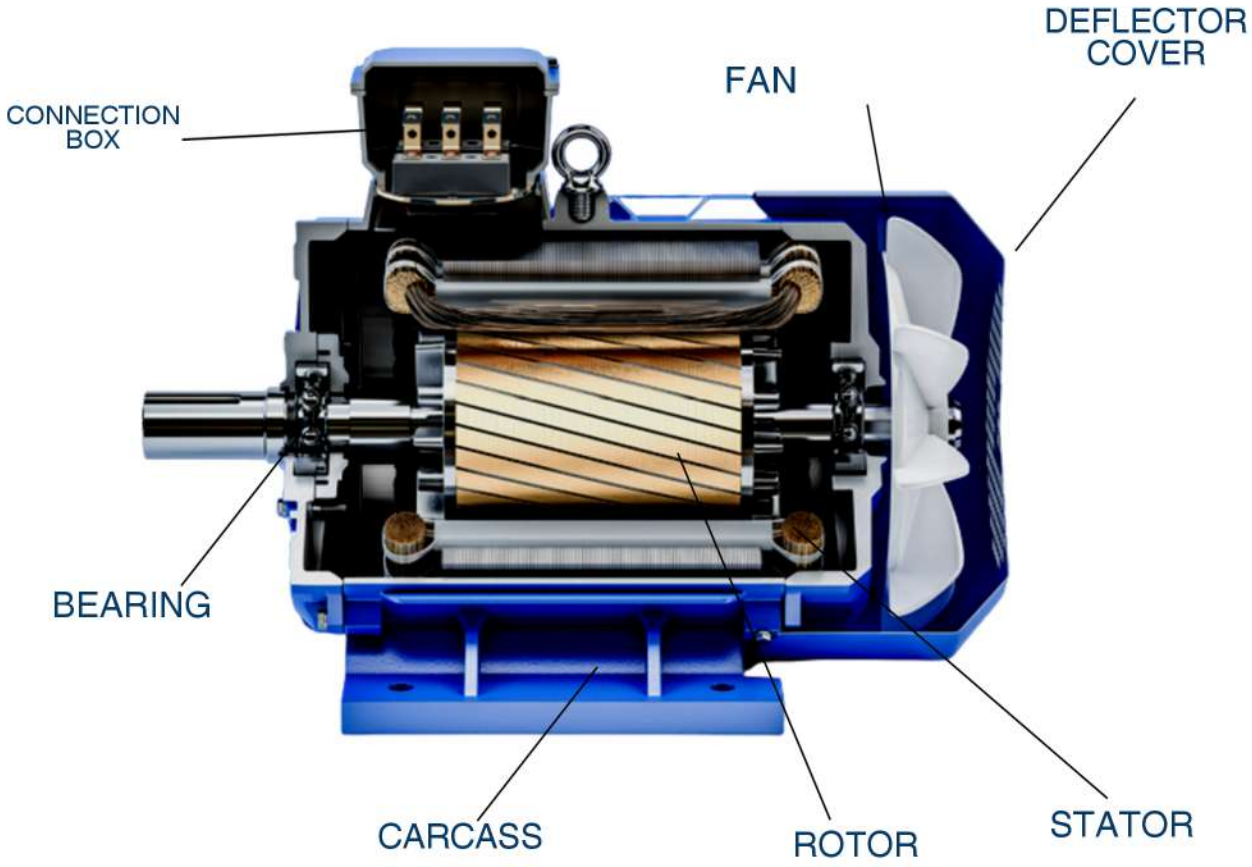


JUST INVERT ONE OF THE PHASES IN THE POWER SUPPLY

CONSTRUCTION PARTS



CONSTRUCTION PARTS



NUMBER AND CLOSURE OF THREE-PHASE MOTORS

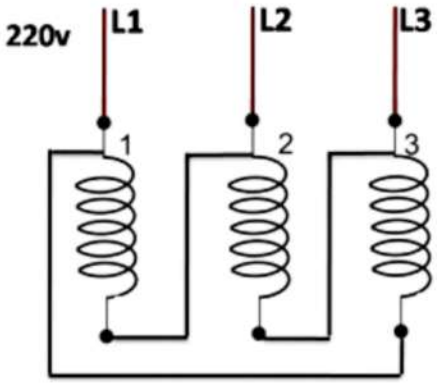
THREE-PHASE INDUCTION MOTORS CAN BE WITH 3, 6, 9 AND 12 TERMINALS

3 TERMINALS

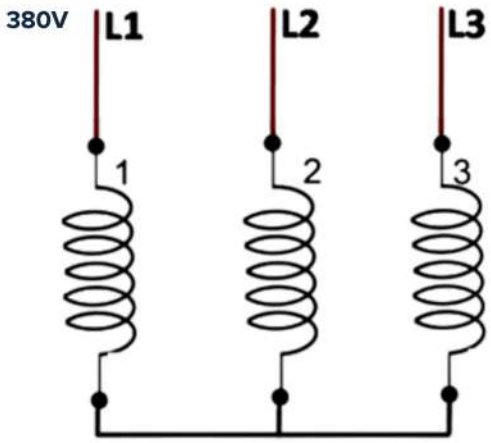
THESE ARE MOTORS THAT HAVE 3 TERMINALS TO BE CONNECTED TO A THREE-PHASE NETWORK. THESE MOTORS ONLY ALLOW TO OPERATE AT JUST ONE VOLTAGE VALUE.

EXAMPLE

FOR 220V



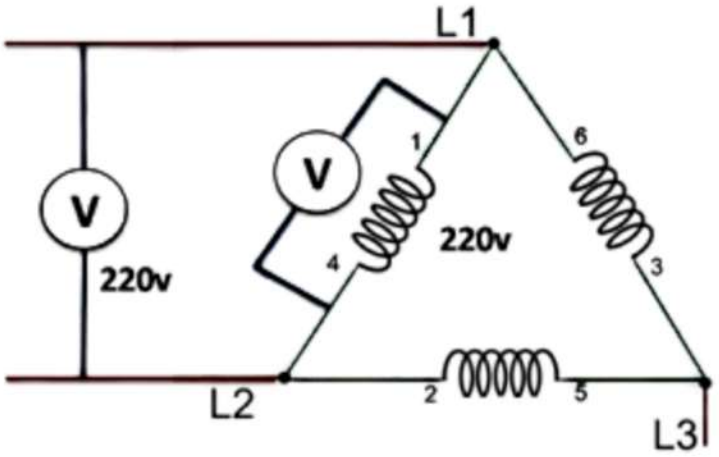
INTERNAL CLOSURE

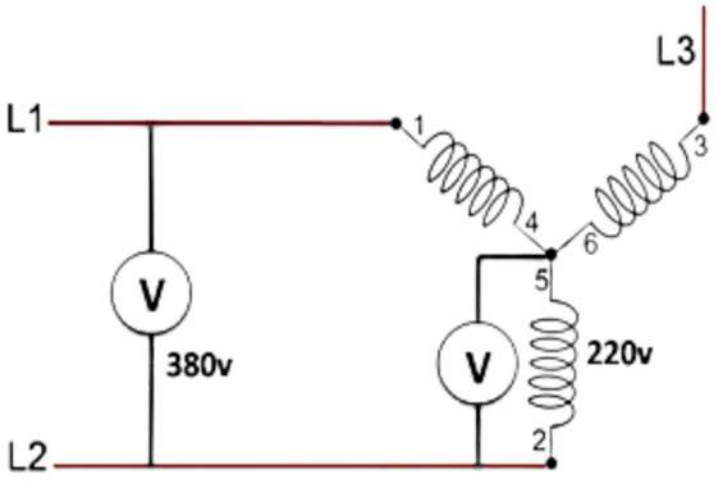


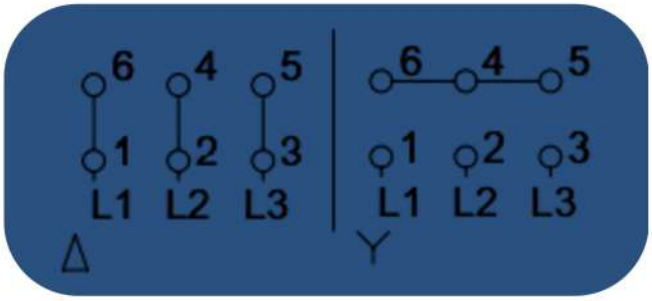
FECHAMENTO INTERNO

6 TERMINALS

THESE ARE MOTORS THAT HAVE 6 TERMINALS TO BE CONNECTED TO A THREE-PHASE NETWORK. THESE MOTORS CAN OPERATE AT TWO VOLTAGES, DEPENDING ON THE CONNECTION TYPE:







WIRING DIAGRAM ON MOTOR BOARD

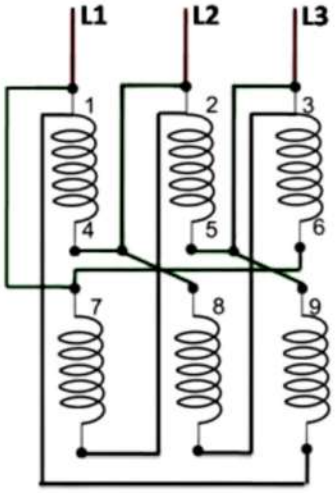
1CV = 736W

9 TERMINALS

THESE MOTORS CAN BE CONNECTED TO TWO VOLTAGES, HOWEVER THE VALUE OF ONE IS ALWAYS TWICE THAT OF THE OTHER.

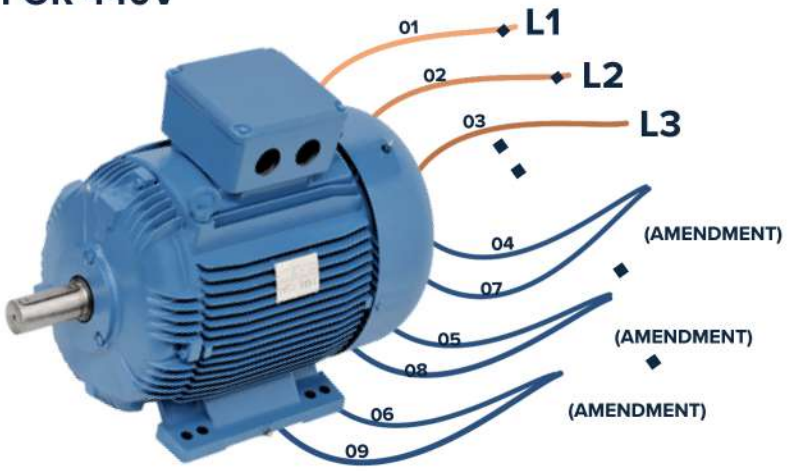
AT 220V – (DOUBLE TRIANGLE) AND 440V – (TRIANGLE: SERIES):

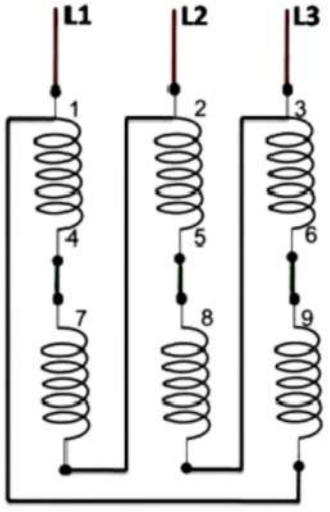
FOR 220V



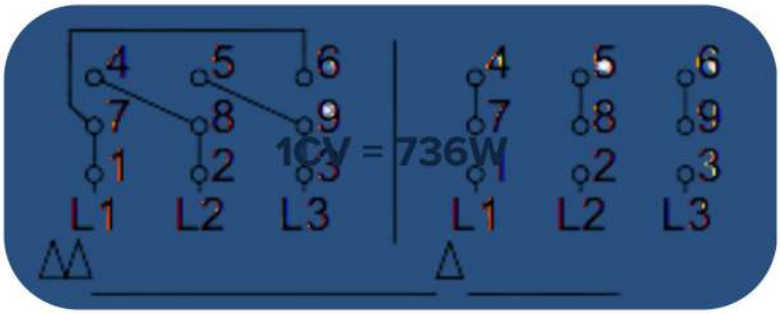
220v - ▲▲

FOR 440V





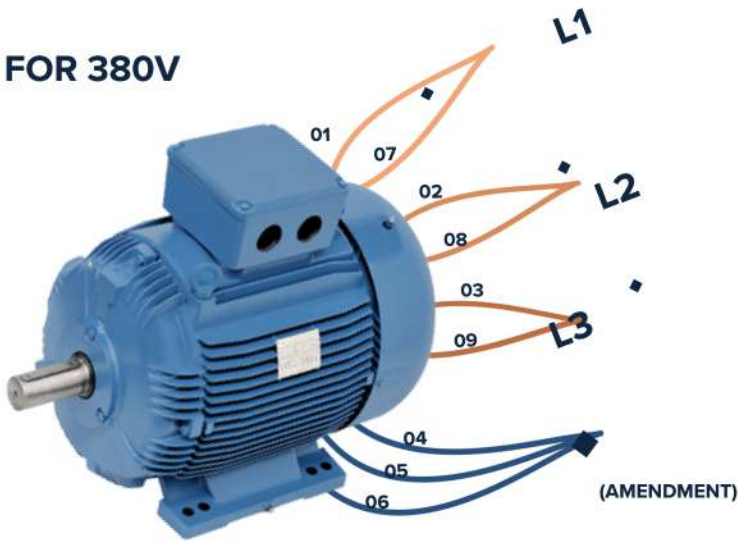
440v - ▲

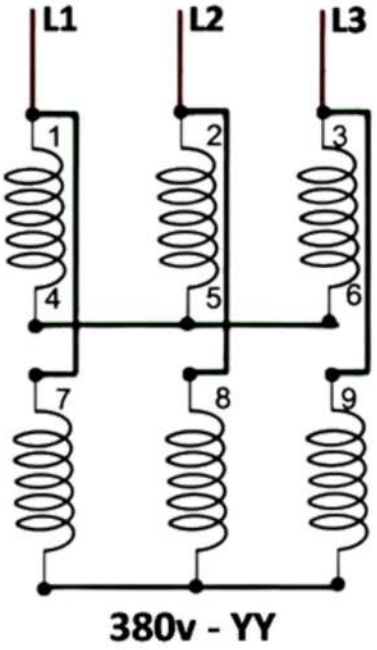


WIRING DIAGRAM ON MOTOR BOARD

AT 380V - (DOUBLE STAR) AND 760V - (STAR - Y SERIES):

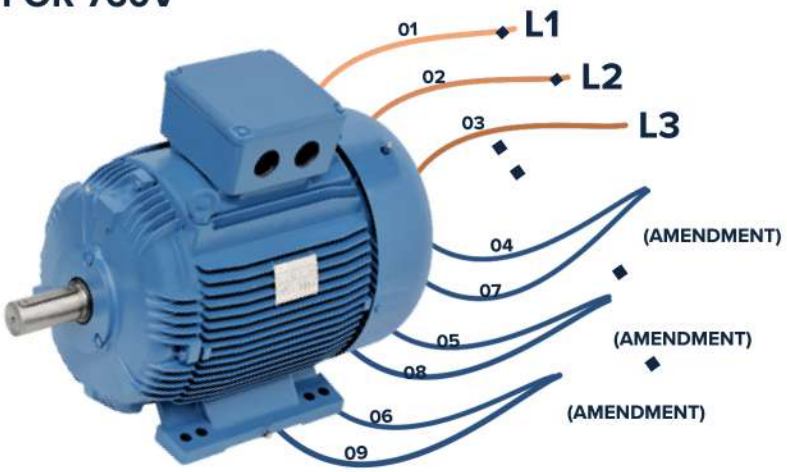
FOR 380V

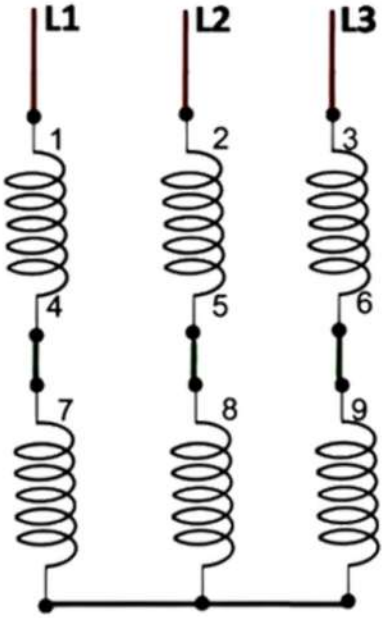




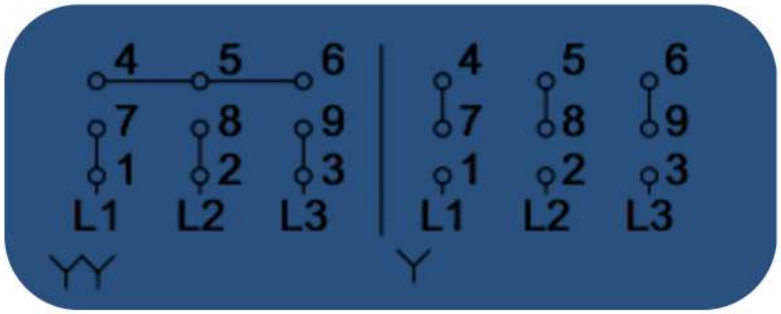
380v - YY

FOR 760V





760v - Y



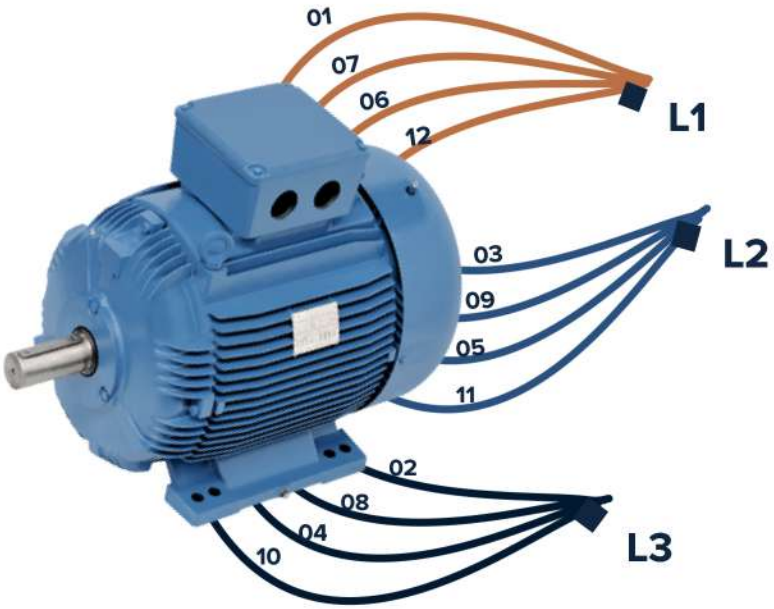
WIRING DIAGRAM ON MOTOR BOARD

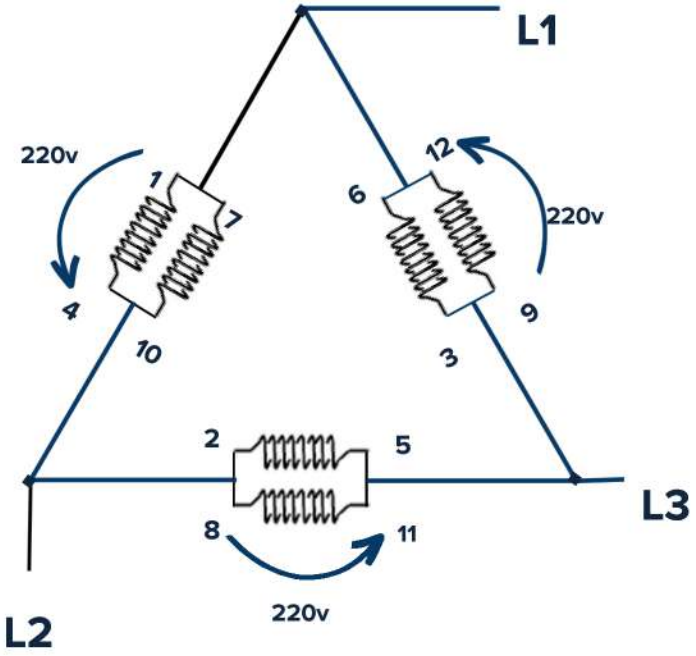
1CV = 736W

12 TERMINALS

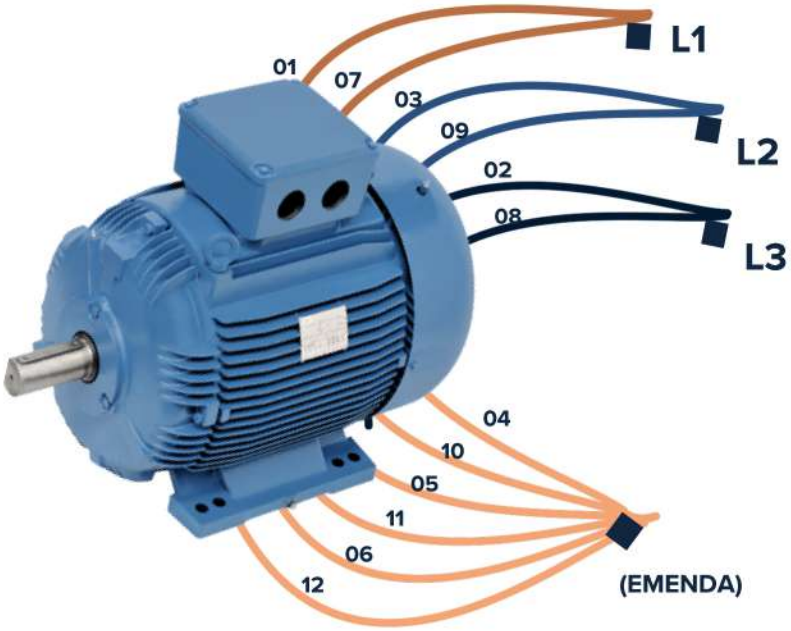
THESE ARE MOTORS THAT HAVE 12 TERMINALS TO BE CONNECTED TO A THREE-PHASE NETWORK. THESE MOTORS CAN OPERATE AT FOUR DIFFERENT VOLTAGES, DEPENDING ON THE TYPE OF CONNECTION:

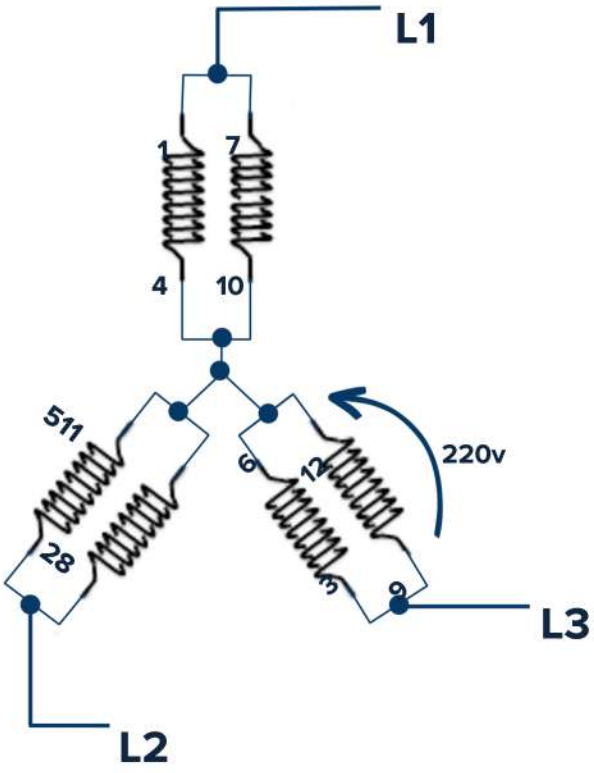
AT 220V – DOUBLE DRIANGLE CONNECTION(▲▲):



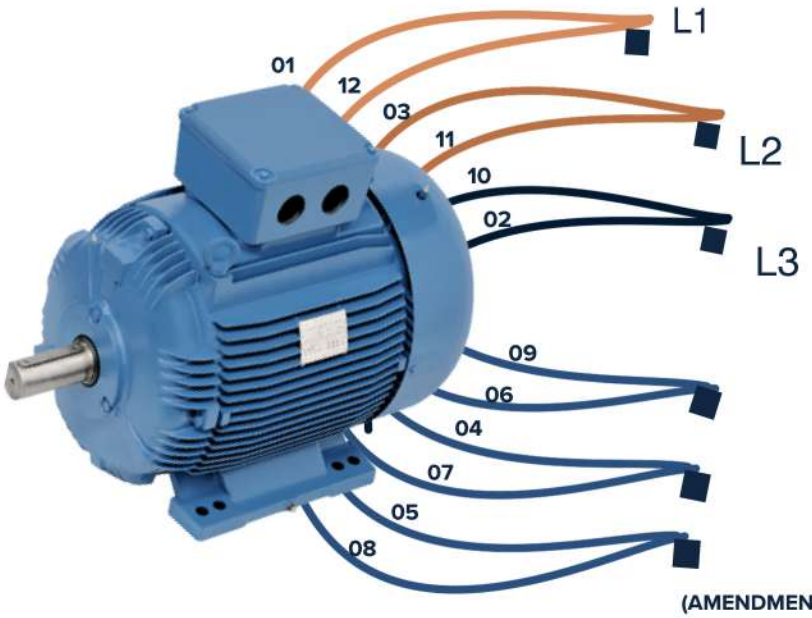


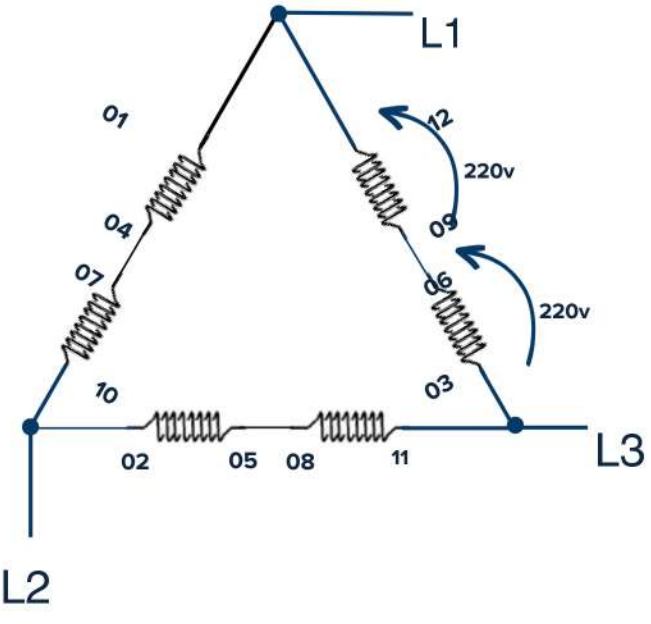
EM 380V – LIGAÇÃO DUPLO ESTRELA(YY):





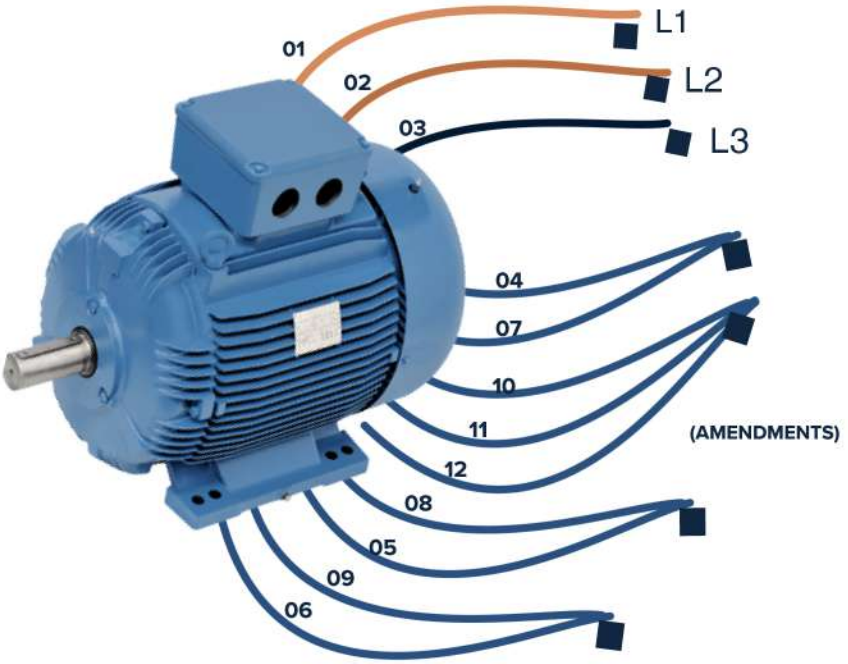
AT 440V – SERIES DRIANGLE CONNECTION:



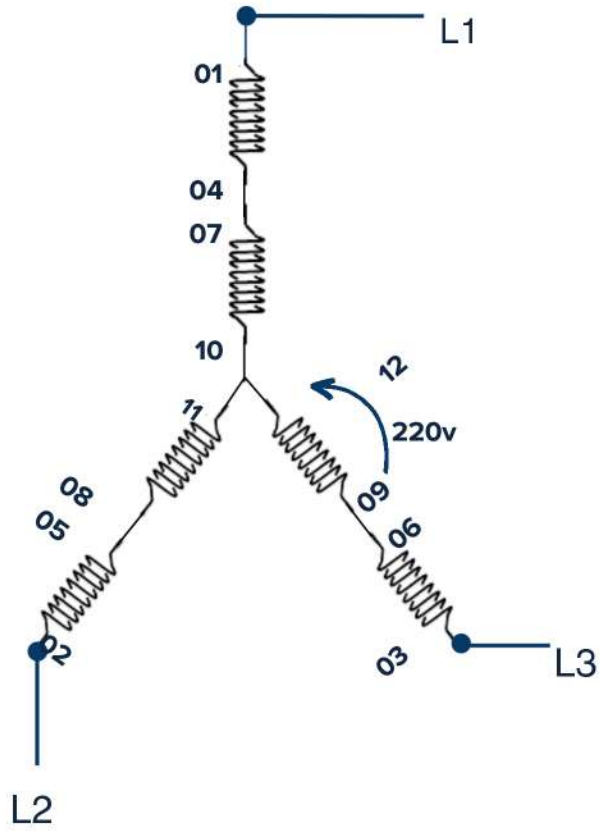


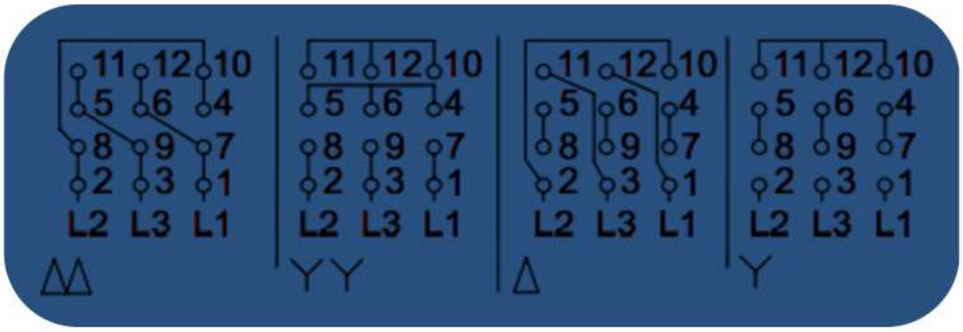
(AMENDMENTS)

AT 760V – SERIES STAR CONNECTION:



(AMENDMENTS)

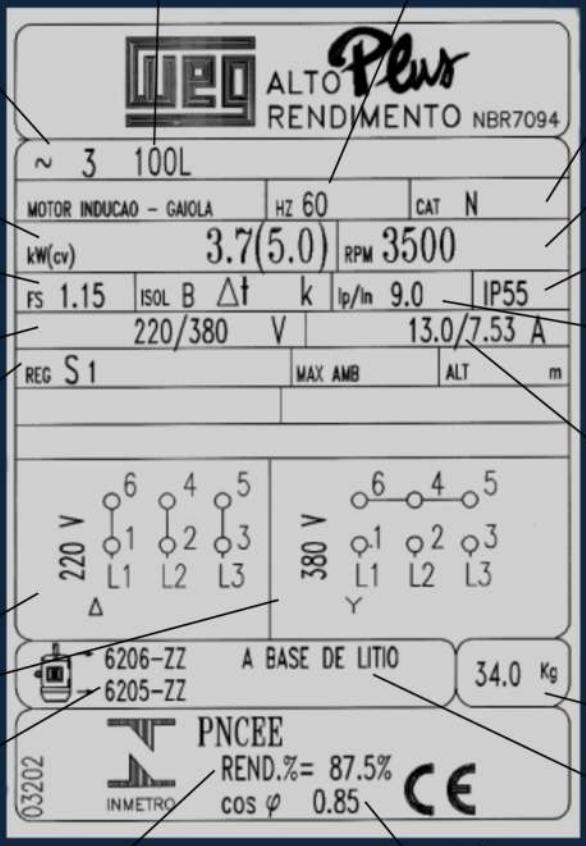




WIRING DIAGRAM ON MOTOR BOARD

1CV = 736W

ENGINE PLATE DATA



THREE-PHASE MOTOR

CASING TYPE

NETWORK FREQUENCY

CONJUGATE CATEGORY

POWER

NOMINAL ROTATION

SERVICE FACTOR

DEGREE OF PROTECTION

NUMBER OF TIMES THE STARTING CURRENT IS GREATER THAN THE NOMINAL CURRENT

NOMINAL VOLTAGES

MOTOR RATINGS

SERVICE REGIME

TYPES OF CONNECTIONS

WEIGHT

BEARING TYPES

TYPE OF LUBRICANT

PERFORMANCE

POWER FACTOR

NOMINAL VOLTAGE IS THE VALUE OF THE MAINS VOLTAGE FOR WHICH THE MOTOR IS DESIGNED. IN THIS CASE IT IS A MOTOR THAT SUPPORTS 2 DIFFERENT VOLTAGES: 220V / 380V NOMINAL POWER:

IT IS THE VALUE OF THE ENGINE'S CAPACITY TO MOVE A MACHINE. AS THE ENGINE TRANSFORMS ELECTRICAL ENERGY INTO MECHANICAL ENERGY, THE POWER CAN BE GIVEN IN KW, CV OR HP. IN THIS EXAMPLE, 5HP / 3.7 KW

11CCVV == 773366W

11HCVP == 774366W

ENGINE PLATE DATA

NOMINAL CURRENT (A): THIS IS THE VALUE OF ELECTRIC CURRENT THAT CIRCULATES IN EACH OF THE PHASES, WHEN THE MOTOR IS RUNNING AT FULL LOAD. THE PLATE INDICATES A NOMINAL CURRENT FOR EACH APPLIED VOLTAGE.

$$In = \frac{P(W)}{V \; x \; \sqrt{3} \; x \; cos\varphi \; x \; n}$$

In = Corrente nominal (A)

P = Potência elétrica (W)

V = Tensão elétrica aplicada (V)

$\sqrt{3} \cong 1{,}73$

$cos\varphi$ = Fator de potência

n = Rendimento (%)

PEAK CURRENT TO NOMINAL CURRENT RATIO (IP/IN): THIS IS THE VALUE OF THE RATIO BETWEEN THE CURRENT THAT THE MOTOR NEEDS TO MOVE THE ROTOR (STARTING CURRENT – IP) AND THE MOTOR OPERATING CURRENT (NOMINAL CURRENT – IN). IN PRACTICE, WITH THIS VALUE, WE CALCULATE THE VALUE OF THE PEAK CURRENT WHEN THE MOTOR STARTS, CONSIDERING THE VALUE ON THE PLATE:

1CV = 736W
IP/IN = 9,0

1IPC V= 9=, 073 X6 IWN

ENGINE PLATE DATA

CONSIDERING THE MOTOR ON THE BOARD ABOVE WITH A NOMINAL CURRENT OF 13.0A, WE HAVE A PEAK CURRENT OF 117.0A.

IP = 91,C0V X = 1 37,306 =W 117A

SERVICE FACTOR (FS): IT IS AN EXTRA POWER RESERVE THAT THE MOTOR CAN PROVIDE TO THE MACHINE, WITHOUT HARMING ITS OPERATION OR BURNING. CONSIDERING THE MOTOR ON THE PLATE: MOTOR POWER = 5 HP F.S = 1.15 (15%) THE MAXIMUM POWER THAT THE MOTOR CAN PROVIDE TO THE MACHINE: 5HP X 1.15 = 5.75 HP WITH THIS THE NOMINAL CURRENT WILL ALSO INCREASE 1.15 TIMES (15%)

EFFECT (ɳ) IS THE RATIO BETWEEN THE POWER THAT THE MOTOR PROVIDES TO THE LOAD

(MECHANICAL POWER THAT IS ON THE PLATE) AND THE ELECTRICAL POWER (ACTIVE) THAT THE MOTOR ABSORBS FROM THE MAINS, INDICATING THE EFFICIENCY OF THE TRANSFORMATION BETWEEN

ELECTRIC ENERGY IN MECHANICS.

ɳ1C =V P =
m 7o3t6oWr

P rede

$$\eta = \frac{\text{1 C VP M=0 7T306R W}}{E_{\Phi} \times 1{,}73 \times I \times \cos}$$

P motor = Motor power in W P grid = Power consumed by the motor E = Grid voltage I = Nominal motor current COS

ϕ = Motor power factor

$$\eta(\%) = \frac{\text{Pmotor } E \times 1{,}73 \times I \times \cos \varphi}{} \times 100$$

POWER FACTOR (COS Φ): THE POWER FACTOR IS THE RATIO BETWEEN THE POWER OF THE MOTOR AND THE POWER CONSUMED BY THE GRID AND IS INDICATED BY COSINE Φ, WHERE Φ IS THE PHASE SHIFT ANGLE OF THE VOLTAGE IN RELATION TO THE CURRENT.

ENGINE PLATE DATA

POWER FACTOR IS AN IMPORTANT ITEM WHEN IT COMES TO THE USE OF ELECTRIC MOTORS. DUE TO THE INDUCTIVE NATURE OF MOTORS, IT IS NORMALLY NECESSARY TO CORRECT THE POWER FACTOR (INCREASE IT). THIS CORRECTION IS DONE BY CONNECTING A CAPACITIVE LOAD, GENERALLY A CAPACITOR OR OVEREXCITED SYNCHRONOUS MOTOR IN PARALLEL WITH THE LOAD.

$$\cos\phi \quad \frac{1=C\ V=7\ 3P6MWOTOR}{E \times 1{,}73 \times I}$$

FREQUENCY (HZ): THIS IS THE VALUE RELATING TO THE FREQUENCY OF THE ELECTRICITY GRID THAT THE MOTOR CAN BE CONNECTED TO. THE FREQUENCY IS DIRECTLY RELATED TO THE SPEED OF THE MOTOR. THE HIGHER THE FREQUENCY, THE HIGHER THE RPM (ROTATION PER MINUTE) THE LOWER THE FREQUENCY, THE LOWER THE RPM (ROTATION PER MINUTE)

RATED SPEED (RPM):

IT IS THE ROTATION PER MINUTE THAT THE ROTOR ROTATES, UNDER THE NOMINAL VOLTAGE, FREQUENCY AND POWER OF THE MOTOR.
SYNCHRONOUS SPEED (NS) THE SYNCHRONOUS SPEED OF A MOTOR (NS) IS DEFINED BY THE ROTATION SPEED OF THE ROTATING MAGNETIC FIELD, WHICH DEPENDS DIRECTLY ON THE NUMBER OF POLES (P) AND THE FREQUENCY (F) OF THE NETWORK, IN HERTZ. THEREFORE, THE SYNCHRONOUS SPEED OF A MOTOR IS GIVEN BY:

$$Ns\ \frac{1=C\ V\ 120\ X\ F}{7\ 3P6W}$$

Ns = Speed of the magnetic field F = Frequency of the network in Hertz (Hz) P = Number of poles of a motor

Nº de pólos	Rotação síncrona por minuto (rpm)	
	60 Hz	50 Hz
2	3.600	3.000
4	1.800	1.500
6	1.200	1.000
8	900	750
10	720	600

ENGINE PLATE DATA

SLIP (S): THIS DIFFERENCE BETWEEN THE MAGNETIC FIELD SPEED (NS) AND THE ROTOR SPEED (NR) IS CALLED AS SLIP (S). IT IS NORMALLY GIVEN IN PERCENTAGE (%):

$$S1 = \frac{C\ V\ N = S\ 7 - 3}{N6RW}$$

$$S(\%)1 = \frac{C\ V\ N = S\ 7\text{-}3\ N6RW \times 100}{NO.}$$

NO.
Ns = Speed of magnetic field
Nr = Speed of rotor S = Slip

ROTOR SPEED (NR) IS THE DIFFERENCE BETWEEN THE SPEED OF THE MAGNETIC FIELD AND THE SLIP

$$NR = 1\ \frac{C(\ V12 = 0\ 7X3}{F6\ W\ ) - S\ P}$$

1CV = 736W

NR = NS - S

THE SPEED OF THE ROTOR OF AN INDUCTION MOTOR UNDER LOAD IS ALWAYS LOWER THAN THE SPEED OF THE MAGNETIC FIELD. THE SPEED INDICATED ON THE PLATE IS THE SPEED OF THE ROTOR.

CATEGORIES(CAT):

THREE-PHASE INDUCTION MOTORS ARE CLASSIFIED INTO CATEGORIES ACCORDING TO THEIR TORQUE CHARACTERISTICS IN RELATION TO SPEED AND STARTING CURRENT. THESE CATEGORIES ARE DEFINED IN STANDARDS AND ARE DIVIDED INTO:

Categoria		Corrente de partida	Conjugado com rotor bloqueado	Conjugado máximo	% Escorregamento
NEMA MG1	NBR 7094				
A	--	Normal	Normal	Alto	Máximo 5%
B	N	Normal	Normal	Normal	Máximo 5%
C	H	Normal	Alto	Normal	Máximo 5%
D	D	Normal	Muito alto	--	Maior que 5%

ENGINE PLATE DATA

INSULATION CLASS: THIS IS THE MAXIMUM TEMPERATURE VALUE THAT A MOTOR CAN OPERATE WITHOUT BURNING ITS COILS.

CLASSE	TEMPERATURA (°C)
A	105
E	120
B	130
F	155
H	180

WORKING REGIME (REG): IS THE DEGREE OF REGULARITY OF THE LOAD TO WHICH THE ENGINE IS SUBJECT, THAT IS, THE REGIME CAN BE CONTINUOUS OR ALTERNATING. S1 – CONTINUOUS REGIME – OPERATION AT CONSTANT LOAD; S2 – LIMITED TIME REGIME – ALTERNATING OPERATION; S3 – PERIODIC INTERMITTENT REGIME – ALTERNATING OPERATION WITH DEFINED TIME.

PROTECTION RATING (IP):

IT IS THE CODE STANDARDIZED BY ABNT (BRAZILIAN ASSOCIATION OF TECHNICAL STANDARDS), COMPRISING 2 NUMBERS, WHICH DEFINES THE PROTECTION OF THE ENGINE AGAINST THE ENTRY OF WATER, DUST OR FOREIGN OBJECTS INTO THE ENGINE.

1ST DIGIT: INDICATES THE DEGREE OF PROTECTION AGAINST PENETRATION OF SOLID BODIES AND ACCIDENTAL CONTACTS. 2ND DIGIT: INDICATES THE DEGREE OF PROTECTION AGAINST PENETRATION OF WATER INSIDE THE ENGINE.

CHAPTER 04

DEVICE TESTING ELECTRIC

INTRODUCTION

INDUSTRIAL PANELS ARE RESPONSIBLE FOR SUPPLYING ELECTRICITY TO THE MOTOR AND CONTROLLING ITS OPERATION. THESE PANELS MAY INCLUDE COMPONENTS SUCH AS: CIRCUIT BREAKERS, RELAYS, PUSHBUTTONS, SIGNALS AND OTHER DEVICES THAT PLAY A CRUCIAL ROLE IN MOTOR CONTROL AND PROTECTION.

IF ANY OF THESE COMPONENTS IS DEFECTIVE OR NOT FUNCTIONING PROPERLY, THE ENGINE MAY NOT RECEIVE ADEQUATE POWER OR MAY BE OPERATED IMPROPERLY, WHICH COULD RESULT IN DAMAGE TO THE ENGINE.

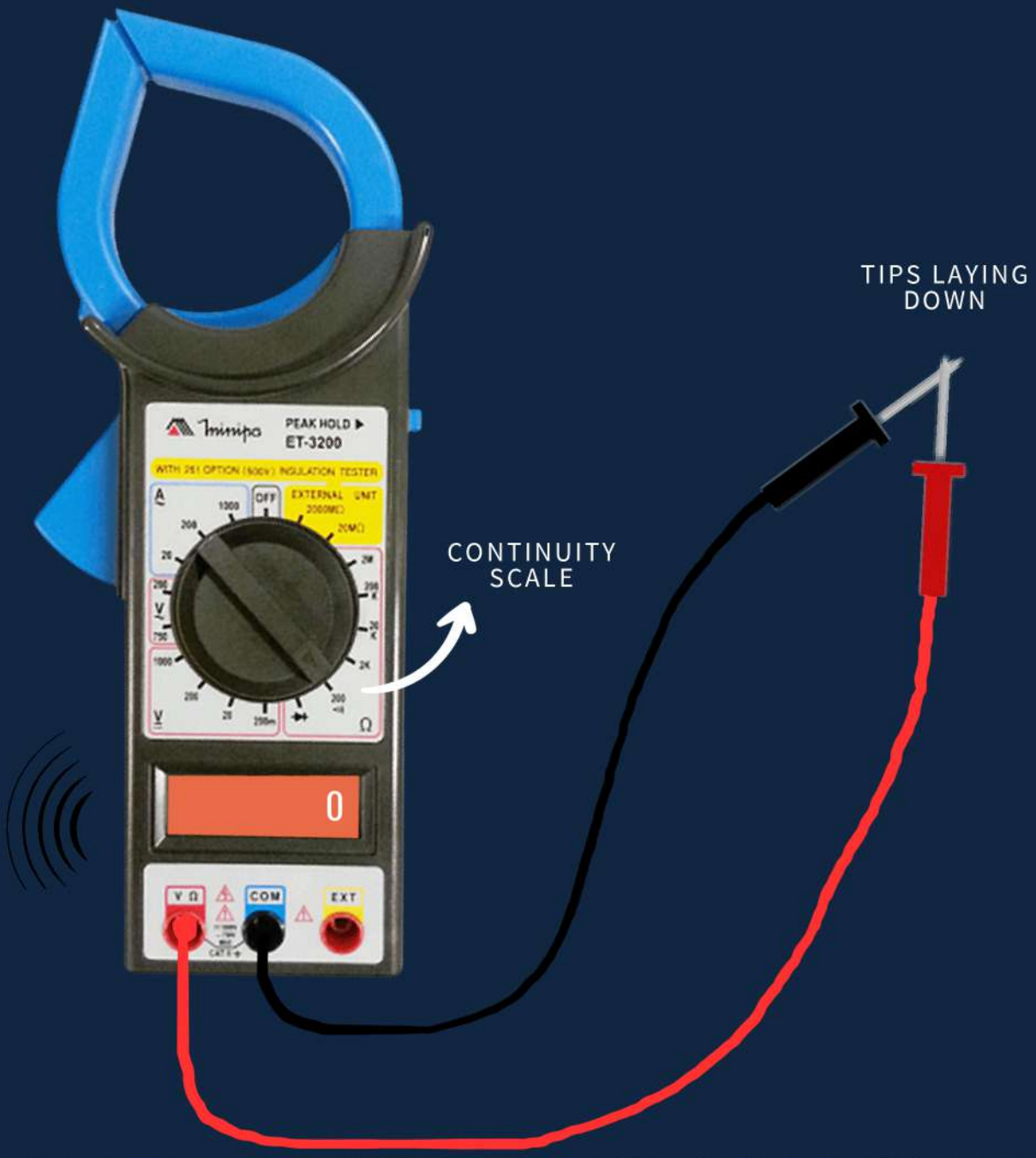
THEREFORE, BEFORE CONCLUDING THAT THE ENGINE IS IN PROBLEM, IT IS IMPORTANT TO TEST ALL COMPONENTS IN THE INDUSTRIAL PANEL TO ENSURE THAT THEY ARE FUNCTIONING PROPERLY AND PROVIDING ADEQUATE POWER TO THE ENGINE. THIS HELPS TO IDENTIFY THE ROOT CAUSE OF THE PROBLEM AND ALLOWS TECHNICIANS TO MAKE NECESSARY CORRECTIONS BEFORE REPLACING THE ENGINE OR TAKING OTHER MORE DRASTIC MEASURES.

IT IS IMPORTANT THAT PROFESSIONALS WHO WORK WITH ELECTRICAL CONTROLS LEARN HOW TO TROUBLESHOOTING INDUSTRIAL PANELS SO THAT THEY CAN IDENTIFY AND SOLVE ELECTRICAL PROBLEMS THAT MAY OCCUR DURING EQUIPMENT OPERATION. THIS INCLUDES KNOWLEDGE OF HOW TO TEST AND REPLACE COMPONENTS, HOW TO IDENTIFY AND SOLVE WIRING PROBLEMS, AND HOW TO PERFORM PREVENTIVE MAINTENANCE ON INDUSTRIAL PANELS.

CLAMPS AMMETER AND CONTIUITY

CLAMPS AMMETER

THE CLAMP METER IS A MEASURING INSTRUMENT THAT CAN BE USED TO MEASURE DIFFERENT ELECTRICAL QUANTITIES, SUCH AS ELECTRICAL VOLTAGE, ELECTRICAL CURRENT AND ELECTRICAL RESISTANCE. THE CONTINUITY TEST IS ONE OF THE OPERATING MODES OF THE CLAMP METER THAT ALLOWS YOU TO CHECKING IF A CIRCUIT OR ELECTRICAL COMPONENT IS CONDUCTING WITHOUT INTERRUPTIONS.

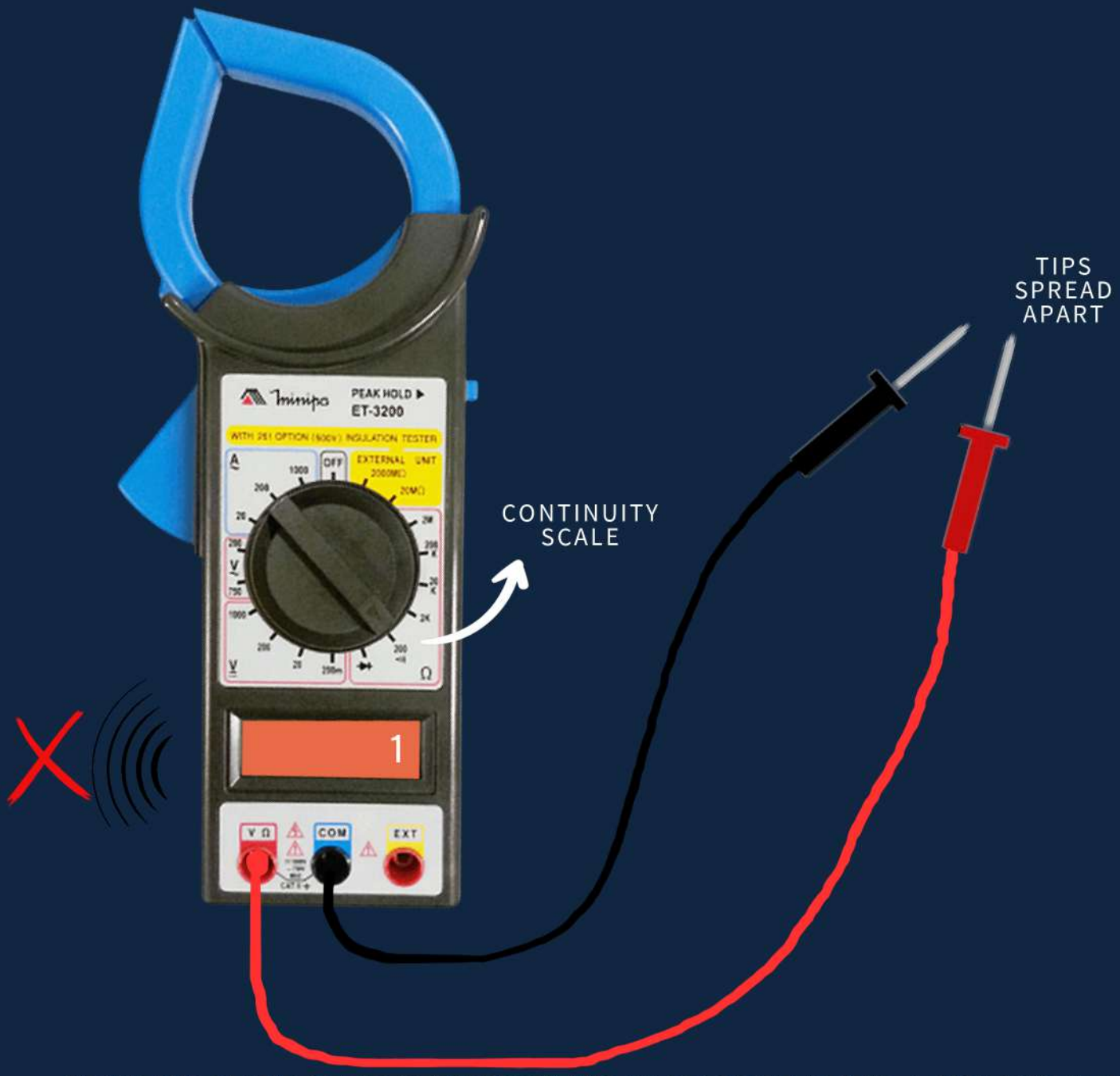


WHEN THE CLAMP METER IS SHOWING "0" OR BELOW "1", IT IS A SIGN THAT IT IS GIVING CONTINUITY AND THE CLAMP METER WILL EMIT A SOUND (BEEP)

CLAMPS AMMETER AND CONTIUITY

CLAMPS AMMETER

THE CLAMP METER IS A MEASURING INSTRUMENT THAT CAN BE USED TO MEASURE DIFFERENT ELECTRICAL QUANTITIES, SUCH AS ELECTRICAL VOLTAGE, ELECTRICAL CURRENT AND ELECTRICAL RESISTANCE. THE CONTINUITY TEST IS ONE OF THE OPERATING MODES OF THE CLAMP METER THAT ALLOWS YOU TO CHECKING IF A CIRCUIT OR ELECTRICAL COMPONENT IS CONDUCTING WITHOUT INTERRUPTIONS.



WHEN THE CLAMP METER IS REPRESENTING "1" OR GREATER. IT IS A SIGN THAT IT IS NOT GIVING CONTINUITY AND THE CLAMP METER WILL NOT EMIT

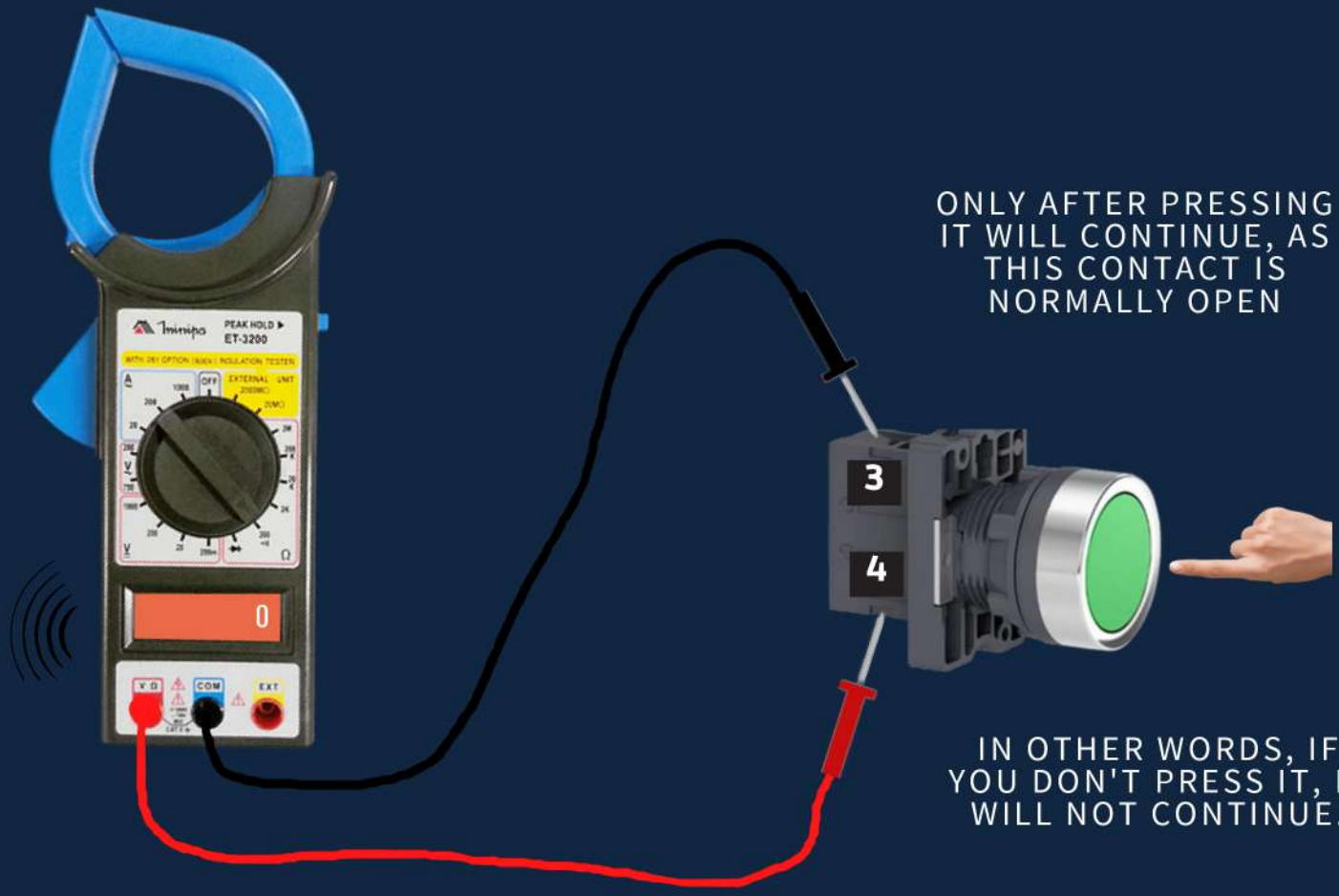
SOUND (BEEP)

PUSH BUTTON TESTING PUSH BUTTON TESTING WITH NORMALLY CLOSED CONTACT

IF YOU PRESS THE BUTTON, IT WILL NOT GIVE CONTINUITY, AS THIS CONTACT IS NORMALLY CLOSED

IN OTHER WORDS, IF WE DON'T PRESS THE BUTTON, IT WILL CONTINUE

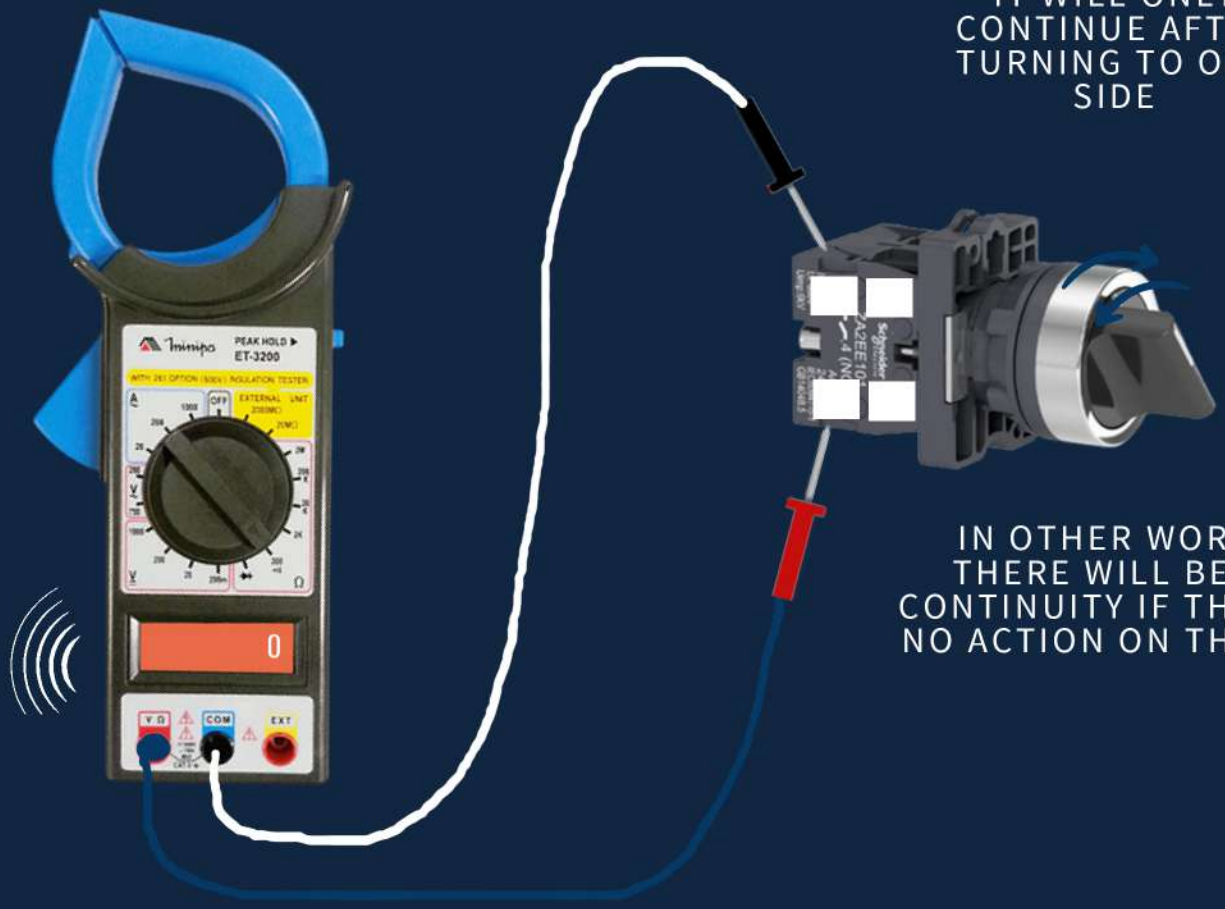
TESTING PUSHBUTTONS WITH NORMALLY OPEN CONTACT



ONLY AFTER PRESSING IT WILL CONTINUE, AS THIS CONTACT IS NORMALLY OPEN

IN OTHER WORDS, IF YOU DON'T PRESS IT, IT WILL NOT CONTINUE.

TEST OF SELECTOR SWITCH WITH NORMALLY OPEN CONTACT



IT WILL ONLY CONTINUE AFTER TURNING TO ONE SIDE

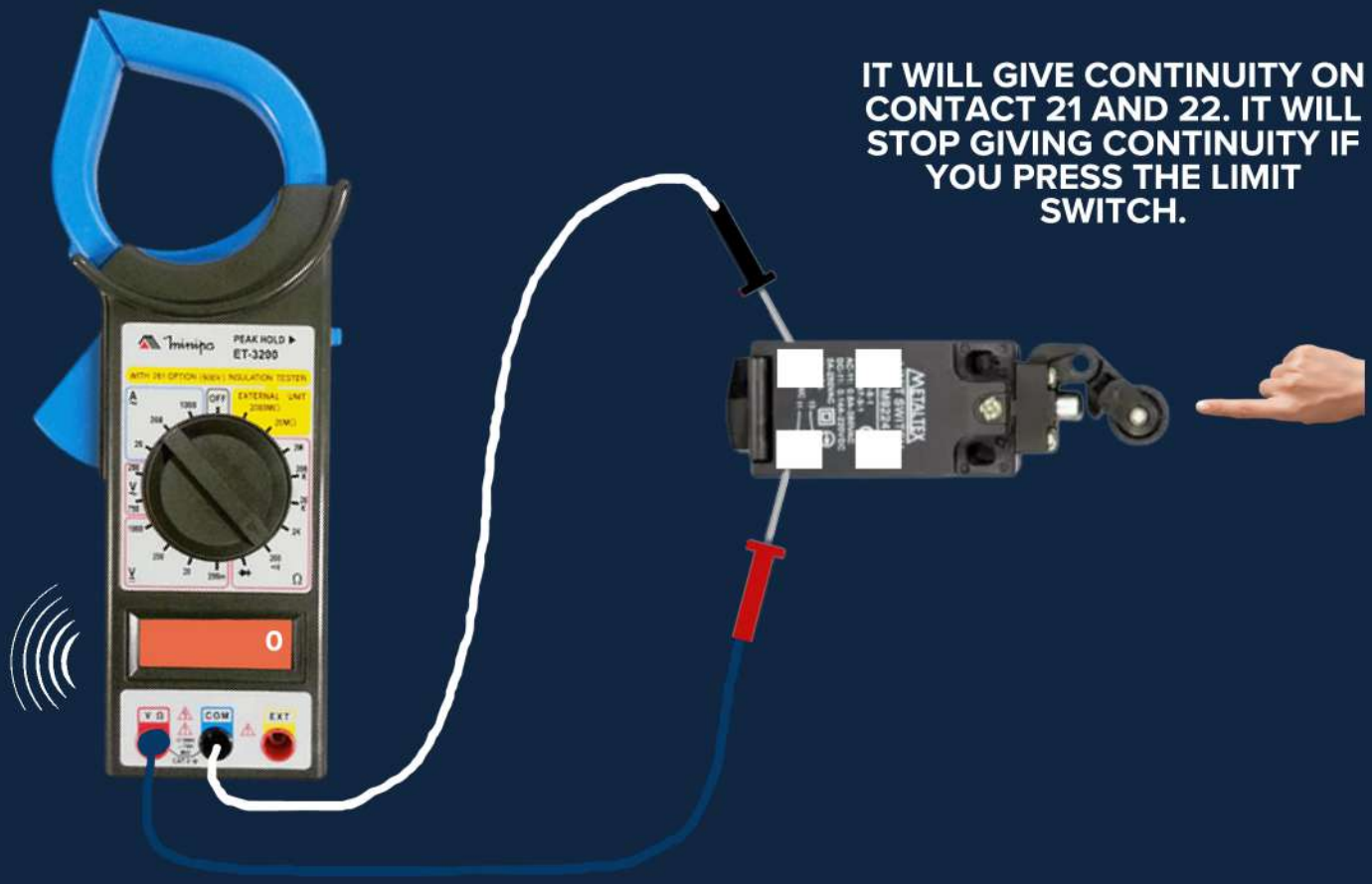
IN OTHER WORDS, THERE WILL BE NO CONTINUITY IF THERE IS NO ACTION ON THE KEY

TEST OF SELECTOR SWITCH WITH NORMALLY OPEN AND CLOSED CONTACT

IT WILL GIVE CONTINUITY ON CONTACT 1 AND 2. IT WILL STOP GIVING CONTINUITY IF YOU TURN THE KEY TO THAT SIDE

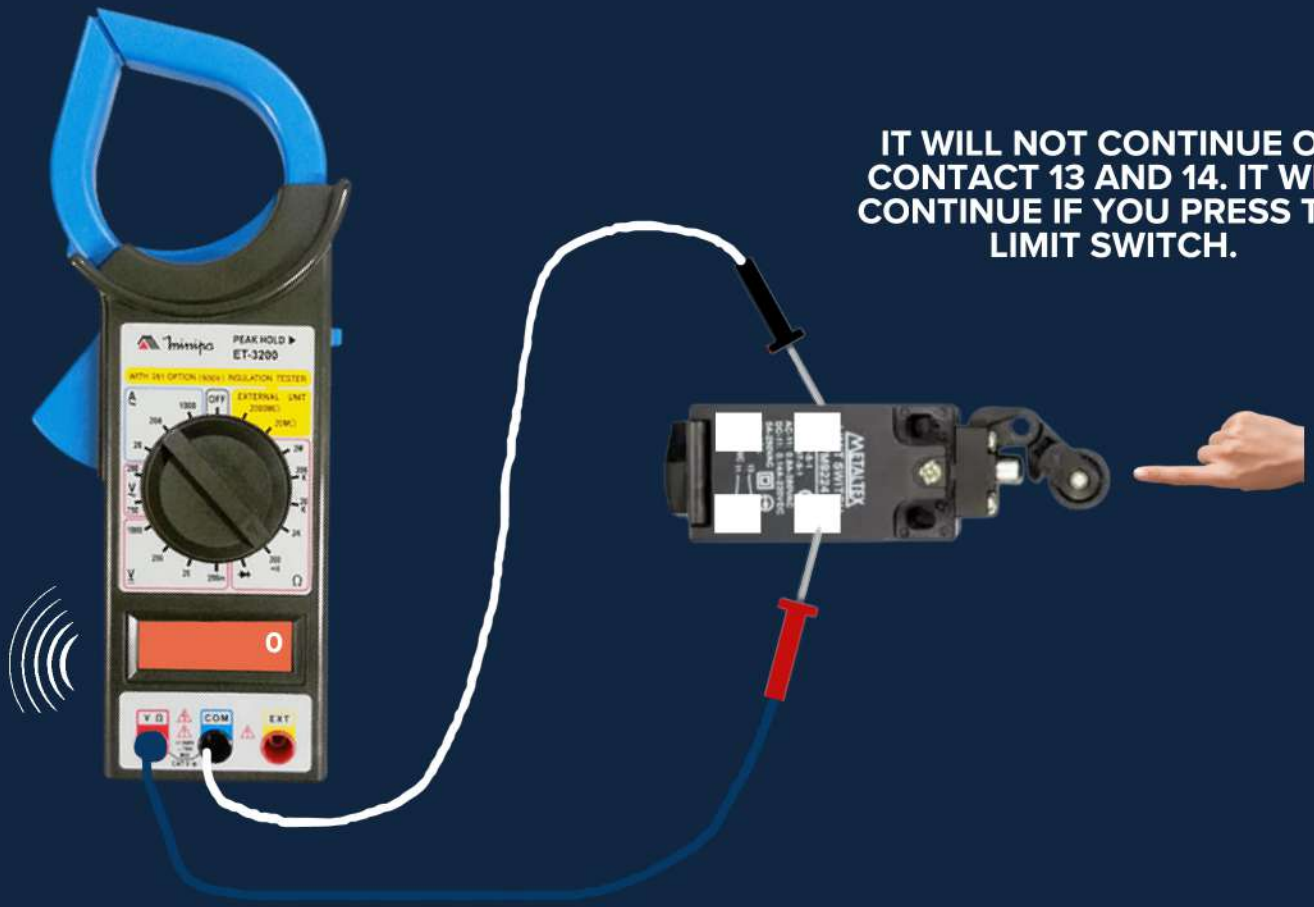
IT WILL NOT GIVE CONTINUITY ON CONTACT 3 AND 4. IT WILL GIVE CONTINUITY IF YOU TURN THE KEY TO THAT SIDE.

TEST OF SELECTOR SWITCH WITH NORMALLY OPEN CONTACT



IT WILL GIVE CONTINUITY ON CONTACT 21 AND 22. IT WILL STOP GIVING CONTINUITY IF YOU PRESS THE LIMIT SWITCH.

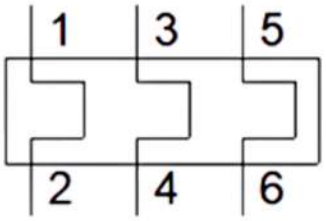
TEST OF SELECTOR SWITCH WITH NORMALLY OPEN AND CLOSED CONTACT



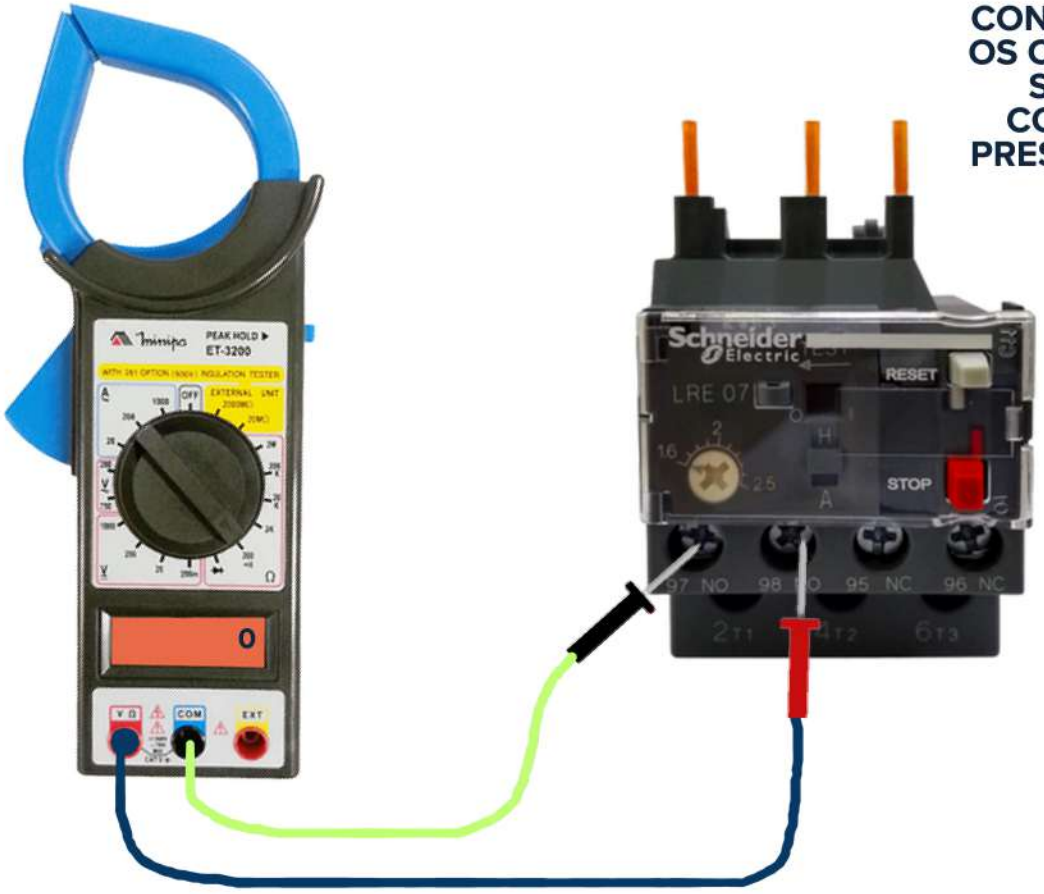
IT WILL NOT CONTINUE ON CONTACT 13 AND 14. IT WILL CONTINUE IF YOU PRESS THE LIMIT SWITCH.

TESTE DE RELÉ TÉRMICO - CONTATOS PRINCIPAIS

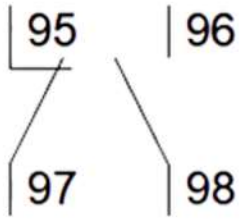
DARÁ CONTINUIDADE NOS CONTATOS 1-2/ 3-4/ 5-6.



TESTE DE RELÉ TÉRMICO - CONTATOS AUXILIARES

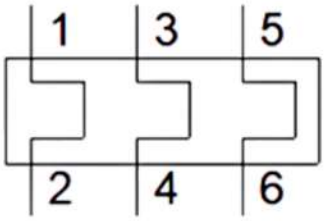


NÃO DARÁ CONTINUIDADE ENTRE OS CONTATOS 97 E 98. SOMENTE DARÁ CONTINUIDADE SE PRESSIONAR O BOTÃO STOP



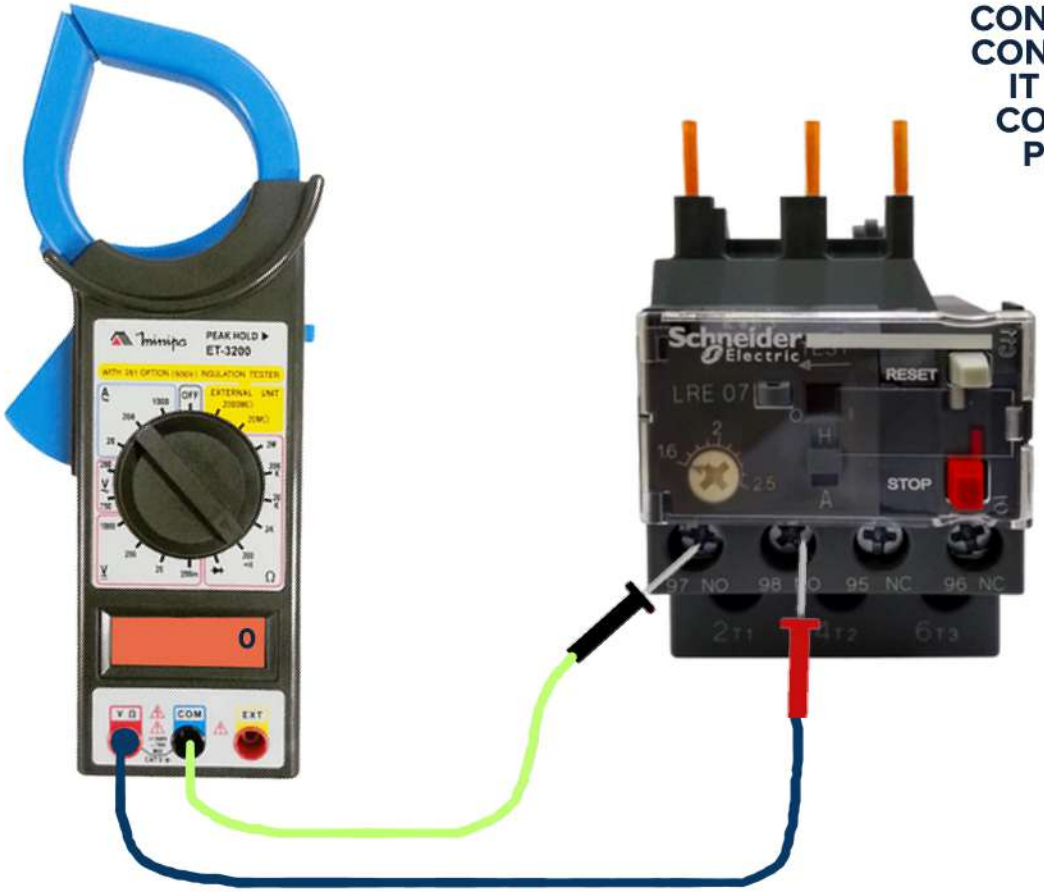
THERMAL RELAY TEST - MAIN CONTACTS

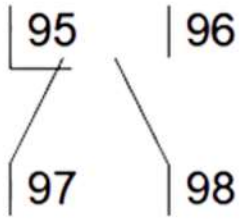
WILL CONTINUE CONTACTS 1-2/ 3- 4/ 5-6.



THERMAL RELAY TEST - AUXILIARY CONTACTS

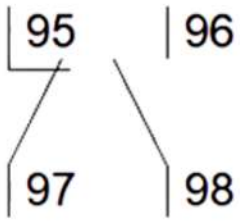
IT WILL NOT GIVE CONTINUITY BETWEEN CONTACTS 97 AND 98. IT WILL ONLY GIVE CONTINUITY IF YOU PRESS THE STOP BUTTON





THERMAL RELAY TEST - MAIN CONTACTS

IT WILL GIVE CONTINUITY BETWEEN CONTACTS 95 AND 96. IT WILL ONLY NOT GIVE CONTINUITY IF YOU PRESS THE STOP BUTTON



CONTACTOR TEST - COIL

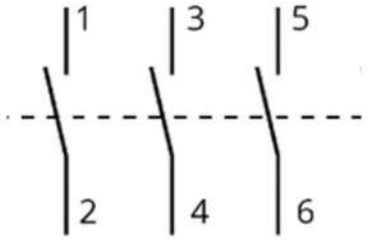
IT WILL GIVE CONTINUITY AND IT IS POSSIBLE TO CHECK THE COIL RESISTANCE BY CHANGING TO THE RESISTANCE SCALE.

RESISTANCE ABOVE 200 OHMS IS ACCEPTABLE

IF IT DOES NOT GENERATE ANY RESISTANCE, THE COIL MAY BE DEFECTIVE

CONTACTOR TEST - POWER CONTACTS

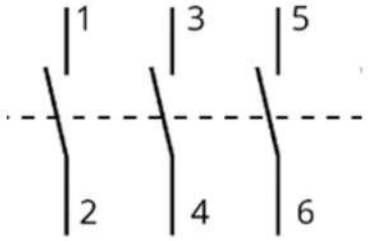
WILL GIVE CONTINUITY ON CONTACTS 1-2 / 3-4 / 5-6 WHEN PRESSING THE MIDDLE OF THE CONTACTOR



CONTACTOR TEST - POWER CONTACTS

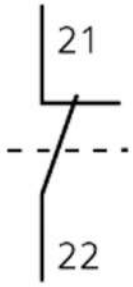
THERE SHOULD NOT BE CONTINUITY BETWEEN THE MAIN CONTACTS: 1-3 / 3-5 / 5-1, FOR EXAMPLE. BECAUSE IF THERE IS CONTINUITY, IT WILL CAUSE A SHORT CIRCUIT AT THE MOMENT OF

ENGINE STARTING



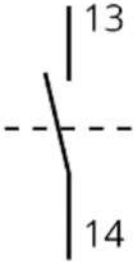
CONTACTOR TEST - AUXILIARY CONTACTS NORMALLY CLOSED

WILL GIVE CONTINUITY. IF YOU PRESS THE MIDDLE OF THE CONTACTOR IT WILL STOP GIVING CONTINUITY, SINCE THE CONTACT IS NORMALLY CLOSED



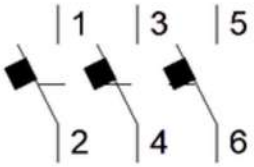
CONTACTOR TEST - AUXILIARY CONTACTS NORMALLY OPEN

IT WILL NOT GIVE CONTINUITY. IF YOU PRESS THE MIDDLE OF THE CONTACTOR IT WILL GIVE CONTINUITY, SINCE THE CONTACT IS NORMALLY OPEN



THERMOMAGNETIC CIRCUIT BREAKER TEST

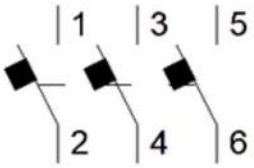
IT WILL GIVE CONTINUITY ON CONTACTS 1-2 / 3-4 / 5-6 IF THE CIRCUIT BREAKER IS IN ON MODE. IF IT IS IN OFF MODE, IT WILL NOT GIVE CONTINUITY



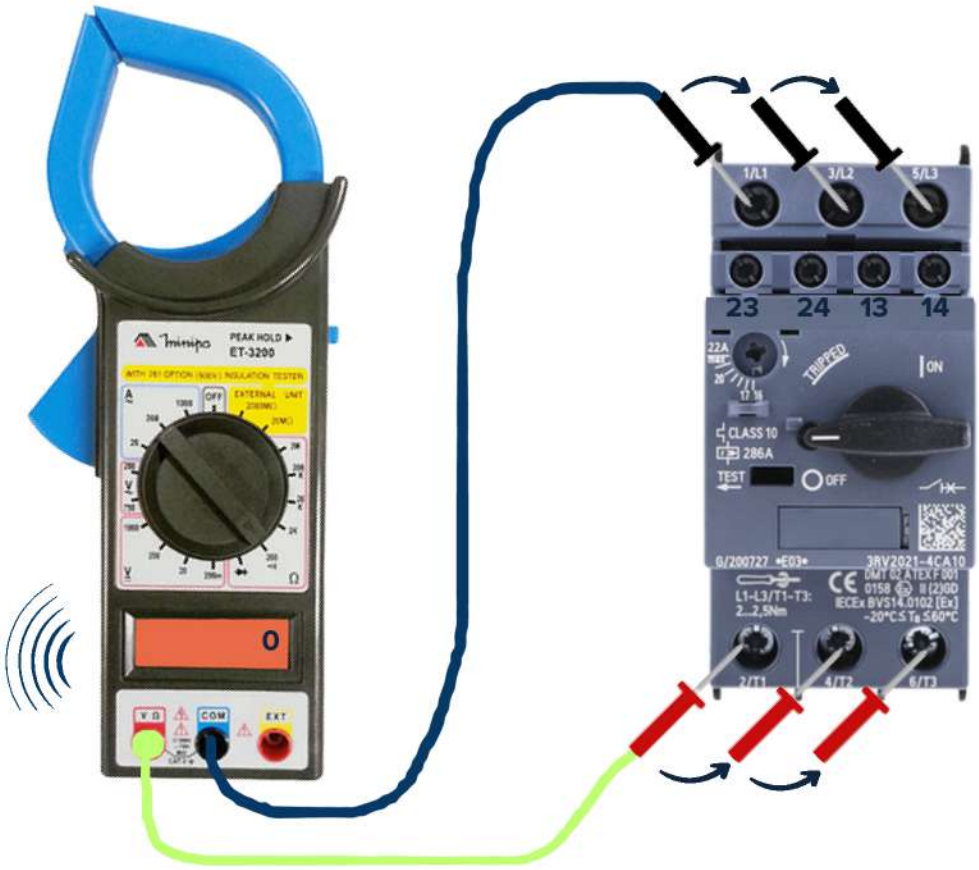
THERMOMAGNETIC CIRCUIT BREAKER TEST

THERE SHOULD NOT BE CONTINUITY BETWEEN CONTACTS 1- 3 / 3-5 / 5-1, FOR EXAMPLE. BECAUSE IF THERE IS CONTINUITY, IT WILL CAUSE A SHORT CIRCUIT AT THE MOMENT OF

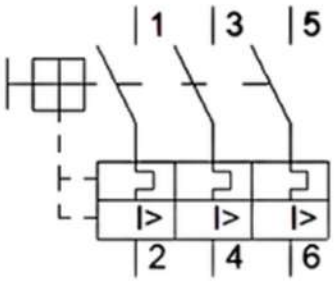
ENGINE STARTING



MOTOR CIRCUIT BREAKER TEST - MAIN CONTACTS



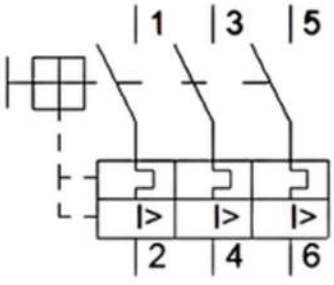
IT WILL GIVE CONTINUITY ON CONTACTS 1-2 / 3-4 / 5-6 IF THE MOTOR CIRCUIT BREAKER IS IN ON MODE. IF IT IS IN OFF MODE, IT WILL NOT GIVE CONTINUITY



MOTOR CIRCUIT BREAKER TEST - MAIN CONTACTS

THERE SHOULD NOT BE CONTINUITY BETWEEN CONTACTS 1- 3 / 3-5 / 5-1, FOR EXAMPLE. BECAUSE IF THERE IS CONTINUITY, IT WILL CAUSE A SHORT CIRCUIT AT THE MOMENT OF

ENGINE STARTING



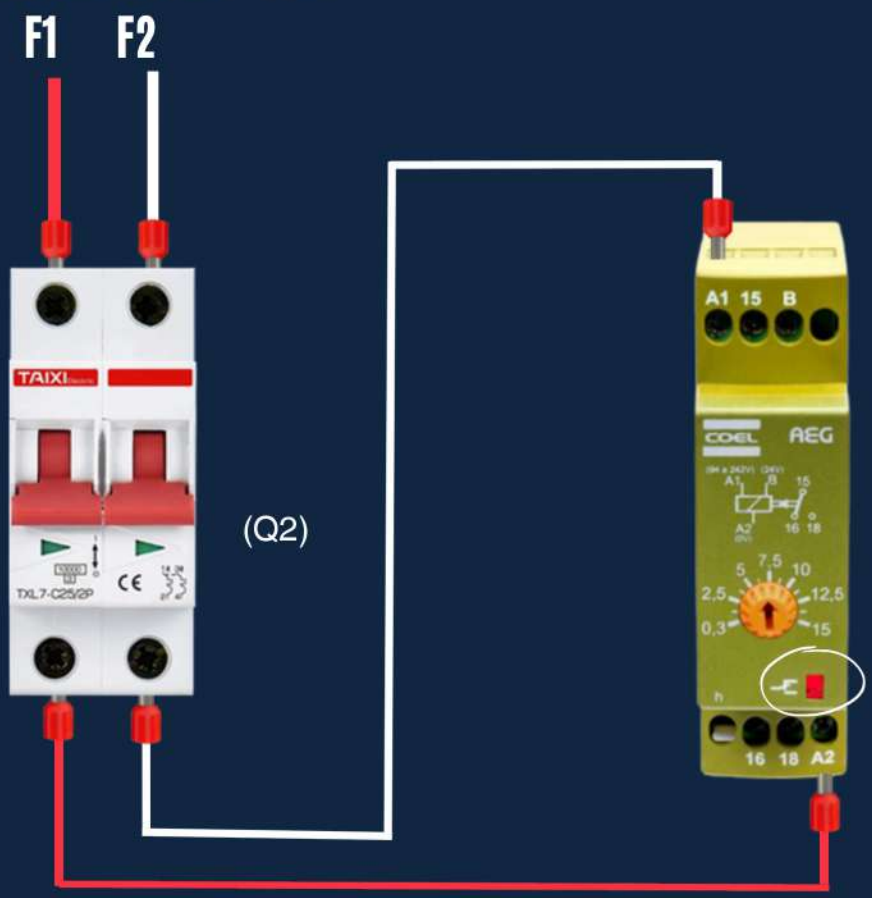
MOTOR CIRCUIT BREAKER TEST - AUXILIARY CONTACTS

IT WILL GIVE CONTINUITY IF THE MOTOR CIRCUIT BREAKER IS IN OFF MODE. IF THE MOTOR CIRCUIT BREAKER IS IN ON MODE, IT WILL NOT GIVE CONTINUITY

MOTOR CIRCUIT BREAKER TEST - AUXILIARY CONTACTS

IT WILL NOT GIVE CONTINUITY IF THE MOTOR CIRCUIT BREAKER IS IN OFF MODE. IF THE MOTOR CIRCUIT BREAKER IS IN ON MODE, IT WILL GIVE CONTINUITY

ON DELAY RELAY TEST - COIL



IT IS NECESSARY TO POWER THE RELAY AND CHECK IF THE INTERNAL RELAY IS BEING ACTIVATED

RELAY ACTIVATED INDICATION

RELAY ON DELAY TEST - AUXILIARY CONTACTS

IT WILL GIVE CONTINUITY IF THE RELAY IS OFF. IF THE RELAY IS POWERED, IT WILL NOT GIVE CONTINUITY AFTER A CERTAIN TIME

RELAY ON DELAY TEST - AUXILIARY CONTACTS

IT WILL NOT GIVE CONTINUITY IF THE RELAY IS OFF. IF THE RELAY IS POWERED, IT WILL GIVE CONTINUITY AFTER A CERTAIN TIME

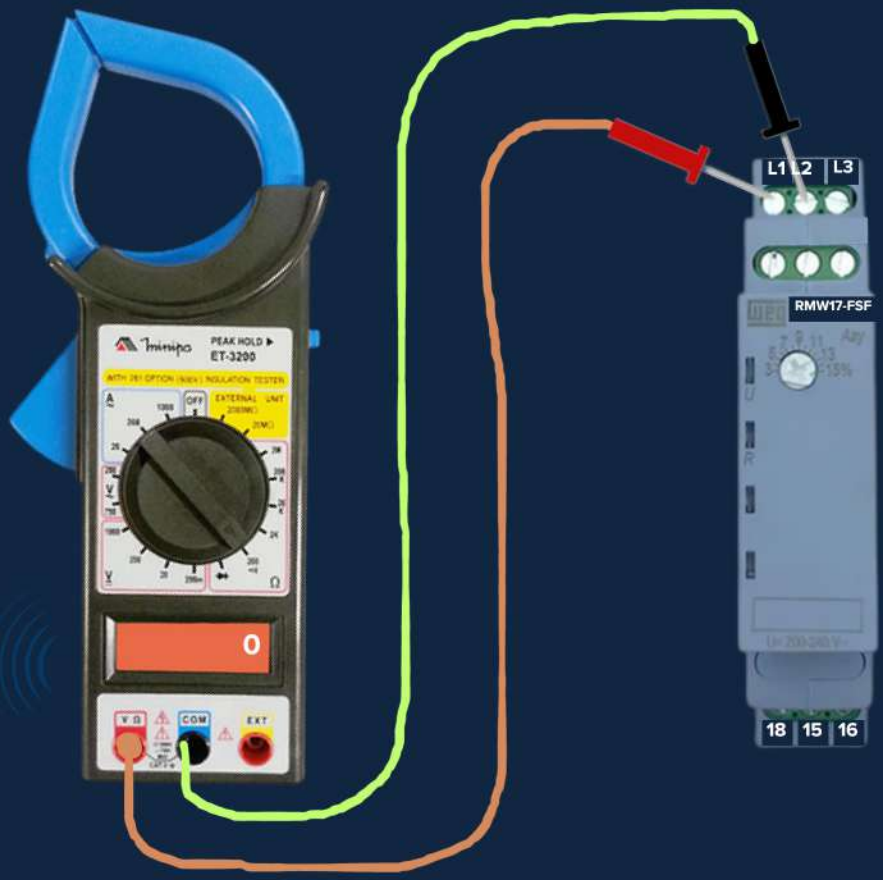
RELAY ON DELAY TEST - AUXILIARY CONTACTS

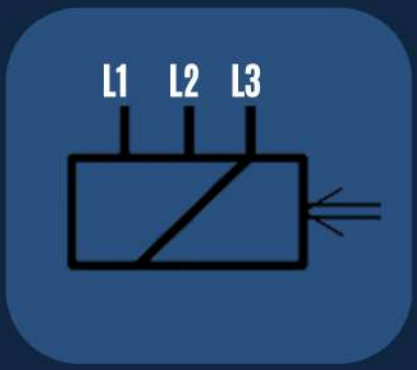
16-18 WILL NOT GIVE CONTINUITY EVEN IF THE RELAY IS ON OR OFF

RELAY TEST PHASE LACK

THERE SHOULD NOT BE CONTINUITY BETWEEN CONTACTS L1- L2 / L2-L3 / L3-L1, FOR EXAMPLE. BECAUSE IF THERE IS CONTINUITY IT WILL CAUSE A SHORT CIRCUIT AT THE MOMENT OF

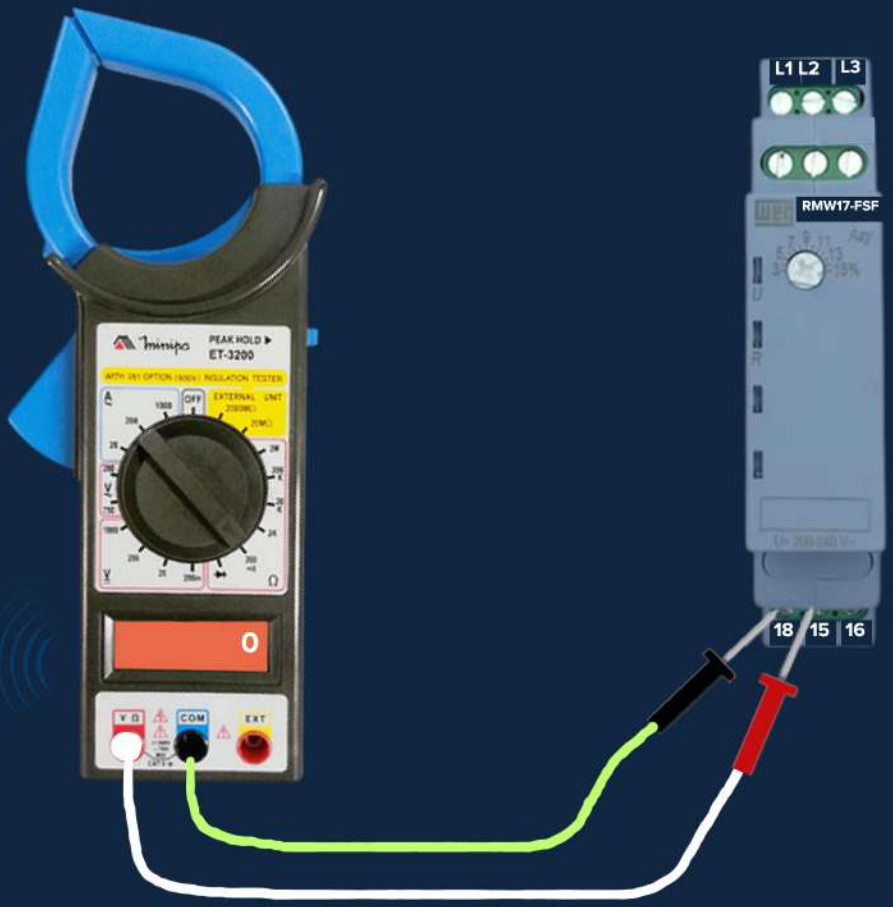
ENGINE STARTING



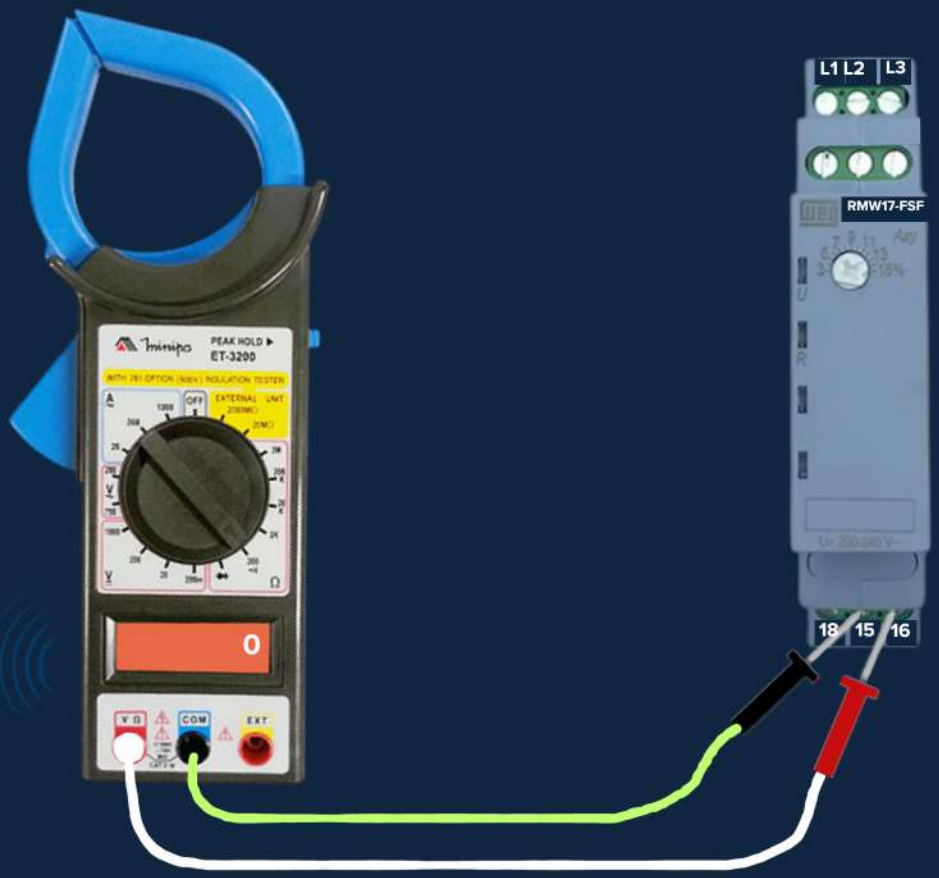


RELAY TEST PHASE LACK - AUXILIARY CONTACTS

IT WILL NOT GIVE CONTINUITY IF THE RELAY IS POWERED WITH THE 3 PHASES IN L1, L2 AND L3. IT WILL GIVE CONTINUITY IF THE RELAY IS NOT POWERED WITH THE PHASES

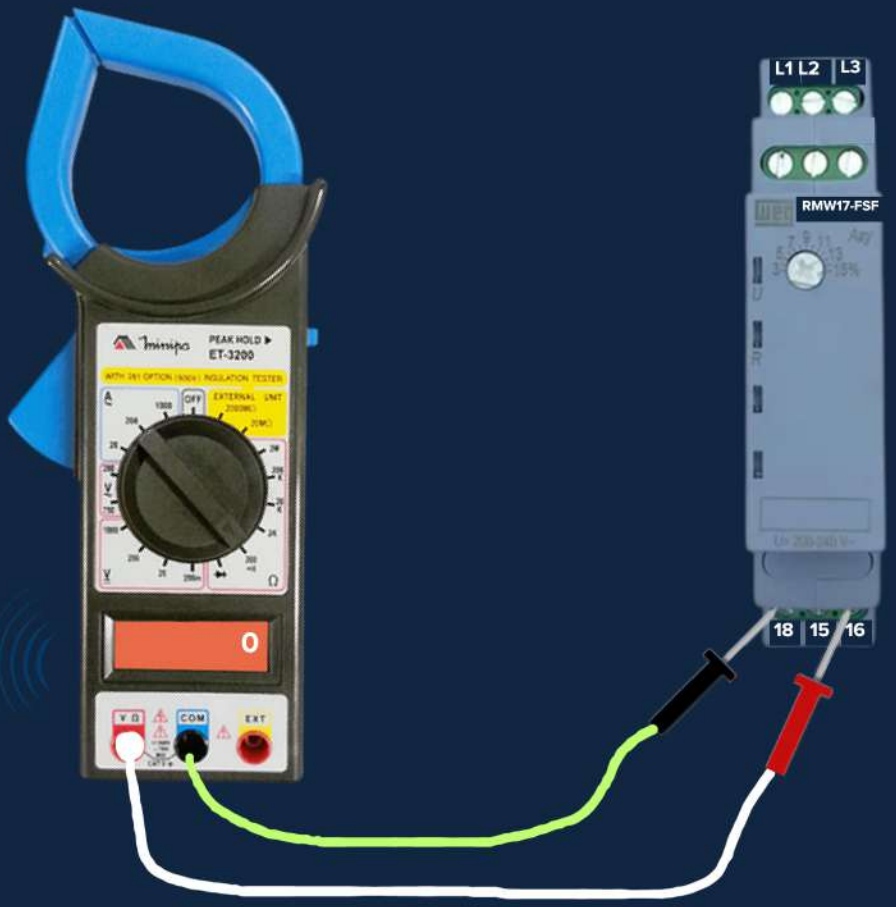


RELAY TEST PHASE LACK - AUXILIARY CONTACTS



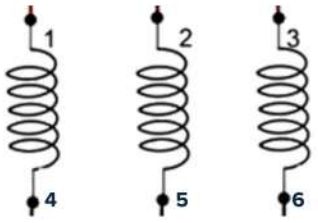
IT WILL GIVE CONTINUITY IF THE RELAY IS POWERED WITH THE 3 PHASES IN L1, L2 AND L3. IT WILL NOT GIVE CONTINUITY IF THE RELAY IS NOT POWERED WITH THE PHASES

RELAY TEST PHASE LACK - AUXILIARY CONTACTS

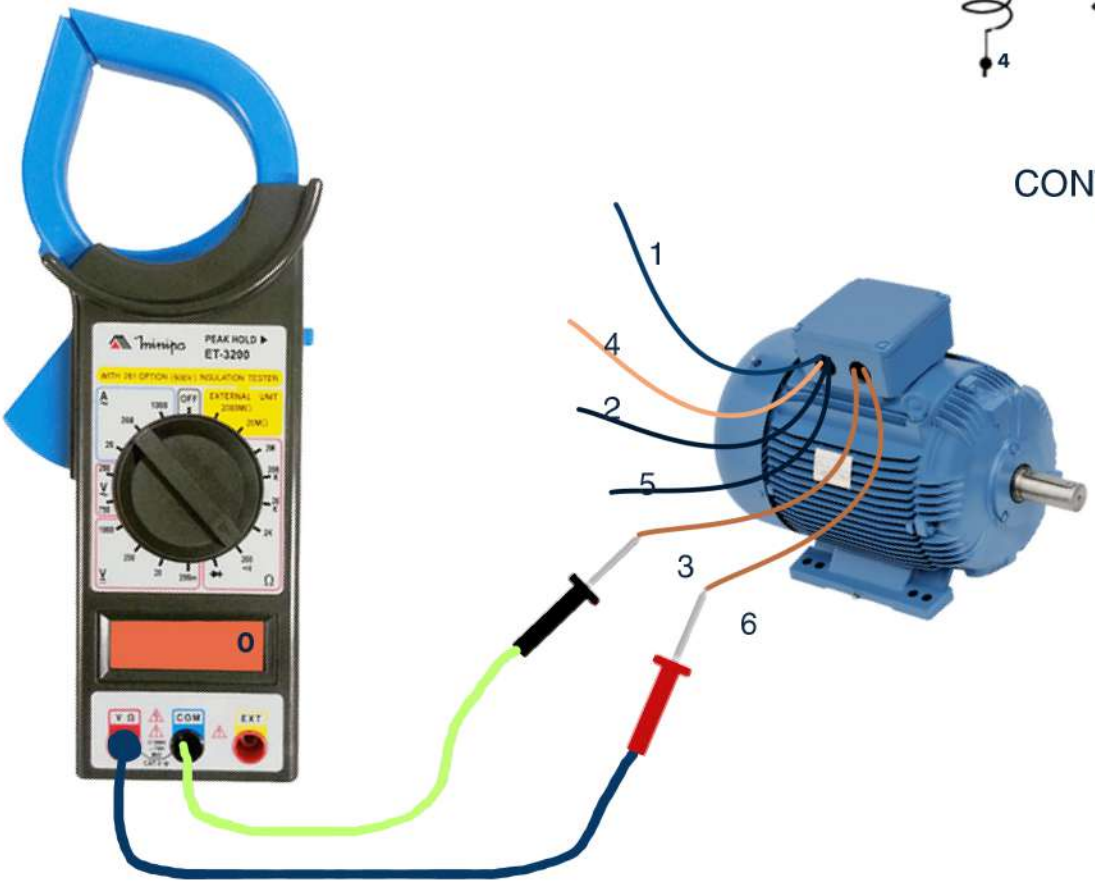


18-16 WILL NOT GIVE CONTINUITY EVEN IF THE RELAY IS POWERED WITH ALL 3 PHASES OR NOT.

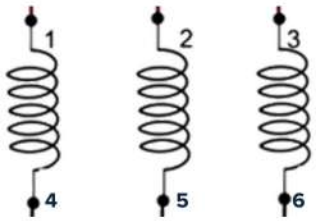
MOTOR COIL TESTING



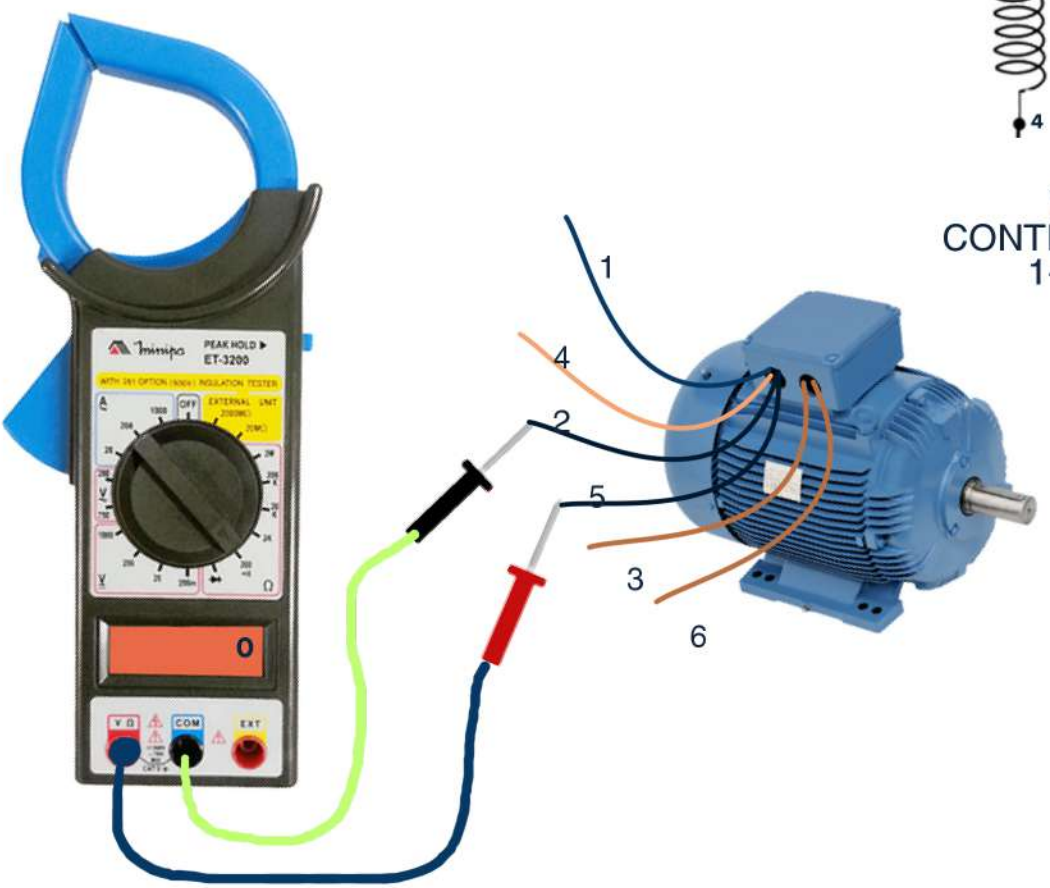
WILL GIVE
CONTINUITY IN REELS
1-4 / 2-5 / 3-6



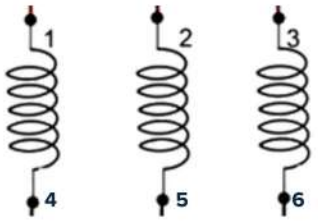
MOTOR COIL TESTING



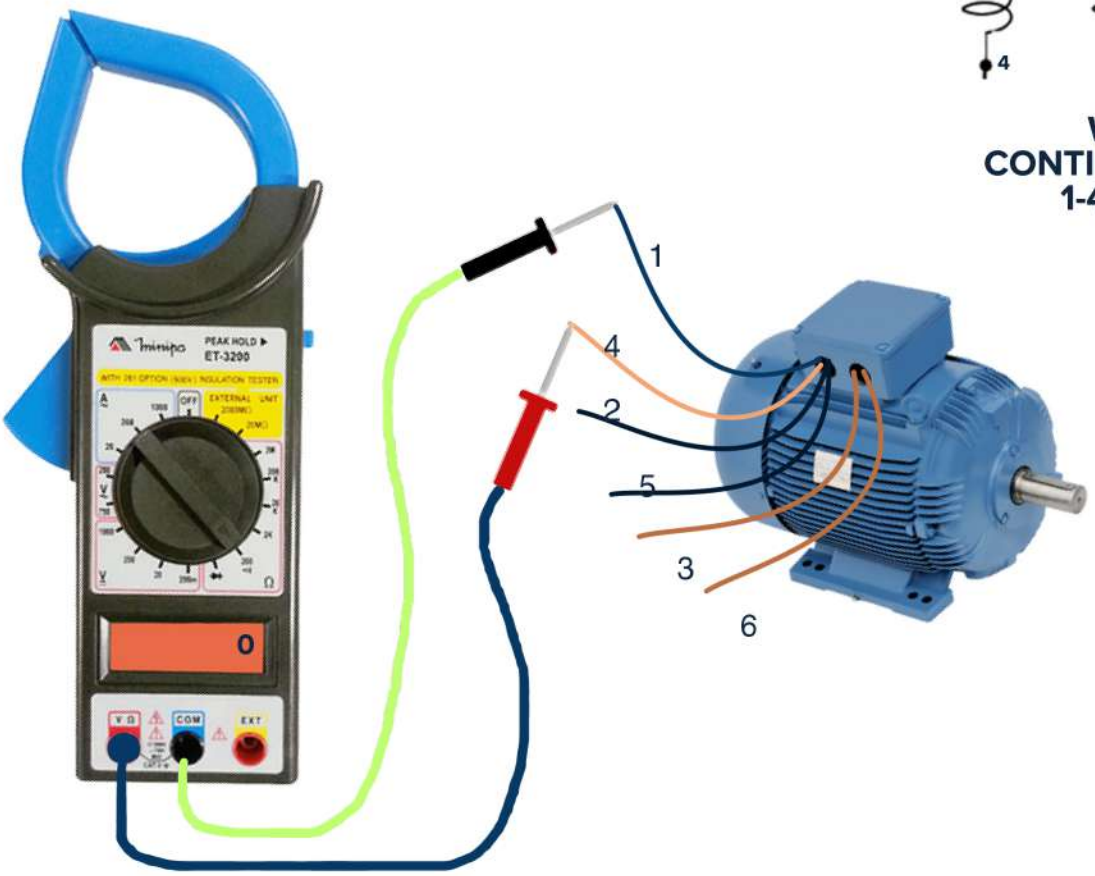
WILL GIVE
CONTINUITY IN REELS
1-4 / 2-5 / 3-6



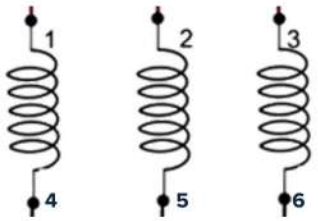
MOTOR COIL TESTING



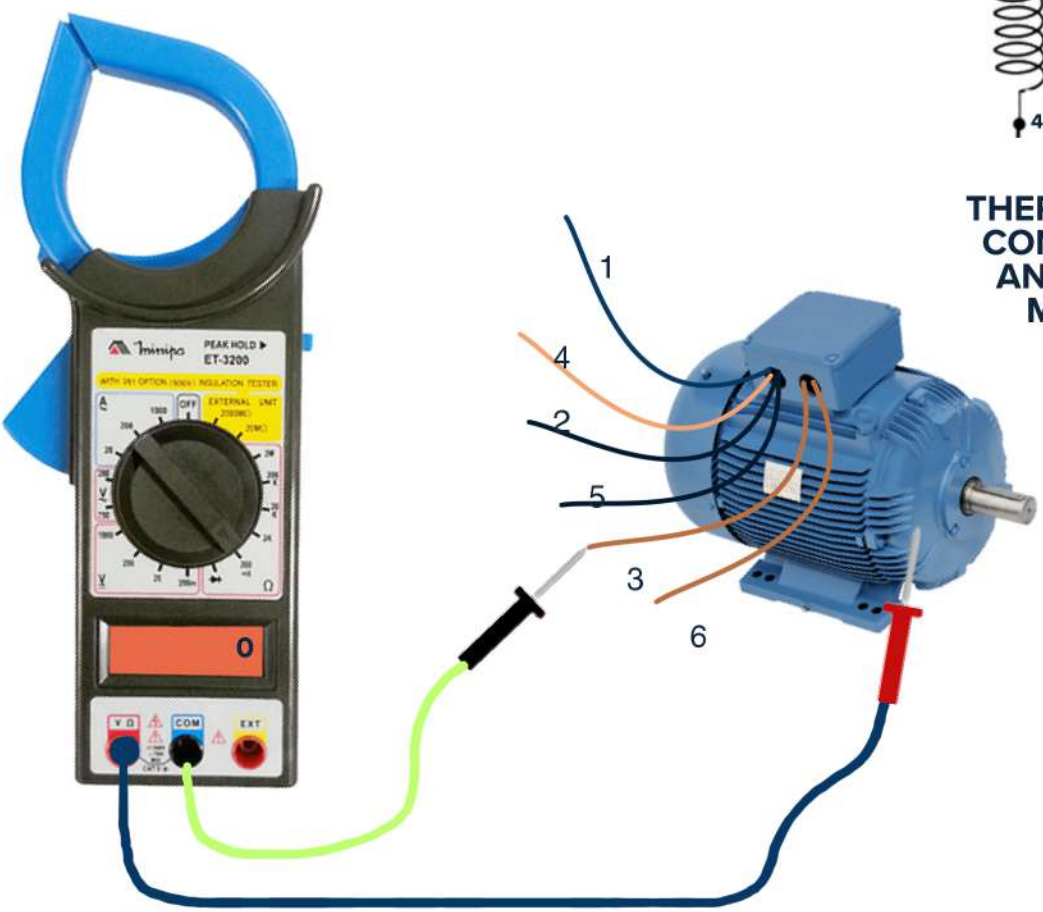
WILL GIVE CONTINUITY IN REELS 1-4 / 2-5 / 3-6



MOTOR COIL TESTING



THERE MUST NOT BE CONTINUITY FROM ANY COIL TO THE MOTOR CASE



ENGINE PLATE DATA

TABLES RELATING TO THE DEGREE OF PROTECTION OF MOTORS

1° Algarismo	
Algarismo	Indicação
0	Sem proteção
1	Proteção contra a entrada de corpos estranhos de dimensões acima de 50mm
2	Proteção contra a entrada de corpos estranhos de dimensões acima de 12mm
3	Proteção contra a entrada de corpos estranhos de dimensões acima de 2,5mm
4	Proteção contra a entrada de corpos estranhos de dimensões acima de 1,0mm
5	Proteção contra acúmulo de poeiras prejudiciais ao motor
6	Totalmente protegido contra poeira

2° Algarismo	
Algarismo	Indicação
0	Sem proteção
1	Proteção contra pingos de água na vertical
2	Proteção contra pingos de água até a inclinação de 15° com relação à vertical
3	Proteção contra pingos de água até a inclinação de 60° com relação à vertical
4	Proteção contra respingos vindos de todas as direções
5	Proteção contra jatos de água vindos de todas as direções
6	Proteção contra água de vagalhões
7	Imersão temporária
8	Imersão permanente

AS THIS MOTOR HAS A PROTECTION DEGREE OF IP55, IT MEANS THAT THIS MOTOR HAS PROTECTION AGAINST: ACCUMULATION OF HARMFUL DUST (1ST DIGIT = 5) AND WATER JETS IN ALL DIRECTIONS (2ND DIGIT = 5)

FUNDAMENTALS OF ELECTRICITY

ELECTRICAL QUANTITIES

THE MAIN ELECTRICAL MAGNITUDES ARE: ELECTRICAL VOLTAGE, ELECTRICAL CURRENT, ELECTRICAL RESISTANCE AND ELECTRICAL POWER.

ELECTRICAL VOLTAGE - V

ELECTRIC VOLTAGE, MEASURED IN VOLTS (V), IS THE DIFFERENCE IN ELECTRIC POTENTIAL BETWEEN TWO POINTS IN A CIRCUIT. IT REPRESENTS THE FORCE THAT PUSHES ELECTRONS IN A CIRCUIT, CAUSING THE FLOW OF ELECTRIC CURRENT. VOLTAGE IS RESPONSIBLE FOR CREATING THE MOVEMENT OF ELECTRONS AND ALLOWS ELECTRIC ENERGY TO BE TRANSFERRED FROM A SOURCE TO A CONSUMER.

ELECTRIC CURRENT - A

ELECTRIC CURRENT, MEASURED IN AMPERES (A), IS THE FLOW OF ELECTRIC CHARGE IN A CIRCUIT. CURRENT IS GENERATED BY THE DIFFERENCE IN POTENTIAL (VOLTAGE) APPLIED IN A CIRCUIT AND IS INFLUENCED BY ITS RESISTANCE.

ELECTRICAL RESISTANCE - Ω

ELECTRICAL RESISTANCE, MEASURED IN OHMS (Ω), IS THE OPPOSITION TO CURRENT FLOW IN A CIRCUIT.

ELECTRICAL POWER (DC) - W

ELECTRICAL POWER, MEASURED IN WATTS (W), IS THE RATE OF TRANSFER OF ELECTRICAL ENERGY IN A CIRCUIT. IT REPRESENTS THE AMOUNT OF ENERGY CONSUMED OR SUPPLIED BY AN ELECTRICAL DEVICE IN A GIVEN PERIOD OF TIME.

SIZING OF ELECTRICAL DEVICES

INTRODUCTION

IN THIS CHAPTER, WE WILL LEARN HOW TO SIZING INDUSTRIAL ELECTRICAL CONTROL DEVICES. AS WE ALREADY KNOW, THESE DEVICES ARE RESPONSIBLE FOR STARTING, SHUTTING DOWN AND CONTROLLING ELECTRICAL EQUIPMENT PRESENT IN INDUSTRIAL MACHINES AND PROCESSES. THEREFORE, IT IS CRUCIAL THAT THEY ARE SIZING CORRECTLY TO ENSURE THE PROPER OPERATION OF THE ELECTRICAL SYSTEM AS A WHOLE.

INADEQUATE SIZING OF ELECTRICAL CONTROL DEVICES CAN LEAD TO A SERIES OF PROBLEMS, SUCH AS ELECTRICAL OVERLOAD, SHORT CIRCUITS, EQUIPMENT FAILURES, PRODUCTION STOPPAGES, LOSS OF MATERIALS AND, IN EXTREME CASES, ACCIDENTS AND SAFETY RISKS FOR WORKERS.

THEREFORE, IT IS ESSENTIAL THAT PROFESSIONALS INVOLVED IN INDUSTRIAL ELECTRICAL PROJECTS KNOW HOW TO DIMENSION THESE DEVICES CORRECTLY AND ACCURATELY. THIS INVOLVES KNOWING THE ELECTRICAL DEMANDS OF EACH EQUIPMENT, CHOOSING THE APPROPRIATE DEVICES FOR EACH APPLICATION AND MAKING ELECTRICAL CONNECTIONS SAFELY AND RELIABLE.

THROUGHOUT THIS CHAPTER, YOU WILL LEARN THE MAIN CONCEPTS AND TECHNIQUES INVOLVED IN SIZING INDUSTRIAL ELECTRICAL CONTROL DEVICES, AND YOU WILL SEE PRACTICAL EXAMPLES OF HOW TO APPLY THEM IN REAL PROJECTS.

WITH THIS KNOWLEDGE IN YOUR HANDS, YOU WILL BE PREPARED TO CREATE

EFFICIENT, SAFE AND RELIABLE INDUSTRIAL ELECTRICAL PROJECTS.

LET'S GO, HERE?

SIZING OF ELECTRICAL CONDUCTORS

STEP 1 – CHECK: • TYPE OF CONDUCTOR INSULATION (PVC; XLPE; ETC..) • CHECK THE INSTALLATION LOCATION (EMBEDDED; ELECTRICAL TRAY; BED; ETC.) • HOW MANY CONDUCTORS FEED THE CIRCUIT (2; 3 CONDUCTORS) • ENVIRONMENT TEMPERATURE • HOW MANY CIRCUITS WILL PASS THROUGH THE SECTION STEP 2 – CALCULATE THE DESIGN CURRENT OR GET THE NOMINAL CURRENT FROM THE MOTOR PLATE:

$$I_P = \frac{P_N}{\sqrt{3}.V.\cos\varphi\ .\eta}$$

$I_P = Corrente\ de\ projeto\ do\ circuito\ (A)$
$P_N = Potência\ elétrica\ nominal\ do\ circuito\ (W)$
$V = Tensão\ nominal\ (V)$
$\eta = Rendimento$
$\cos\varphi = Fator\ de\ potência$

DESIGN CURRENT = MOTOR RATED CURRENT

STEP 3 – CALCULATE THE CORRECTED DESIGN CORRECTION:

$$I'_P = \frac{I_N\ .fs}{FCT\ .\ FCA}$$

I'_P = corrente de projeto corrigida
$I_N = corrente\ nominal\ do\ motor$
$fs = fator\ de\ serviço\ do\ motor$
FCT = fator de correção de temperatura
FCA = fator de correção de agrupamento

SIZING OF ELECTRICAL CONDUCTORS

STEP 4 – CHECK IN THE TABLE WHICH DRIVER IS MOST SUITABLE:

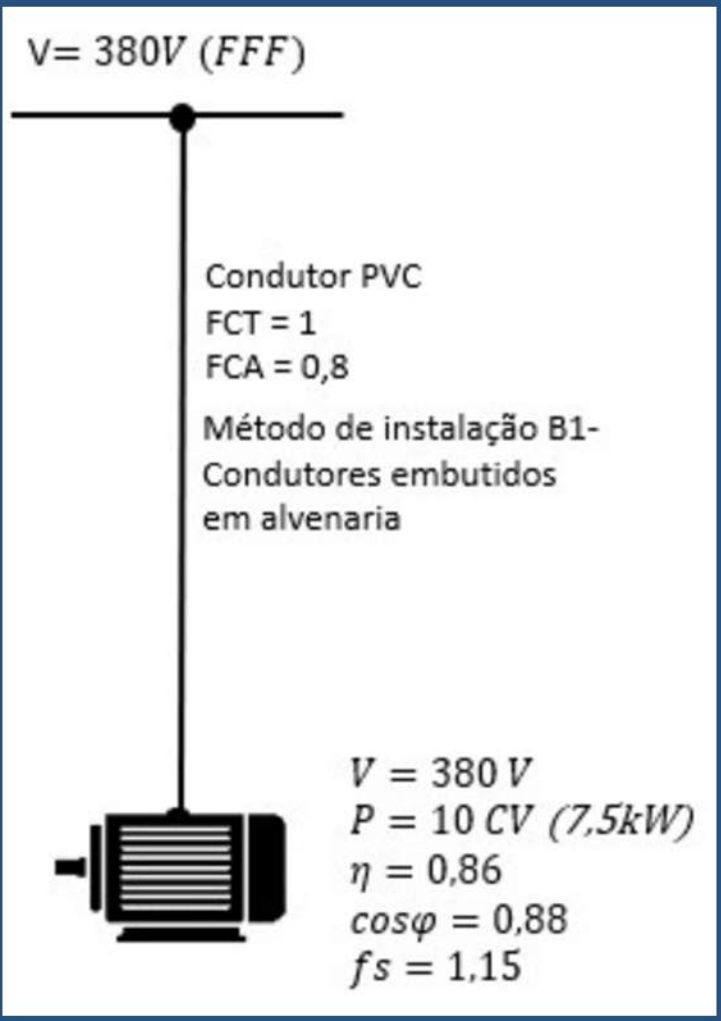
Tabela 36 NBR 5410
Capacidade de condução de corrente, em A
Isolação de PVC - 70°C (30°C Ambiente) (20°C solo)
Métodos de referência A1, A2, B1, B2, C e D

Seções nominais mm²	Métodos de referência indicados na tabela 33											
	A1		A2		B1		B2		C		D	
	Número de condutores carregados											
	2	3	2	3	2	3	2	3	2	3	2	3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Cobre												
0,5	7	7	7	7	9	8	9	8	10	9	12	10
0,75	9	9	9	9	11	10	11	10	13	11	15	12
1	11	10	11	10	14	12	13	12	15	14	18	15
1,5	14,5	13,5	14	13	17,5	15,5	16,5	15	19,5	17,5	22	18
2,5	19,5	18	18,5	17,5	24	21	23	20	27	24	29	24
4	26	24	25	23	32	28	30	27	36	32	38	31
6	34	31	32	29	41	36	38	34	46	41	47	39
10	46	42	43	39	57	50	52	46	63	57	63	52
16	61	56	57	52	76	68	69	62	85	76	81	67
25	80	73	75	68	101	89	90	80	112	96	104	86
35	99	89	92	83	125	110	111	99	138	119	125	103
50	119	108	110	99	151	134	133	118	168	144	148	122
70	151	136	139	125	192	171	168	149	213	184	183	151
95	182	164	167	150	232	207	201	179	258	223	216	179
120	210	188	192	172	269	239	232	206	299	259	246	203
150	240	216	219	196	309	275	265	236	344	299	278	230
185	273	245	248	223	353	314	300	268	392	341	312	258
240	321	286	291	261	415	370	351	313	461	403	361	297
300	367	328	334	298	477	426	401	358	530	464	408	336
400	438	390	398	355	571	510	477	425	634	557	478	394
500	502	447	456	406	656	587	545	486	729	642	540	445
630	578	514	526	467	758	678	626	559	843	743	614	506
800	669	593	609	540	881	788	723	645	978	865	700	577
1 000	767	679	698	618	1 012	906	827	738	1 125	996	792	652

THE TABLE ABOVE (TABLE 36 OF NBR 5410) IS USED TO SIZING CONDUCTORS WITH PVC INSULATION - 70° C FOR INSTALLATION METHODS (A1, A2, B1, B2, C AND D) IN ACCORDANCE WITH NBR 5410. IF THE TYPE OF INSULATION OR INSTALLATION METHOD IS DIFFERENT, IT WILL BE NECESSARY TO USE OTHER TABLES PROVIDED FOR IN NBR 5410 ITSELF.

EXAMPLE 01 SIZING OF ELECTRICAL CONDUCTORS

INSTALLATION OF A THREE-PHASE INDUCTION MOTOR, WITH THE FOLLOWING CHARACTERISTICS:



STEP 1 – CHECK: • TYPE OF INSULATION: PVC • INSTALLATION LOCATION: EMBEDDED IN MASONRY - B1 • HOW MANY CONDUCTORS FEED YOUR CIRCUIT: 3 • TEMPERATURE: AMBIENT 30°C • HOW MANY CIRCUITS WILL PASS TOGETHER: 1 (ALONE)

EXAMPLE 01 SIZING OF ELECTRICAL CONDUCTORS

STEP 2 – CALCULATE THE DESIGN CURRENT OR GET THE NOMINAL CURRENT FROM THE MOTOR PLATE:

$$I_P = \frac{P_N}{\sqrt{3}.V.\cos\varphi\ .\eta}$$

$$I_P = \frac{7500}{\sqrt{3}.380.0{,}88.0{,}86}$$

$$I_P = 15{,}07A$$

STEP 3 – CALCULATE THE CORRECTED DESIGN CORRECTION:

$$I'_P = \frac{I_N\ .fs}{FCT\ .\ FCA} \qquad I'_P = \frac{15{,}07.1{,}15}{1\ .\ 0{,}8}$$

$$I'_P = 21{,}66A$$

AFTER CALCULATING THE CORRECTED DESIGN CURRENT, IT WILL BE NECESSARY TO CONSULT THE CONDUCTOR SIZING TABLE, WHERE THE CURRENT THAT THE CABLE SUPPORTS MUST BE GREATER THAN THE CORRECTED DESIGN CURRENT (CORRECTED MOTOR RATED CURRENT)

EXAMPLE 01 SIZING OF ELECTRICAL CONDUCTORS

STEP 4 – CHECK IN THE TABLE WHICH DRIVER IS MOST SUITABLE:

Tabela 36 NBR 5410
Capacidade de condução de corrente, em A
Isolação de PVC - 70°C (30°C Ambiente) (20°C solo)
Métodos de referência A1, A2, B1, B2, C e D

Seções nominais mm²	Métodos de referência indicados na tabela 33											
	A1		A2		B1		B2		C		D	
	Numero de condutores carregados											
	2	3	2	3	2	3	2	3	2	3	2	3
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Cobre												
0,5	7	7	7	7	9	8	9	8	10	9	12	10
0,75	9	9	9	9	11	10	11	10	13	11	15	12
1	11	10	11	10	14	12	13	12	15	14	18	15
1,5	14,5	13,5	14	13	17,5	15,5	16,5	15	19,5	17,5	22	18
2,5	19,5	18	18,5	17,5	24	21	23	20	27	24	29	24
4	26	24	25	23	32	28	30	27	36	32	38	31
6	34	31	32	29	41	36	38	34	46	41	47	39
10	46	42	43	39	57	50	52	46	63	57	63	52
16	61	56	57	52	76	68	69	62	85	76	81	67
25	80	73	75	68	101	89	99	80	112	96	104	86
35	99	89	92	83	125	110	111	99	138	119	125	103
50	119	108	110	99	151	134	133	118	168	144	148	122
70	151	136	139	125	192	171	168	149	213	184	183	151
95	182	164	167	150	232	207	201	179	258	223	216	179
120	210	188	192	172	269	239	232	206	299	259	246	203
150	240	216	219	196	309	275	265	236	344	299	278	230
185	273	245	248	223	353	314	300	268	392	341	312	258
240	321	286	291	261	415	370	351	313	461	403	361	297
300	367	328	334	298	477	426	401	358	530	464	408	336
400	438	390	398	355	571	510	477	425	634	557	478	394
500	502	447	456	406	656	587	545	486	729	642	540	445
630	578	514	526	467	758	678	626	559	843	743	614	506
800	669	593	609	540	881	788	723	645	978	865	700	577
1 000	767	679	698	618	1 012	906	827	738	1 125	996	792	652

BASED ON THE TABLE, IT IS POSSIBLE TO SIZE THE 4MM² DRIVER TO POWER THE POWER CIRCUIT OF THE THREE-PHASE INDUCTION MOTOR, SINCE THE CURRENT IT SUPPORTS IS 28A, GREATER THAN THE DESIGN CURRENT WHICH IS 21.66A. THE CONTROL CIRCUIT CAN BE USED WITH A 1.0MM² OR 1.5MM² CABLE, AS THE CURRENT THAT FLOWS THROUGH THE CONTROL CIRCUIT IS VERY LOW, ONLY TO CONNECT CONTACTORS AND SIGNALS.

DIMENSIONAMENTO DE CONDUTORES ELÉTRICOS

TABELA PARA FATORES DE TEMPERATURA

Tabela 40 NBR 5410
Fatores de correção para temperaturas ambientes diferentes de 30°C (Ambiente) e 20°C (solo)

°C	PVC	EPR ou XLPE
Ambiente		
10	1,22	1,15
15	1,17	1,12
20	1,12	1,08
25	1,06	1,04
35	0,94	0,96
40	0,87	0,91
45	0,79	0,87
50	0,71	0,82
55	0,61	0,76
60	0,50	0,71
65	–	0,65
70	–	0,58
75	–	0,50
80	–	0,41
Do solo		
10	1,10	1,07
15	1,05	1,04
25	0,95	0,96
30	0,89	0,93
35	0,84	0,89
40	0,77	0,85
45	0,71	0,80
50	0,63	0,76
55	0,55	0,71
60	0,45	0,65
65	–	0,60
70	–	0,53
75	–	0,46
80	–	0,38

TABELA PARA FATORES DE AGRUPAMENTO

Tabela 42
Fatores de correção aplicáveis a condutores agrupados em feixe (em linhas abertas ou fechadas) e a condutores agrupados num mesmo plano, em camada única

Ref.	Forma de agrupamento dos condutores	Número de circuitos ou de cabos multipolares												Tabelas dos métodos de referência
		1	2	3	4	5	6	7	8	9 a 11	12 a 15	16 a 19	≥20	
1	Em feixe: ao ar livre ou sobre superfície; embutidos; em conduto fechado	1,00	0,80	0,70	0,65	0,60	0,57	0,54	0,52	0,50	0,45	0,41	0,38	36 a 39 (métodos A a F)
2	Camada única sobre parede, piso, ou em bandeja não perfurada ou prateleira	1,00	0,85	0,79	0,75	0,73	0,72	0,72	0,71	0,70				36 e 37 (método C)
3	Camada única no teto	0,95	0,81	0,72	0,68	0,66	0,64	0,63	0,62	0,61				
4	Camada única em bandeja perfurada	1,00	0,88	0,82	0,77	0,75	0,73	0,73	0,72	0,72				38 e 39 (métodos E e F)
5	Camada única sobre leito, suporte etc.	1,00	0,87	0,82	0,80	0,80	0,79	0,79	0,78	0,78				

SIZING OF THERMOMAGNETIC CIRCUIT BREAKER

STEP 1 – CHECK: • THE DESIGN CURRENT OF THE MOTOR (NOMINAL CURRENT) • THE CURRENT THAT THE CABLE THAT WILL POWER THE MOTOR SUPPORTS • IDENTIFY THE CIRCUIT BREAKER ACTUATION CURVE (B; C OR D) • DETERMINE IF THE CIRCUIT BREAKER WILL BE MONOPOLAR, BIPOLAR AND TRIPOLAR STEP 2 – PERFORM THE CALCULATIONS

$$I_B \leq I_n \leq I_z$$

I_B é a corrente de projeto do circuito;

I_n é a corrente nominal do dispositivo de proteção (ou corrente de ajuste, para dispositivos ajustáveis);

I_z é a máxima capacidade de condução de corrente dos condutores, nas condições previstas para sua instalação;

STEP 3 – CHOOSE THE MOST APPROPRIATE CIRCUIT BREAKER CURRENT

Veja alguns valores de corrente nominal de disjuntores das normas NBR NM 60898 e NBR IEC 60947-2:

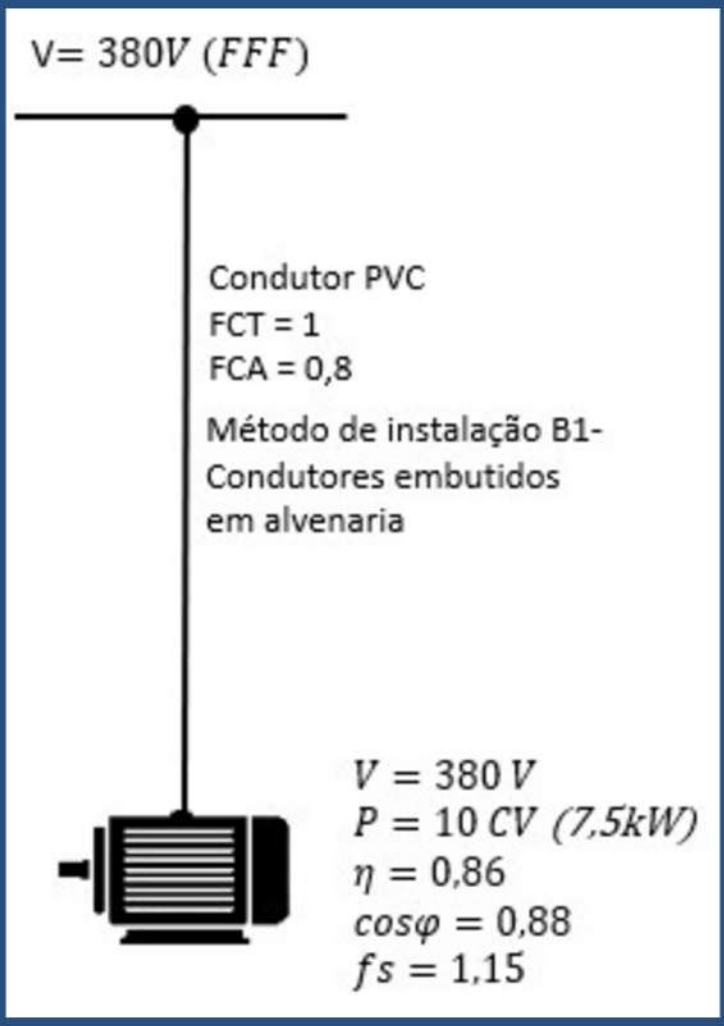
- 2 A, 4 A, 6 A, 10 A, 16 A, 20 A, 25 A, 32 A, 40 A, 50 A, 63 A, 70 A, 80 A, 100 A, 125 A.

EXAMPLE: BIPOLAR CIRCUIT

BREAKER CURVE C - 10A
3KA (SHORT CIRCUIT CURRENT)

EXAMPLE 01 SIZING OF THERMOMAGNETIC CIRCUIT BREAKER

INSTALLATION OF A THREE-PHASE INDUCTION MOTOR, WITH THE FOLLOWING CHARACTERISTICS:



STEP 1 – CHECK: • THE MOTOR DESIGN CURRENT: 15.07A • THE CURRENT THAT THE CABLE THAT WILL POWER THE MOTOR SUPPORTS: 28A • IDENTIFY THE CIRCUIT BREAKER ACTUATION CURVE: CURVE C • DETERMINE IF THE CIRCUIT BREAKER WILL BE THREE-POLE (POWER) AND BI-POLE (COMMAND) STEP 2 – PERFORM THE CALCULATIONS

$$I_B \leq I_n \leq I_z \longrightarrow 15{,}07 \leq I_n \leq 28$$

EXAMPLE 01 SIZING OF THERMOMAGNETIC CIRCUIT BREAKER

STEP 3 – CHOOSE THE MOST APPROPRIATE CIRCUIT BREAKER CURRENT

Veja alguns valores de corrente nominal de disjuntores das normas NBR NM 60898 e NBR IEC 60947-2:

- 2 A, 4 A, 6 A, 10 A, 16 A, 20 A, 25 A, 32 A, 40 A, 50 A, 63 A, 70 A, 80 A, 100 A, 125 A.

BASED ON CURRENT VALUES, THE MOST SUITABLE THERMOMAGNETIC CIRCUIT BREAKER IS 20A FOR THE POWER CIRCUIT. FOR THE CONTROL CIRCUIT, THE CURRENT PRODUCED BY THE CONTACTORS MUST BE TAKEN INTO ACCOUNT. IN GENERAL, A 10A CIRCUIT BREAKER IS USED FOR CONVENTIONAL MOTOR STARTING SYSTEMS.

THE APPROXIMATE CURRENT OF A POWER CONTACTOR UNDER AN

ELECTRICAL VOLTAGE IS 0.5A

POWER CIRCUIT

THREE-POLE CIRCUIT BREAKER

CURVE C - 20A
3KA (SHORT CIRCUIT CURRENT)

CONTROL CIRCUIT BREAKER BIPOLAR

CURVE C - 10A
3KA (SHORT CIRCUIT CURRENT)

SIZING OF MOTOR CIRCUIT BREAKER

STEP 1 – CHECK: • THE MOTOR DESIGN CURRENT (NOMINAL CURRENT) • THE NUMBER OF AUXILIARY CONTACTS (NO AND NC) STEP 2 – PERFORM THE CALCULATIONS

$$I_{DM} = I_n . 1{,}25$$

I_{DM} = Corrente nominal do dijuntor motor
I_n = Corrente nominal do motor

STEP 3 – CHECK THE MANUFACTURER'S TABLE TO FIND THE MOTOR CIRCUIT BREAKER THAT IS MOST SUITABLE:

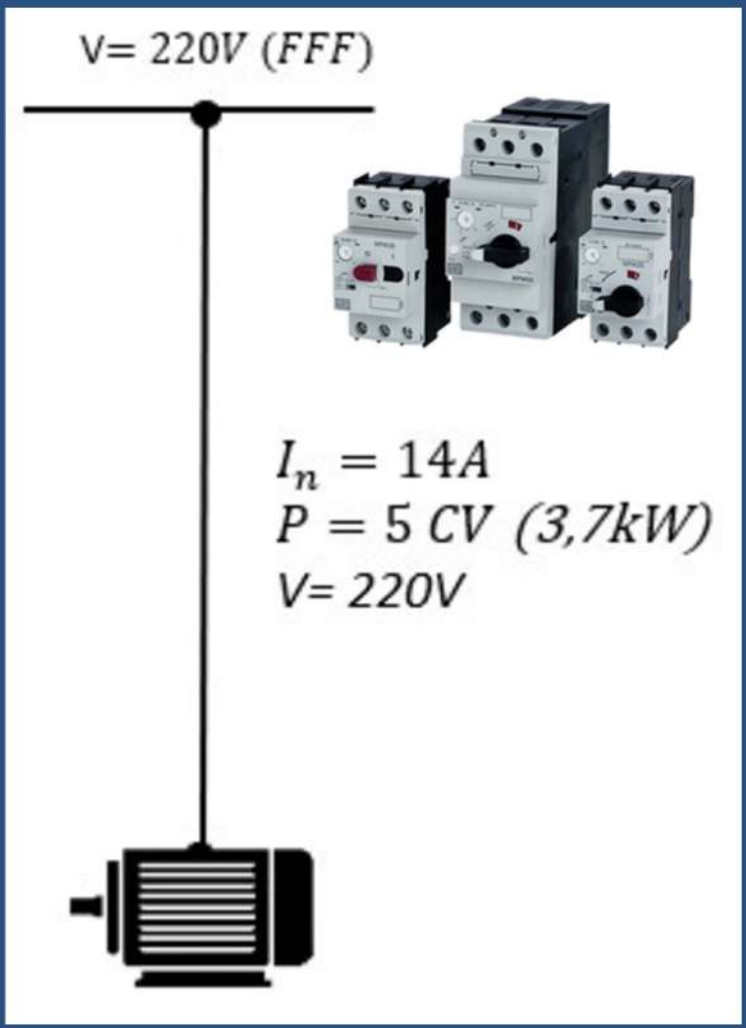
Disjuntor-Motor Termomagnético MPW18 - Proteção Contra Sobrecarga e Curto-Circuito

Tabela orientativa para seleção da proteção de motores trifásicos 60 Hz - 4 polos[1]			Corrente nominal	Faixa de ajuste da corrente nominal	Disparo magnético instantâneo 13x In	Terminal parafuso		Peso
220-240 V cv / kW	380-415 V cv / kW	440-480 V cv / kW	In (A)	In (A)	Im (A)	Referência	Código	kg
-	-	-	0,16	0,1...0,16	2,08	MPW18-3-C016	12429311	0,28
-	-	-	0,25	0,16...0,25	3,25	MPW18-3-C025	12429312	
-	-	0,16 / 0,12	0,4	0,25...0,4	5,2	MPW18-3-D004	12429313	
-	0,16 / 0,12	0,25 / 0,18	0,63	0,4...0,63	8,2	MPW18-3-C063	12429315	
0,16 / 0,12	0,33 / 0,25	0,33 / 0,25	1	0,63...1	13	MPW18-3-U001	12429317	
0,33 / 0,25	0,5 / 0,37	1 / 0,75	1,6	1...1,6	20,8	MPW18-3-D016	12429368	
0,5 / 0,37	1 / 0,75	1,5 / 1,1	2,5	1,6...2,5	32,5	MPW18-3-D025	12429369	
1 / 0,75	2 / 1,5	2 / 1,5	4	2,5...4	52	MPW18-3-U004	12429370	
1,5 / 1,1	3 / 2,2	4 / 3	6,3	4...6,3	82	MPW18-3-D063	12429371	
3 / 2,2	6 / 4,5	7,5 / 5,5	10	6,3...10	130	MPW18-3-U010	12429372	
5 / 3,7	10 / 7,5	12,5 / 9,2	16	10...16	208	MPW18-3-U016	12429373	
6 / 4,5	10 / 7,5	12,5 / 9,2	18	12...18	234	MPW18-3-U018	12429374	

EXAMPLE OF MANUFACTURER'S TABLE

SIZING OF MOTOR CIRCUIT BREAKER EXAMPLE 01

INSTALLATION OF A THREE-PHASE INDUCTION MOTOR, WITH THE FOLLOWING CHARACTERISTICS:



STEP 1 – CHECK: • MOTOR DESIGN CURRENT (NOMINAL CURRENT): 14A • NUMBER OF AUXILIARY CONTACTS (NO AND NC): 1 NO + 1 NC

STEP 2 – PERFORM THE CALCULATIONS

$I_{DM} = I_n . 1{,}25 \rightarrow I_{DM} = 14 . 1{,}25 \rightarrow I_{DM} = 17{,}25\ A$

SIZING OF MOTOR CIRCUIT BREAKER EXAMPLE 01

STEP 3 – CHECK THE MANUFACTURER'S TABLE TO FIND THE MOTOR CIRCUIT BREAKER THAT IS MOST SUITABLE:

Disjuntor-Motor Termomagnético MPW18 - Proteção Contra Sobrecarga e Curto-Circuito

Tabela orientativa para seleção da proteção de motores trifásicos 60 Hz - 4 polos[1]			Corrente nominal	Faixa de ajuste da corrente nominal	Disparo magnético instantâneo 13x In	Terminal parafuso		Peso
220-240 V cv / kW	380-415 V cv / kW	440-480 V cv / kW	In (A)	In (A)	Im (A)	Referência	Código	kg
-	-	-	0,16	0,1...0,16	2,08	MPW18-3-C016	12429311	
-	-	-	0,25	0,16...0,25	3,25	MPW18-3-C025	12429312	
-	-	0,16 / 0,12	0,4	0,25...0,4	5,2	MPW18-3-D004	12429313	
-	0,16 / 0,12	0,25 / 0,18	0,63	0,4...0,63	8,2	MPW18-3-C063	12429315	
0,16 / 0,12	0,33 / 0,25	0,33 / 0,25	1	0,63...1	13	MPW18-3-U001	12429317	
0,33 / 0,25	0,5 / 0,37	1 / 0,75	1,6	1...1,6	20,8	MPW18-3-D016	12429368	0,28
0,5 / 0,37	1 / 0,75	1,5 / 1,1	2,5	1,6...2,5	32,5	MPW18-3-D025	12429369	
1 / 0,75	2 / 1,5	2 / 1,5	4	2,5...4	52	MPW18-3-U004	12429370	
1,5 / 1,1	3 / 2,2	4 / 3	6,3	4...6,3	82	MPW18-3-D063	12429371	
3 / 2,2	6 / 4,5	7,5 / 5,5	10	6,3...10	130	MPW18-3-U010	12429372	
5 / 3,7	10 / 7,5	12,5 / 9,2	16	10...16	208	MPW18-3-U016	12429373	
6 / 4,5	10 / 7,5	12,5 / 9,2	18	12...18	234	MPW18-3-U018	12429374	

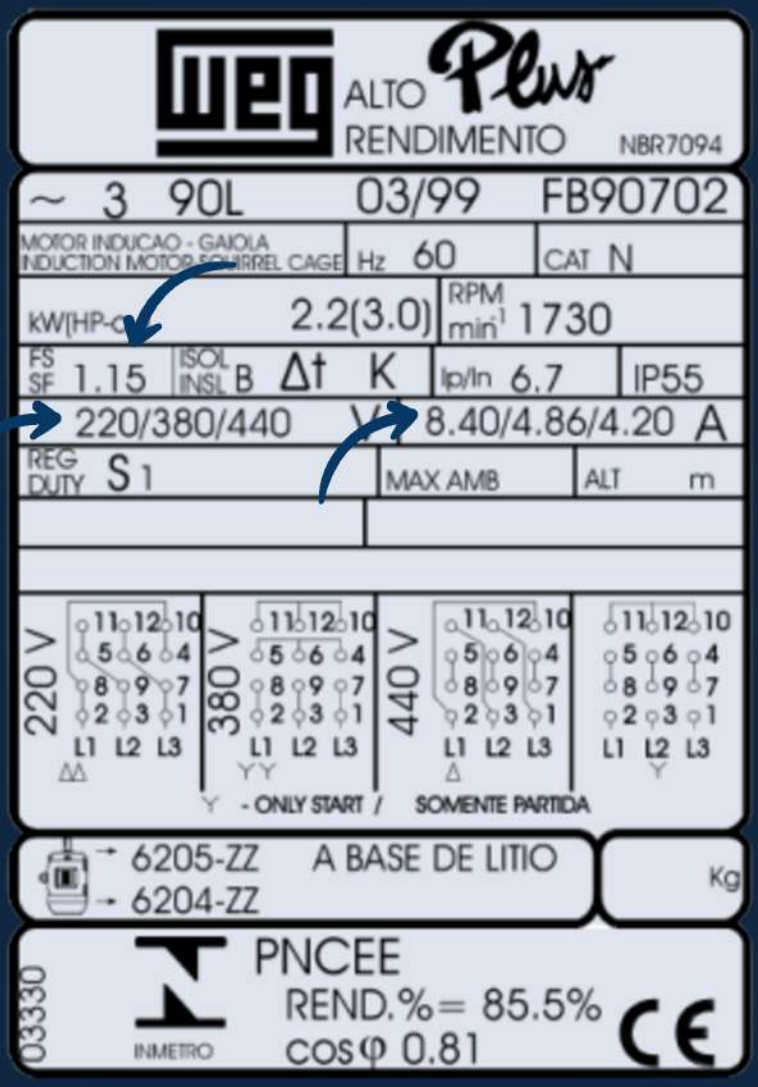
MOTOR CIRCUIT BREAKER MODEL:
MPW18-3UO18 NOMINAL VOLTAGE: 220 V
ADJUSTMENT RANGE: 12..18A MAXIMUM
CURRENT: 18 A AUXILIARY CONTACTS: 1
NO AND 1 NC

THERMAL RELAY SIZING - DIRECT START

TO SIZING A THERMAL RELAY, WE FOLLOW 5 SIMPLE STEPS:

STEP 1 – CHECK:

- **NOMINAL CURRENT (IN) OF THE LOAD**
- **CONNECTION TYPE (DIRECT START, STAR TRIANGLE, ETC.)**
- **CLIMATIC CONDITIONS (AMBIENT TEMPERATURE)**



FOR THE EXAMPLE, WE WILL CONSIDER A THREE-PHASE MOTOR CONNECTED TO A DIRECT STARTER SWITCH, IN A 220V/60HZ NETWORK WITH A NOMINAL CURRENT OF 8.40A, AS PER THE IDENTIFICATION PLATE ABOVE.

STEP 2 – CONSIDER THE SERVICE FACTOR (F.S) TO DIMENSION THE THERMAL RELAY CURRENT (IR):

Motores com F.S < 1,15	**Ir = 1,15 X In**
Motores com F.S >= 1,15	**Ir = 1,25 X In**

THERMAL RELAY SIZING

STEP 3 – WE CALCULATE THE RELAY SIZING CURRENT (IR): SINCE FS = 1.15, WE WILL USE THE FORMULA: IR = 1.25 X IN

In = 8,40 A
FS = 1,15

→ **Ir = 1,25 X 8,4 = 10,5A**

STEP 4 – NOW THAT WE KNOW THE CURRENT TO SIZING THE RELAY (IR = 10.5A), LET'S CONSIDER OTHER FACTORS TO CHOOSE THE MOST SUITABLE THERMAL RELAY:

- WHETHER THE RELAY WILL BE USED COUPLED TO THE CONTACTOR OR DIRECTLY ON THE PANEL;
- THE RELAY ADJUSTMENT RANGE;
- THE TEMPERATURE CORRECTION FACTOR MUST BE CONSIDERED (ACORDING TO THE MANUFACTURER)

STEP 5 – SEE MANUFACTURER'S MANUAL:

Montagem direta	Faixas de corrente (A)	Diagrama	Fusível máximo (gL/gG)[1]	Referência	Código	Peso kg
CWM9...40	0,28...0,4		2	RW27-1D3-D004	10045630	
CWM9...40	0,43...0,63		2	RW27-1D3-C063	10186032	
CWM9...40	0,56...0,8		2	RW27-1D3-D008	10186033	
CWM9...40	0,8...1,2		4	RW27-1D3-D012	10045631	
CWM9...40	1,2...1,8		6	RW27-1D3-D018	10045632	
CWM9...40	1,8...2,8		6	RW27-1D3-D028	10452548	
CWM9...40	2,8...4		10	RW27-1D3-U004	10452213	
CWM9...40	4...6,3		16	RW27-1D3-D063	10045633	0,165
CWM9...40	5,6...8		20	RW27-1D3-U008	10452197	
CWM9...40	7...10		25	RW27-1D3-U010	10045634	
CWM9...40	8...12,5		25	RW27-1D3-D125	10452967	
CWM9...40	10...15		35	RW27-1D3-U015	10452384	
CWM9...40	11...17		40	RW27-1D3-U017	10452204	
CWM9...40	15...23		50	RW27-1D3-U023	10452205	
CWM9...40	22...32		63	RW27-1D3-U032	10452382	
CWM32...40	25...40		90	RW67-1D3-U040	10452216	0,320
CWM32...40	32...50		125	RW67-1D3-U050	10452217	
CWM50...80	25...40		90	RW67-2D3-U040	10844133	
CWM50...80	32...50		125	RW67-2D3-U050	10186035	
CWM50...80	40...57		150	RW67-2D3-U057	10452201	0,320
CWM50...80	50...63		150	RW67-2D3-U063	10452218	
CWM50...80	57...70		175	RW67-2D3-U070	10045635	
CWM50...80	63...80		200	RW67-2D3-U080	10045636	
CWM95...105	63...80		200	RW117-1D3-U080	10186370	
CWM95...105	75...97		225	RW117-1D3-U097	10410002	0,490
CWM95...105	90...112		250	RW117-1D3-U112	10410003	

THERMAL RELAY SIZING

AS WE USE THE WEG MANUAL, THE SUITABLE THERMAL RELAY ACCORDING TO OUR EXAMPLE WILL BE:

Relé Térmico modelo: RW27-1D3-D125

•ADJUSTMENT RANGE: 8A TO 12.5A •DIRECT MOUNTING ON CONTACTOR (MODEL): CWM9

ADJUSTMENT - DIRECT START

2 STEPS TO ADJUST THE THERMAL RELAY FOR YOUR LOAD: STEP 1

– CHECK THE MOTOR'S NOMINAL CURRENT AND SERVICE FACTOR

(THESE DATA IS ON THE MOTOR PLATE):

RELAY ADJUSTMENT MUST BE MADE IN ACCORDANCE WITH THE MOTOR'S RATED CURRENT, SERVICE FACTOR (F.S) AND TYPE OF CONNECTION.

•IN = 8.4A

• FS: 1.15 STEP 2 – CALCULATE THE THERMAL RELAY ADJUSTMENT CURRENT:

CONSIDERING A DIRECT CONNECTION, THE RELAY ADJUSTMENT CURRENT WILL BE:

Corrente de Regulagem = Corrente Nominal X Fator de Serviço do Motor

Regulagem = In X 1,15 = 8,4 X 1,15 = 9,66A

ADJUSTMENT - STAR TRIANGLE

CONSIDERING A Y KEY ▲, THE RELAY REGULATION CURRENT IT WILL BE:

In = 8,4A
FS: 1,15

$$\text{Regulagem} = \frac{\text{In} \times 1{,}15}{\sqrt{3}} = \frac{8{,}4 \times 1{,}15}{\sqrt{3}} = \frac{9{,}66\text{A}}{\sqrt{3}} = 5{,}58\text{A}$$

NOTE: IN THIS CASE, WE CANNOT USE THE SAME RELAY THAT WAS DIMENSIONED IN THE PREVIOUS EXAMPLE, DUE TO THE CURRENT RANGE. ACCORDING TO THE WEG CATALOG, THE MOST SUITABLE THERMAL RELAY FOR THIS NEW SITUATION WILL BE:

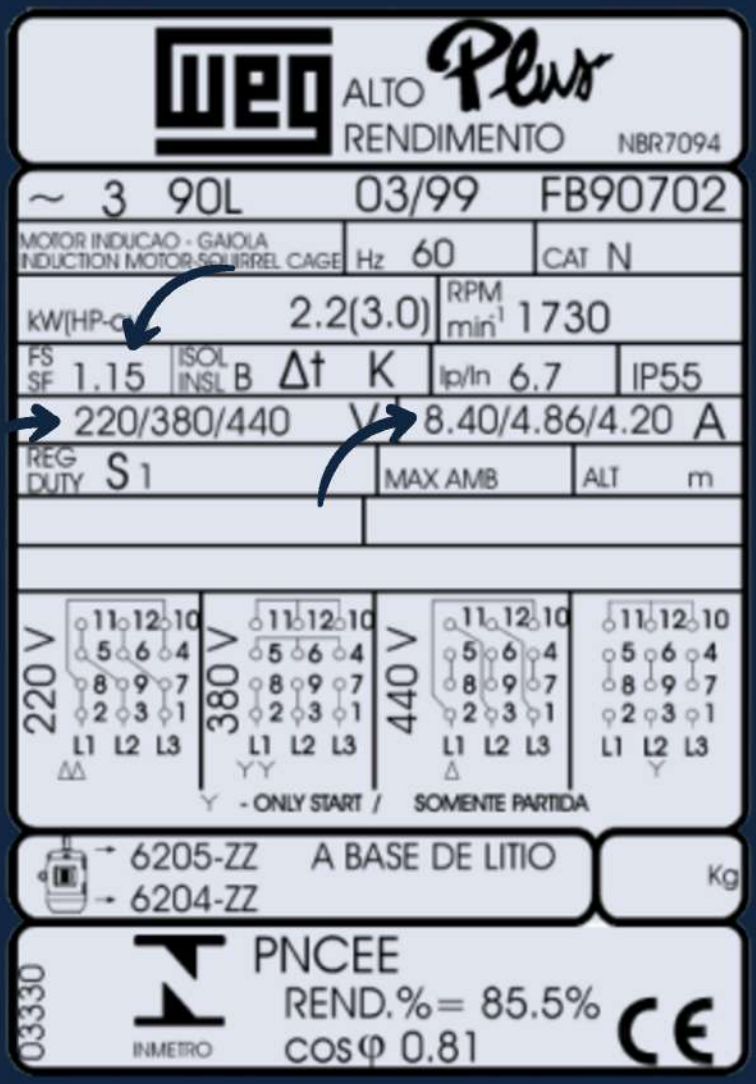
THERMAL RELAY MODEL: RW27-1D3-D63
•ADJUSTMENT RANGE: 4A TO 6.3A
•DIRECT MOUNTING ON CONTACTOR MODEL: CWM9

1 - Local para identificação
2 - Tecla *Reset* + Multifunção
3 - Dial de ajuste de corrente
4 - Terminais dos contatos auxiliares
5 - Terminais dos contatos principais

O relé possui um botão de Reset e na mesma tecla 4 funções sendo:
A - Função somente de rearme automático. A função stop/teste não é permitida;
AUTO - Função de rearme automático e função stop/teste;
HAND - Função de rearme manual e função stop/teste;
H - Função somente de rearme manual. A função stop/teste não é permitida.

CONTACTOR SIZING

EXAMPLE 01: LET'S CONSIDER A THREE-PHASE MOTOR AS SHOWN ON THE NAMEPLATE BELOW CONNECTED TO A DIRECT STARTER SWITCH IN A 220V/60HZ NETWORK AND CURRENT OF 8.40A



STEP 1 – CHECK • TYPE OF LOAD (RESISTIVE, MOTORS, ETC.) • VOLTAGE AND FREQUENCY OF THE LOAD MAINS • NOMINAL CURRENT (IN) AND NOMINAL VOLTAGE OF THE LOAD THAT THE CONTACTOR WILL CONTROL. • COIL SUPPLY VOLTAGE (AUXILIARY CIRCUIT)

CONTACTOR SIZING

STEP 2 – CONSIDER THE SERVICE FACTOR (F.S) TO CALCULATE THE MAXIMUM MOTOR CURRENT (IMAX):

F.S = 1.15 (15% ABOVE), THEREFORE: IMAX = IN X F.S = 8.4 X1.15 → IMAX = 9.66A

STEP 3 – CALCULATE THE CONTACTOR CURRENT (I-CONTACTOR), CONSIDERING 15% ABOVE THE MAXIMUM MOTOR CURRENT:

• IMAX: 9.66 A • ICONTATOR = IMAX X 1.15 = 9.66 X 1.15 • I CONTACTOR = 11.11A

STEP 4 – CHECK

-HOW MANY CONTACTS WILL BE USED IN THE CIRCUIT (NO AND NC)

-A CATEGORY OF EMPLOYMENT (AC1,AC2,AC3, ETC)

COIL SUPPLY VOLTAGE (127VAC, 220VAC, 24VDC, ETC)

IF THE MOTOR IS A THREE-PHASE SQUIRREL CAGE INDUCTION MOTOR WITH

FULL LOAD SHUTDOWN, THE CONTACTOR'S USE CATEGORY WILL BE AC3.

STEP 4 – WITH THIS INFORMATION, CHOOSE THE MOST SUITABLE CONTACTOR BY CONSULTING THE MANUFACTURER'S MANUAL. CONTACTOR MODEL: CW B12-11-30 D23 NOMINAL VOLTAGE: 220 V DUTY CATEGORY: AC3 MAXIMUM CURRENT: 12 A COIL VOLTAGE: 220 V (MODEL D23)

CONTACTOR SIZING

Tripolares de 9 A a 38 A (AC-3)

I_e máx. (U_e ≤440 V)	$I_e = I_th$ (U_e ≤690 V) θ ≤55 °C	Potência nominal de emprego em AC-3[1] Motor trifásico - IV polos - 60 Hz - 1.800 rpm						Contatos auxiliares por contator		Referência para completar com a tensão de comando	Peso[4]
AC-3	AC-1	220 V 230 V	380 V	400 V 415 V	440 V	500 V	660 V 690 V	*3 / *4	*1 / *2		
A	A	kW / cv	kW / cv	kW / cv	kW / cv	kW / cv	kW / cv	NA	NF		kg
9	25	2,2 / 3	3,7 / 5	3,7 / 5	4,5 / 6	5,5 / 7,5	5,5 / 7,5	1	1	CWB9-11-30♦	0,372
12	25	3 / 4	5,5 / 7,5	5,5 / 7,5	5,5 / 7,5	7,5 / 10	7,5 / 10	1	1	CWB12-11-30♦	0,372
18	32	4,5 / 6	7,5 / 10	9,2 / 12,5	9,2 / 12,5	9,2 / 12,5	9,2 / 12,5	1	1	CWB18-11-30♦	0,372
25	40	5,5 / 7,5	11 / 15	11 / 15	11 / 15	15 / 20	15 / 20	1	1	CWB25-11-30♦	0,408
32	50	9,2 / 12,5	15 / 20	15 / 20	15 / 20	18,5 / 25	18,5 / 25	1	1	CWB32-11-30♦	0,408
38	50	9,2 / 12,5	18,5 / 25	18,5 / 25	22 / 30	18,5 / 25	18,5 /25	1	1	CWB38-11-30♦	0,408

Fonte: WEG

Corrente máxima do contator

Substitua "♦" pelo código da tensão de comando[2].

Corrente Alternada

Código	D02	D07	D13	D23	D24	D25	D33	D34	D35	D36	D39
V (50/60 Hz)	24	48	110	220	230	240	380	400	415	440	480

Tensão de alimentação da bobina

Corrente Contínua

Código	C02	C03	C07	C09	C12	C13	C15
V CC	12	24	48	60	110	125	220

NOTE: NOTE THAT THE MOTOR IN THE EXAMPLE HAS 3HP AND THE MANUFACTURER'S MANUAL INDICATES A CONTACTOR WITH A CURRENT OF 9A, HOWEVER ACCORDING TO OUR CALCULATIONS, CONSIDERING THE MOTOR'S SERVICE FACTOR, WE WILL USE A CONTACTOR WITH A HIGHER CURRENT (12A), GUARANTEEING A LONGER USEFUL LIFE FOR THE EQUIPMENT.

CHOOSE THE CONTACTOR COIL VOLTAGE ACCORDING TO THE AUXILIARY CIRCUIT VOLTAGE, AS IT MAY BE DIFFERENT FROM THE MOTOR SUPPLY VOLTAGE (MAIN CIRCUIT).

SIZING OF CONTACTORS FOR STARTER - DRIANGLE

IT SHOULD BE NOTED THAT K1 IS SUBJECT TO THE LINE CURRENT IN STARTING IN STARTER, THAT IS, THE CURRENT WILL BE 1/3 OF THE NOMINAL STARTING. AFTER CLOSING IN DRIANGLE, K1 WILL BE SUBJECT TO THE PHASE CURRENT OF THE MOTOR, THAT IS:

$$I_{K1} = \frac{I_N}{\sqrt{3}} = 0{,}58 x I_N$$

SIZING OF K1 AND K2

FOR K2, AT Y START, CONTACTOR K2 IS DISCONNECTED; WHEN SWITCHING TO TRIANGLE, K2 WILL BE SUBJECT TO PHASE CURRENT, AS K1. LIKE THIS:

$$I_{K2} = \frac{I_N}{\sqrt{3}} = 0{,}58 x I_N$$

SO TO SIZING K1 AND K2 - TRIANGLE

$$I_{K1/2} = 1{,}15 x (0{,}58 x I_N)$$

IK1/2 = NOMINAL CURRENT OF CONTACTOR USE IN = NOMINAL CURRENT 1.15 = INCREASE OF 15%

K3 DIMENSIONING

IT SHOULD BE NOTED THAT K3 IS SUBJECT TO THE PHASE/LINE CURRENT IN STARTING IN STARTER, THAT IS, THE CURRENT WILL BE 1/3 OF THE NOMINAL STARTING CURRENT. AFTER CLOSING IN DRIANGLE, K3 WILL BE DISCONNECTED.

$$I_{K3} = \frac{I_N}{3} = 0{,}33 x I_N$$

SO TO SIZING FROM K3 - STAR

$$I_{K3} = 1{,}15 x (0{,}33 x I_N)$$

SIZING OF K1 AND K2 - AS PER EXAMPLE 2

EXAMPLE 02: LET'S CONSIDER A THREE-PHASE MOTOR OF 10HP, 380V, 14.9A, (IP/IN=7.9) CONNECTED TO A STAR-DELTA SWITCH:

STEP 1 – CHECK • TYPE OF LOAD (RESISTIVE, MOTORS, ETC.)
• LOAD MAINS VOLTAGE AND FREQUENCY
• NOMINAL CURRENT (IN) AND NOMINAL VOLTAGE OF THE LOAD THAT

THE CONTACTOR WILL CONTROL.

• COIL SUPPLY VOLTAGE (AUXILIARY CIRCUIT) STEP 2 – CALCULATE THE

CONTACTOR CURRENT (I - CONTACTOR), CONSIDERING 15% ABOVE THE

MAXIMUM MOTOR CURRENT:

IK2 E K3 = 1,15 X (0,58 X IN)=

IK2 E K3 = 1.15 X (0.58 X 14.9) = 9.9A

STEP 3 – CHECK -HOW MANY CONTACTS WILL BE USED IN THE CIRCUIT (NO AND NC) -THE USE CATEGORY (AC1, AC2, AC3, ETC) -THE COIL SUPPLY VOLTAGE (127VAC, 220VAC, 24VDC, ETC)

IF THE MOTOR IS A THREE-PHASE SQUIRREL CAGE INDUCTION MOTOR WITH FULL LOAD SHUTDOWN, THE CONTACTOR'S USE CATEGORY WILL BE AC3.

SIZING OF K1 AND K2 - AS PER EXAMPLE 2

STEP 4 – WITH THIS INFORMATION, CHOOSE THE MOST SUITABLE CONTACTOR BY CONSULTING THE MANUFACTURER'S MANUAL.

CONTACTOR MODEL: CWC012 NOMINAL VOLTAGE: 220 V DUTY

CATEGORY: AC3 MAXIMUM CURRENT: 12 A COIL VOLTAGE: 220 V (MODEL D23)

Contatores

Modelos		CW07	CWC07	CWC09	CWC012	CWC016	CWC025
Potência nominal de emprego em AC-3 [1]							
220/230 VCA	(kW / cv)	1,5 / 2	1,5 / 2	2,2 / 3	3 / 4	3,7 / 5	5,5 / 7,5
380 VCA	(kW / cv)	3 / 4	3 / 4	3,7 / 5	5,5 / 7,5	7,5 / 10	11 / 15
400/415 VCA	(kW / cv)	3 / 4	3 / 4	3,7 / 5	5,5 / 7,5	7,5 / 10	11 / 15
440 VCA	(kW / cv)	-	3,7 / 5	4,5 / 6	5,5 / 7,5	7,5 / 10	11 / 15
500 VCA	(kW / cv)	-	3,7 / 5	4,5 / 6	5,5 / 7,5	7,5 / 10	11 / 15
660/690 VCA	(kW / cv)	-	3 / 4	3,7 / 5	5,5 / 7,5	7,5 / 10	11 / 15
Correntes nominais de emprego ($U_e \leq 440$ V)							
I_e AC-3	(A)	7 [2]	7	9	12	16	22
I_e AC-1	(A)	16 [2]	18	20	22	22	32
I_e AC-4	(A)	-	2,8	3,5	4,5	5	9

BASED ON THE TABLE ABOVE, IT IS POSSIBLE TO VERIFY THAT THE CONTACTOR WITH A CURRENT OF 12A IS GREATER THAN THE CALCULATED NOMINAL CURRENT OF 9.9A

SIZING OF K3 - AS PER EXAMPLE 2

STEP 1 – CHECK • TYPE OF LOAD (RESISTIVE, MOTORS, ETC.) • VOLTAGE AND FREQUENCY OF THE LOAD MAINS • NOMINAL CURRENT (IN) AND NOMINAL VOLTAGE OF THE LOAD THAT THE CONTACTOR WILL CONTROL. • COIL SUPPLY VOLTAGE (AUXILIARY CIRCUIT)

SIZING OF K3 - AS PER EXAMPLE 2

STEP 2 – CALCULATE THE CONTACTOR CURRENT (I - CONTACTOR), CONSIDERING 15% ABOVE THE MAXIMUM MOTOR CURRENT:

$$IK3 = 1{,}15 \times (0{,}33 \times IN)$$

$$IK3 = 1{,}15 \times (0{,}33 \times 14{,}9) = 5{,}65A$$

STEP 3 – CHECK -HOW MANY CONTACTS WILL BE USED IN THE CIRCUIT (NO AND NC) -THE USE CATEGORY (AC1, AC2, AC3, ETC) -THE COIL SUPPLY VOLTAGE (127VAC, 220VAC, 24VDC, ETC)

IF THE MOTOR IS A THREE-PHASE SQUIRREL CAGE INDUCTION MOTOR WITH FULL LOAD SHUTDOWN, THE CONTACTOR'S USE CATEGORY WILL BE AC3.

SIZING OF K3 - AS PER EXAMPLE 2

Contatores

Modelos		CW07	CWC07	CWC09	CWC012	CWC016	CWC025
Potência nominal de emprego em AC-3 [1]							
220/230 VCA	(kW / cv)	1,5 / 2	1,5 / 2	2,2 / 3	3 / 4	3,7 / 5	5,5 / 7,5
380 VCA	(kW / cv)	3 / 4	3 / 4	3,7 / 5	5,5 / 7,5	7,5 / 10	11 / 15
400/415 VCA	(kW / cv)	3 / 4	3 / 4	3,7 / 5	5,5 / 7,5	7,5 / 10	11 / 15
440 VCA	(kW / cv)	-	3,7 / 5	4,5 / 6	5,5 / 7,5	7,5 / 10	11 / 15
500 VCA	(kW / cv)	-	3,7 / 5	4,5 / 6	5,5 / 7,5	7,5 / 10	11 / 15
660/690 VCA	(kW / cv)	-	3 / 4	3,7 / 5	5,5 / 7,5	7,5 / 10	11 / 15
Correntes nominais de emprego ($U_e \leq 440$ V)							
I_e AC-3	(A)	7 [3]	7	9	12	16	22
I_e AC-1	(A)	16 [3]	18	20	22	22	32
I_e AC-4	(A)	-	2,8	3,5	4,5	5	9

BASED ON THE TABLE ABOVE, IT IS POSSIBLE TO VERIFY THAT THE CONTACTOR WITH A CURRENT OF 7A IS GREATER THAN THE CALCULATED NOMINAL CURRENT OF 5.65A

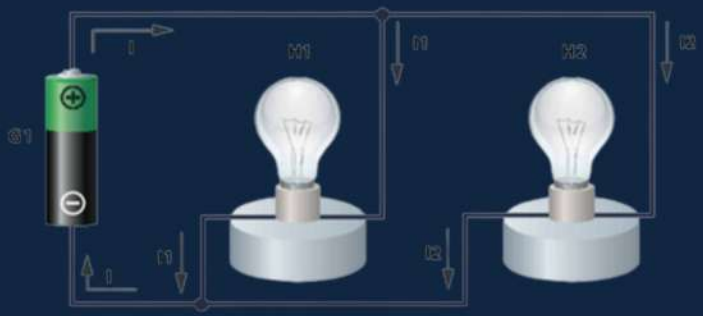
ELECTRICAL CIRCUIT

SERIES CIRCUIT

IT IS ONE WHOSE COMPONENTS ARE CONNECTED ONE AFTER THE OTHER, THIS MODE MAKES IT SO THAT THERE IS ONLY ONE SINGLE PATH FOR THE ELECTRIC CURRENT.

CHARACTERISTICS OF THE SERIES CIRCUIT: 1) THE ELECTRIC CURRENT IS THE SAME AT EACH POINT OF THE CIRCUIT.
2)THE ELECTRIC VOLTAGE IS DIVIDED IN EACH LOAD.
3) THE OPERATION OF THE CIRCUIT IS DEPENDENT, THAT IS, IF ONE OF THE LOADS IS REMOVED FROM THE CIRCUIT OR STOPS WORKING, THE OTHER LOAD WILL ALSO STOPS WORKING.

PARALLEL CIRCUIT



A PARALLEL CIRCUIT IS ONE WHOSE COMPONENTS ARE CONNECTED NEXT TO EACH OTHER, CAUSING MORE THAN ONE PATH FOR ELECTRIC CURRENT.

PARALLEL CIRCUIT CHARACTERISTICS:

1)THE ELECTRICAL VOLTAGE IS THE SAME AT EACH POINT IN THE CIRCUIT.
2)THE ELECTRIC CURRENT IS DIVIDED INTO EACH LOAD.
3) THE CIRCUIT OPERATION IS INDEPENDENT, THAT IS, IF ONE OF THE LOADS IS REMOVED FROM THE CIRCUIT OR STOPS WORKING, THE OTHER LOAD REMAINS WORKING.

ACTIVE, REACTIVE AND APPARENT POWER AND POWER FACTOR

ACTIVE POWER

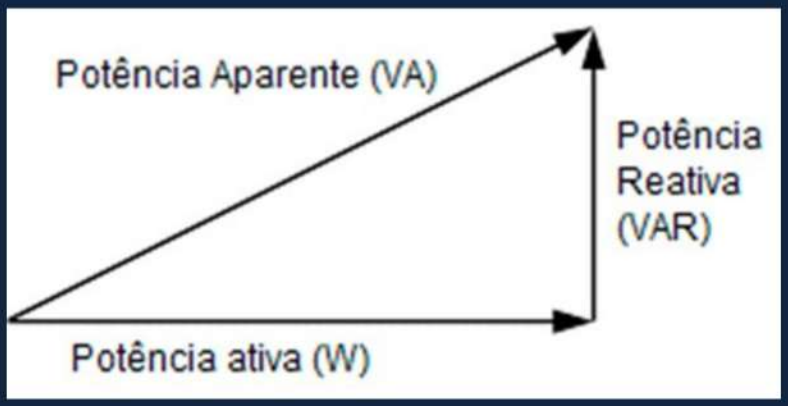
ACTIVE POWER, MEASURED IN KW, IS THAT WHICH EFFECTIVELY CARRIES OUT WORK, GENERATING HEAT, LIGHT, MOVEMENT, ETC.

REACTIVE POWER

REACTIVE POWER, MEASURED IN KVAR, IS USED ONLY IN THE CREATION AND MAINTENANCE OF THE ELECTROMAGNETIC FIELDS OF INDUCTIVE LOADS.

APPARENT POWER

ACTIVE POWER AND REACTIVE POWER, TOGETHER, CONSTITUTE THE APPARENT POWER, MEASURED IN KVA, WHICH IS THE TOTAL POWER GENERATED AND TRANSMITTED TO THE LOAD. THE SO-CALLED POWER TRIANGLE IS USED TO SHOW, GRAPHICALLY, THE RELATIONSHIP BETWEEN ACTIVE, REACTIVE AND APPARENT POWER.



POWER FACTOR

IT IS AN INDEX THAT RELATES THE ACTIVE AND REACTIVE ENERGY OF AN ELECTRICAL INSTALLATION, BEING ONE OF THE MAIN INDICATORS OF ENERGY EFFICIENCY. A POWER FACTOR CLOSE TO 1 INDICATES LOW CONSUMPTION OF REACTIVE ENERGY IN RELATION TO ACTIVE ENERGY.

CONVERSION OF HORSE POWER (HP) TO WATTS

1 HP = 745,69 W

HORSEPOWER (HCV) TO WATTS CONVERSION

1 CV = 735.49 W

SUMMARY OF THE MAIN UNITS OF MEASUREMENT

ELECTRIC GREATNESS	UNIT OF MEASUREMENT	LETTER
ELECTRICAL VOLTAGE	VOLTS	E, U, U, V
ELECTRIC CURRENT	AMPERE	I
ELECTRICAL RESISTANCE	OHM	R
ELECTRIC POWER (DC)	WATT	P
ACTIVE POWER	WATT	P
REACTIVE POWER	VOLT-AMPERE REACTIVE	Q
APPARENT POWER	VOLT-AMPERE	S

INDUSTRIAL ELECTRICAL DEVICES

THERMOMAGNETIC CIRCUIT BREAKER

CIRCUIT BREAKERS ARE SWITCHING AND PROTECTION DEVICES CAPABLE OF INTERRUPTING ELECTRIC CURRENT WHEN ABNORMAL WORKING CONDITIONS ARISE IN THE CIRCUIT THAT RESULT IN AN OVERCURRENT (CURRENT ABOVE THE PERMITTED VALUE) CAUSED BY AN OVERLOAD IN THIS ELECTRIC CIRCUIT OR BY THE OCCURRENCE OF A SHORT CIRCUIT.

TYPES OF CIRCUIT BREAKERS

THERMOMAGNETIC CIRCUIT BREAKER TRIPOLAR

CIRCUIT BREAKER THERMOMAGNETIC BIPOLAR

CIRCUIT BREAKER THERMOMAGNETIC MONOPOLAR

CIRCUIT BREAKER INSIDE

BORNE SUPERIOR

THERMAL TRIGGER (BIMETALLIC)

CONNECTION AND DISCONNECTION MECHANISM

MOBILE CONTACT FIXED

CONTACT EXTINGUISHING CHAMBER

MEGNETIC SHUTDOWN (COIL)

MANEUVERING LEVER

BORNE INFERIOR

CIRCUIT BREAKER PROTECTION

PROTECTION OF
3 PHASES

2-PHASE
PROTECTION

1 PHASE
PROTECTION

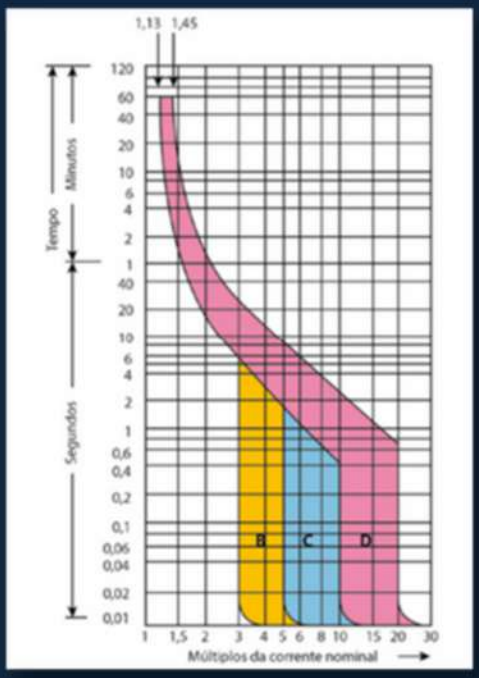
CIRCUIT BREAKER TRIP CHARACTERISTIC CURVE

The ABNT NBR NM 60898 standard defines, for instantaneous actuation of the circuit breaker, curves B, C and D

Circuit breaker Curve B: short-circuit actuation is between 3 and 5 times its nominal current (In). Applied to resistive circuits, such as: incandescent lamps, showers, taps and electric heaters.

Circuit breaker Curve C: short-circuit actuation is between 5 and 10 times its nominal current (In). Applied to inductive circuits, such as: air conditioning units, electric motors, washing machines, etc.

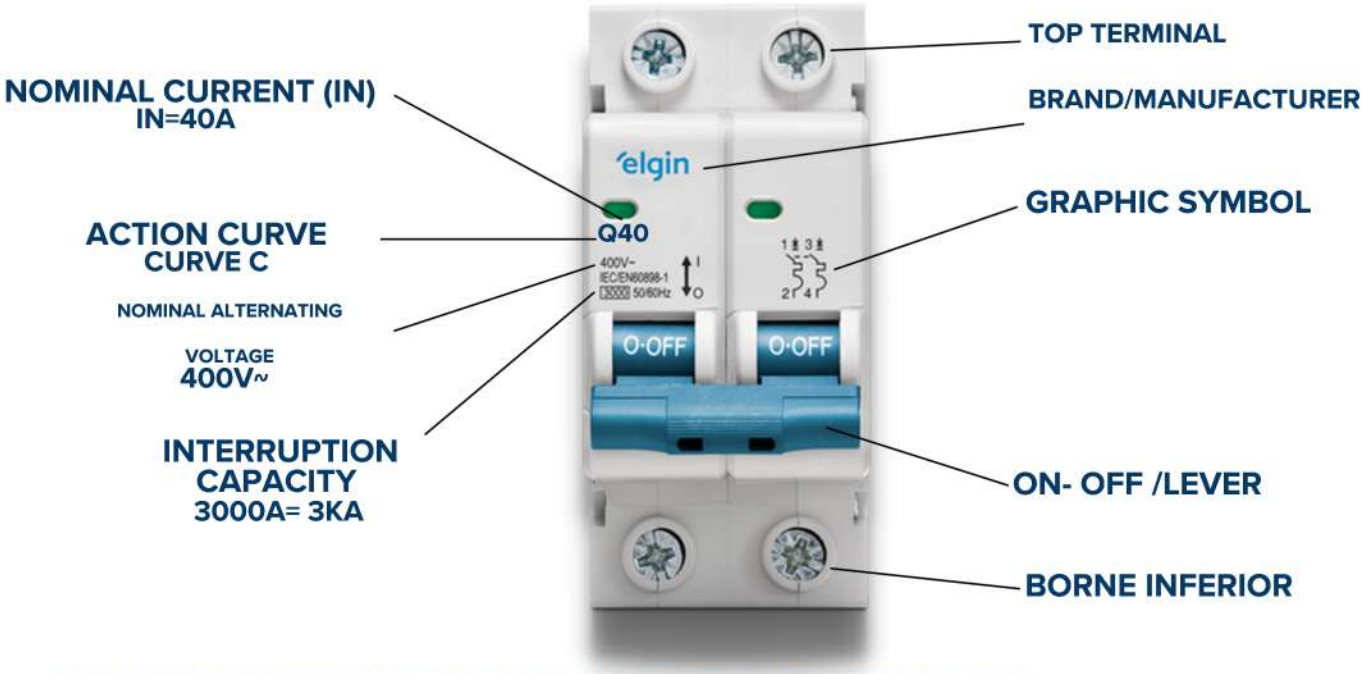
Curve D Circuit Breaker: short-circuit actuation is between 10 and 20 times its nominal current (In). They are used to protect circuits that supply highly inductive loads, such as large motors, large transformers, and circuits with similar loads.



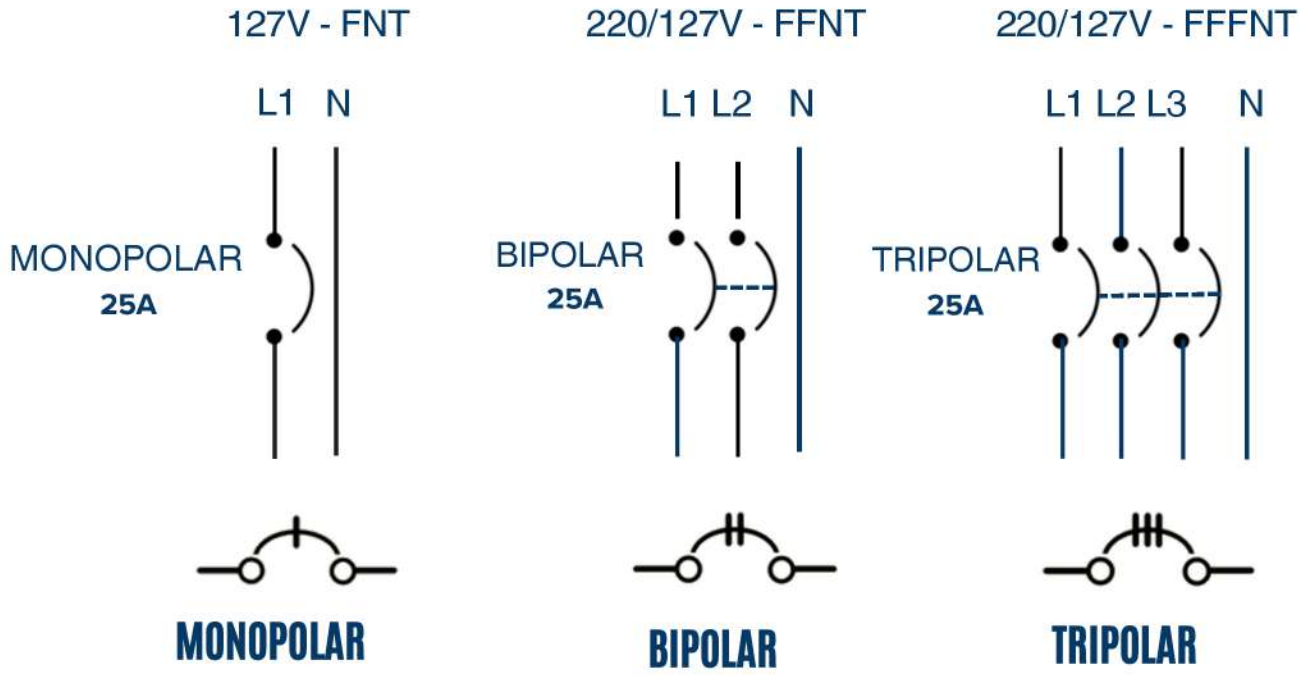
ACCORDING TO NBR NM 60898 AND NBR IEC 60947-2, SEE SOME NOMINAL CURRENT VALUES FOR MINI CIRCUIT BREAKERS:

2A, 4A, 6A, 10 A, 16A, 20A, 25A, 32A, 40A, 50A, 63A, 70A, 80A, 100A, 125A.

THE CIRCUIT BREAKER'S RATED CURRENT (IN) MUST BE GREATER THAN OR EQUAL TO THE CIRCUIT'S DESIGN/RATED CURRENT AND LESS THAN OR EQUAL TO THE CURRENT THAT THE DRIVER CAN HANDLE.



SYMBOLISMS USED FOR THE THERMOMAGNETIC CIRCUIT BREAKER



THE ACTUATION CURVES OF THERMOMAGNETIC CIRCUIT BREAKERS ARE WRITTEN ON THE FRONT

ACTION CURVE
CURVE B

ACTION CURVEACTION CURVE
CURVE C

CURVE D

PRACTICAL APPLICATION

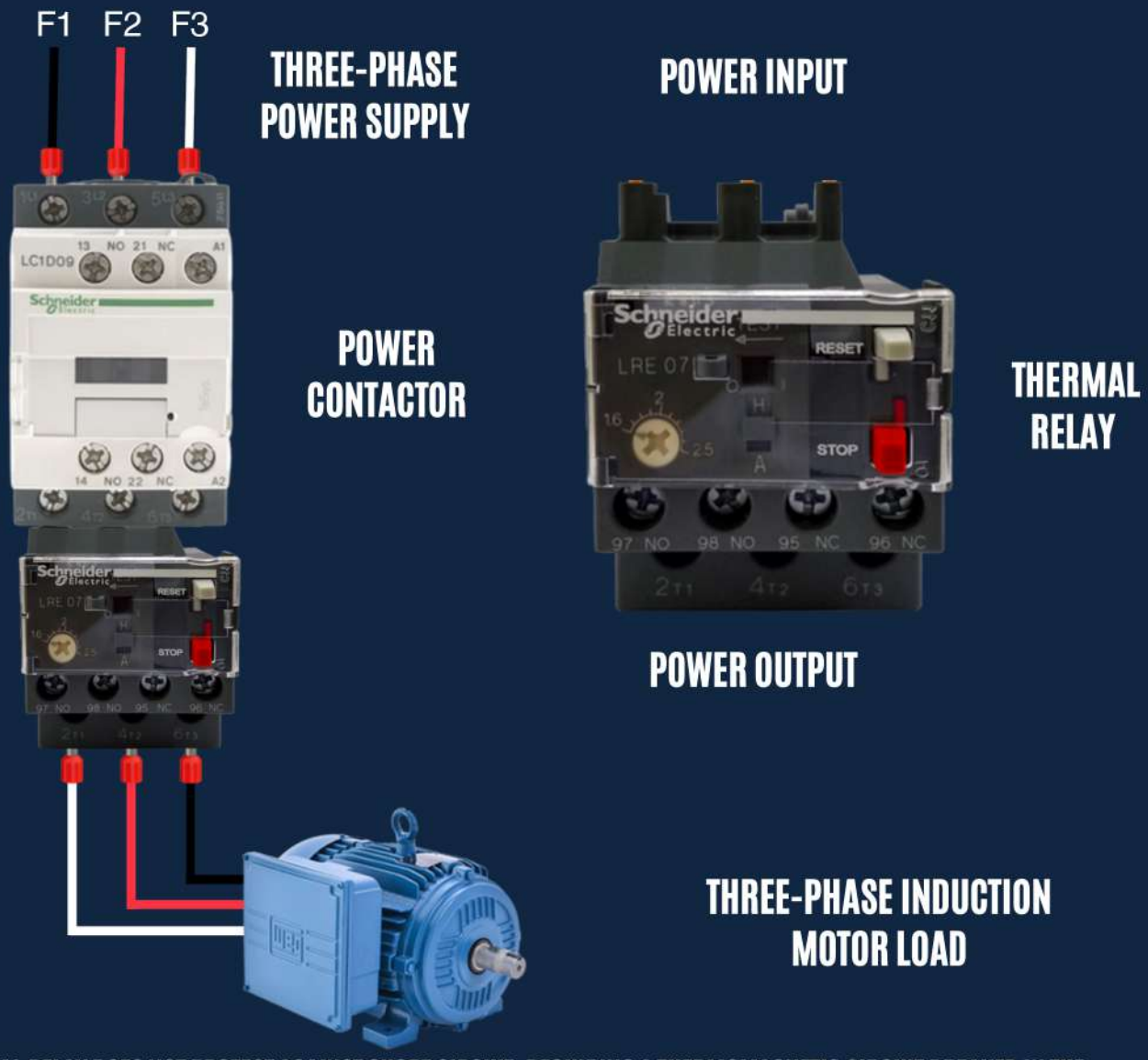
CONTROL PANEL

THREE-POLAR THERMO-MAGNETIC CIRCUIT BREAKER C CURVE

BIPOLAR THEROMAGNETIC CIRCUIT BREAKER CURVE C

THERMAL RELAY

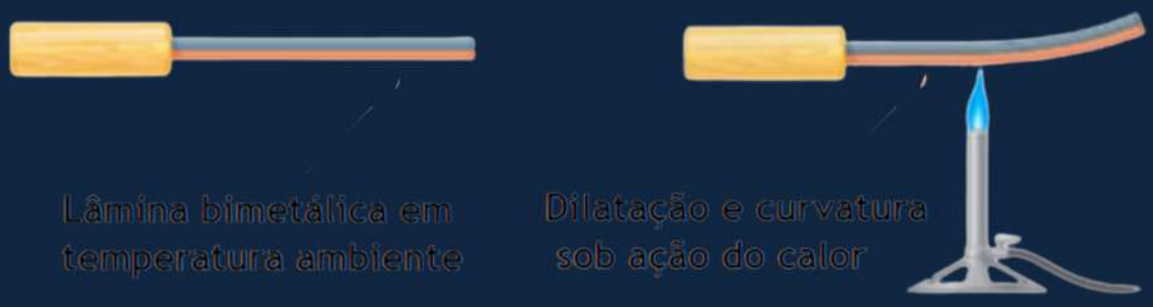
THESE ARE DEVICES THAT USE TO PROTECT MOTORS AGAINST OVERLOAD AND PHASE LACK. THEY ARE NORMALLY CONNECTED BETWEEN THE CONTACTOR AND THE LOAD.



THE THERMAL RELAY DOES NOT PROTECT AGAINST SHORT CIRCUIT, REQUIRING A THERMOMAGNETIC CIRCUIT BREAKER IN THE CIRCUIT

HOW DOES A THERMAL RELAY WORK?

BIMETALLIC BLADES ARE MADE BY JOINING TWO DIFFERENT METALS, NORMALLY NICKEL-IRON. AS THESE METALS HAVE DIFFERENT EXPANSION COEFFICIENTS, THE BLADES BEND UNDER THE ACTION OF HEAT.

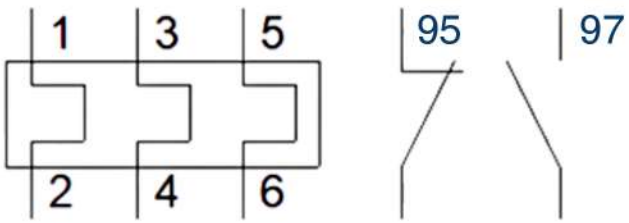


THE THERMAL RELAY HAS 3 BIMETALLIC BLADES, WHERE EACH ONE IS WOUND BY THE CONDUCTING WIRE RESPONSIBLE FOR POWERING THE LOAD. WHEN AN OVERLOAD OR A PHASE LACK OCCURS IN THE CIRCUIT, THE MOTOR CURRENT WILL INCREASE AS THIS MOTOR CURRENT IS THE SAME THAT PASSES THROUGH THE WIRES WOUND IN THE BIMETALLIC BLADES, THE TEMPERATURE IN THE BLADES WILL ALSO INCREASE, WHICH WILL CAUSE THEM TO BEND UNDER THE ACTION OF HEAT, INTERNALLY ACTIVATING A MECHANISM AND ACTIVATING THE NORMALLY OPEN (NO) AND NORMALLY CLOSED (NC) AUXILIARY CONTACTS.

NORMALLY OPEN (NO) CONTACT = 97 AND 98

NORMALLY CLOSED (NC) CONTACT = 95 AND 96

SYMBOLISMS USED FOR THERMAL RELAY



ELECTRICAL VOLTAGE INPUT

ELECTRICAL VOLTAGE OUTPUT FOR THE MOTOR

UPPER MAIN CONTACT TERMINALS: THIS IS WHERE THE POWER SUPPLY ENTERS AND, AFTER PASSING THROUGH THE CONTACTOR, ENTERS THE THERMAL RELAY.

TEST BUTTON: THIS BUTTON CHECKS THAT THE RELAY IS FUNCTIONING CORRECTLY BEFORE EVEN POWERING THE CIRCUIT. WHEN YOU PRESS THIS BUTTON, THE NORMALLY CLOSED (NC) CONTACT OPENS AND THE NORMALLY OPEN (NO) CONTACT CLOSES. IN THIS WAY WE CHECK WHETHER THE CIRCUIT WILL BE PROTECTED OR NOT IN THE EVENT OF OVERLOAD.

NOMINAL CURRENT ADJUSTMENT: WITH A THIN SCREWDRIVER IT IS POSSIBLE TO ADJUST THE RELAY ACCORDING TO THE CURRENT OF THE LOAD (MOTOR) THAT WILL BE PROTECTED, ACCORDING TO THE SIZING.

RESET/REARM BUTTON: THIS BUTTON IS USED WHEN THE THERMAL RELAY IS CONFIGURED TO WORK IN MANUAL RESET, WHEN THERE IS A FAILURE, IT WILL BE NECESSARY TO PRESS THE RESET/REARM BUTTON TO ALLOW THE THERMAL RELAY TO WORK AGAIN. STOP BUTTON: THIS BUTTON IS DIRECTLY CONNECTED TO THE NORMALLY CLOSED (NC) CONTACT OF THE THERMAL RELAY, CONTACT 95 AND 96. WHEN PRESSING THIS STOP BUTTON, CONTACT 95 AND 96 WILL OPEN, DISCONNECTING THE CIRCUIT.

MANUAL (H) OR AUTOMATIC (A) RESET BUTTON: IN THE MANUAL (H) POSITION, THE RELAY WILL DISARM, TURNING OFF THE CIRCUIT AND WILL ONLY RESET AGAIN IF THE OPERATOR PRESSES THE RESET BUTTON TO RECONNECT THE CIRCUIT. IN THE AUTOMATIC (A) POSITION, THE RELAY WILL DISARM, TURNING OFF THE CIRCUIT AND WILL RESET BY ITSELF, AFTER THE BLADES HAVE COOLED, TURNING THE CIRCUIT ON AUTOMATICALLY.

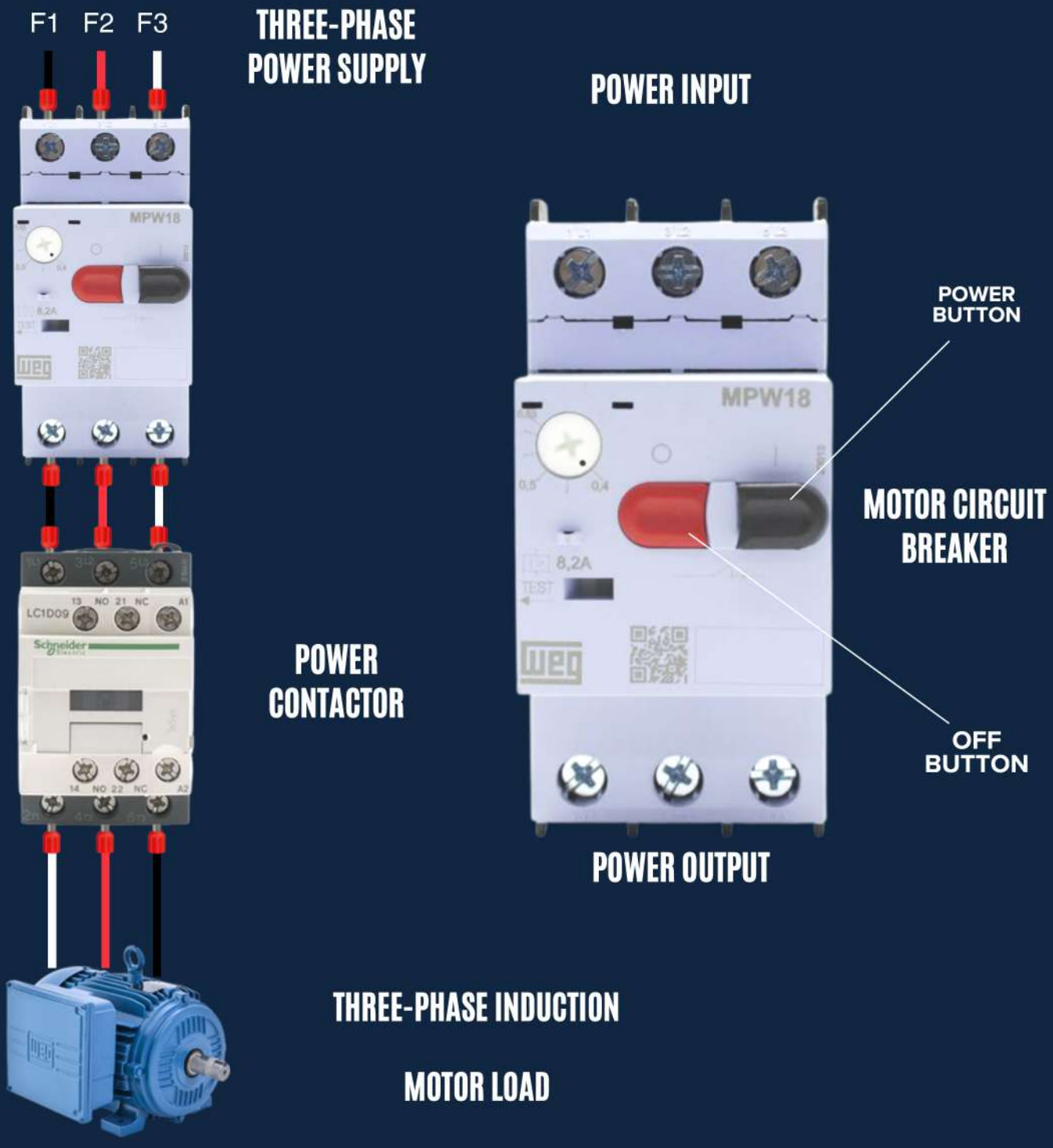
LOWER MAIN CONTACT TERMINALS: WHERE THE POWER OUTPUT FOR THE ELECTRIC MOTOR IS CONNECTED.

PRACTICAL APPLICATION

CONTROL PANEL

MOTOR CIRCUIT BREAKER

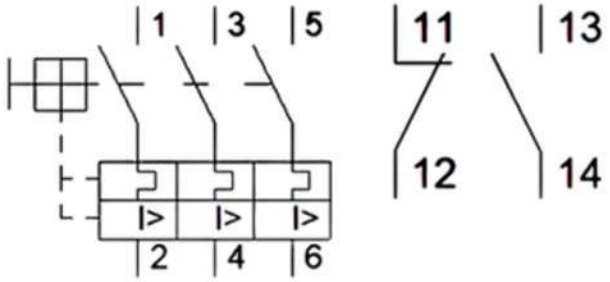
MOTOR CIRCUIT BREAKERS ARE DEVICES THAT, IN ADDITION TO PROTECTING ELECTRICAL INSTALLATIONS AGAINST SHORT CIRCUITS, PROTECT THE MOTOR AGAINST OVERLOAD. THEY COMBINE THE FUNCTIONS OF A CIRCUIT BREAKER AND A THERMAL RELAY IN THE SAME DEVICE. THEY ARE USED TO PROTECT ELECTRICAL CIRCUITS AND TO START AND/OR PROTECT MOTORS. THEY HAVE A HIGH CURRENT INTERRUPTION CAPACITY, WHICH FAVORS THEIR APPLICATION IN INSTALLATIONS WITH A HIGH RATE OF SHORT CIRCUITS.



NORMALLY OPEN (NO) CONTACT = 13 AND 14

NORMALLY CLOSED (NC) CONTACT = 21 AND 22

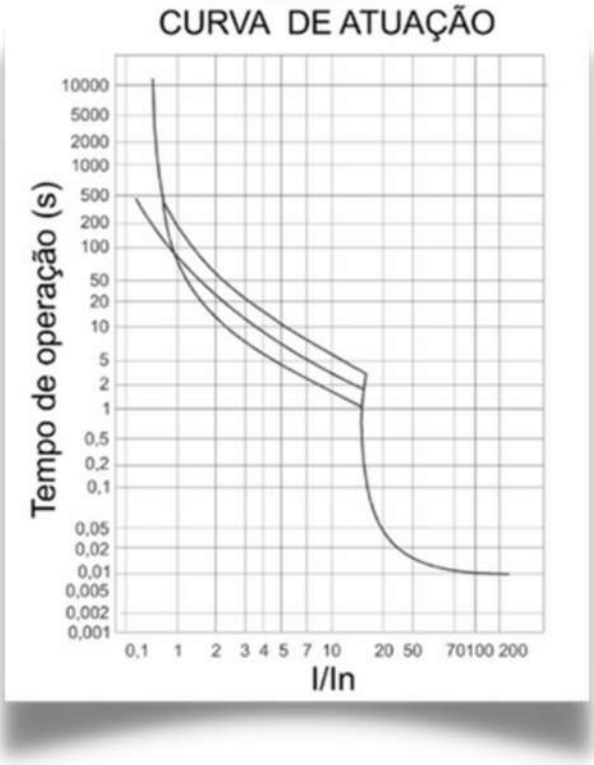
SYMBOLISMS USED FOR MOTOR CIRCUIT BREAKERS



CONTACTS MAIN CONTACTS
AUXILIARY CONTACTS

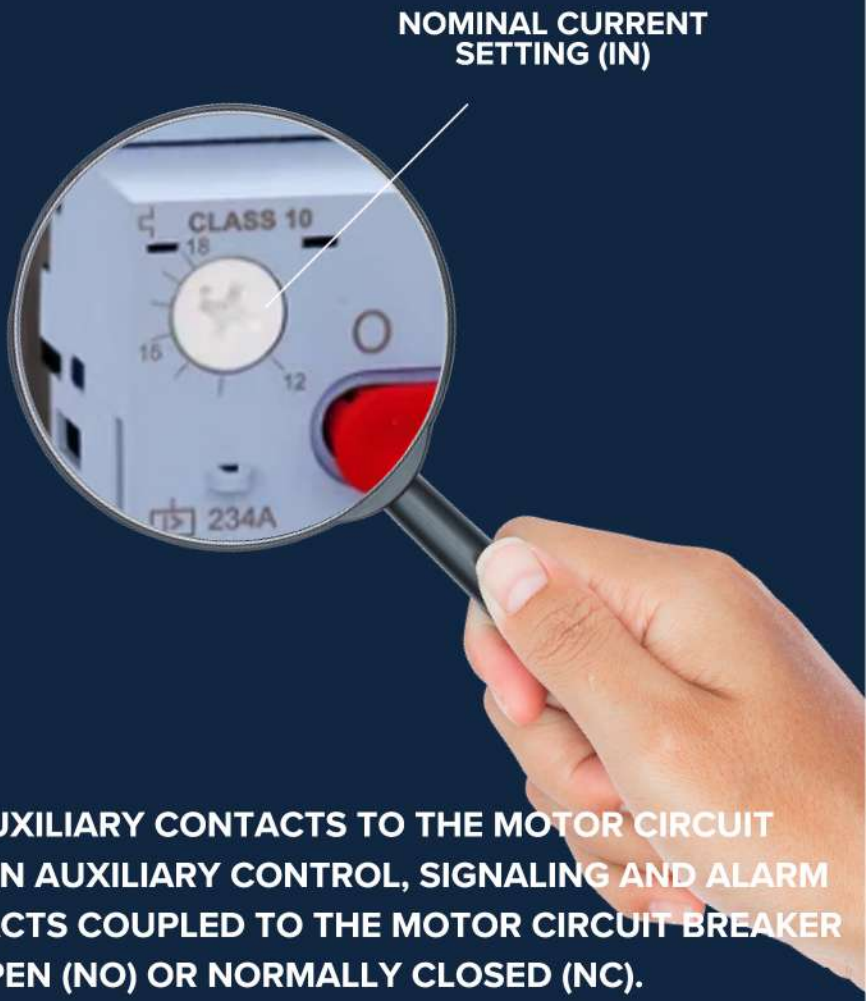
HOW DOES A MOTOR CIRCUIT BREAKER WORK?

TO TURN ON THE MOTOR CIRCUIT BREAKER, SIMPLY ACTUATE A HANDLE, PRESSING OR TURNING DEPENDING ON THE MODEL USED. WHEN THE CIRCUIT BREAKER IS TURNED ON, ITS AUXILIARY CONTACTS CHANGE POSITION, THAT IS, THE NORMALLY OPEN CONTACTS CLOSE, AND THE NORMALLY CLOSED CONTACTS OPEN. THROUGH MAGNETIC TRIGGERING, THE MOTOR CIRCUIT BREAKER OFFERS PROTECTION AGAINST SHORT CIRCUITS, SINCE IT WILL DISCONNECT (OPEN) THE ELECTRIC CURRENT WHENEVER IT REACHES 13X THE REGULATED TRIGGER CURRENT. THE THERMAL TRIGGER IS RESPONSIBLE FOR PROTECTION AGAINST OVERLOAD AND PHASE LACK. ITS PRINCIPLE OF ACTION IS THROUGH BIMETALLIC MATERIALS WITH DIFFERENT EXPANSION COEFFICIENTS. WHEN OVERHEATING OCCURS, THE BIMETALLIC BLADES DEFORM, CAUSING THE CIRCUIT BREAKER TO OPEN THE CIRCUIT. WHEN THE CIRCUIT IS OPENED, THE AUXILIARY CONTACTS RETURN TO THEIR ORIGINAL POSITION.



The characteristic curve on the side corresponds to a motor circuit breaker with an adjustment range from 24 A to 32 A.

THE MOTOR CIRCUIT BREAKER HAS ADJUSTMENT IN THE OVERLOAD PROTECTION ON ITS FRONT PART. THIS ADJUSTMENT ALLOWS FOR BETTER PERFORMANCE IN THE EVENT OF OVERLOAD IN RELATION TO CIRCUIT BREAKERS WITH THERMOMAGNETIC FUNCTIONS. THIS ADJUSTMENT HAS AN ACTUATION RANGE WITH MINIMUM AND MAXIMUM CURRENT THAT IT WILL SUPPORT. EXAMPLE: 12 A TO 18 A



IT IS POSSIBLE TO ATTACH AUXILIARY CONTACTS TO THE MOTOR CIRCUIT BREAKER, WHICH CAN BE USED IN AUXILIARY CONTROL, SIGNALING AND ALARM CIRCUITS. THE AUXILIARY CONTACTS COUPLED TO THE MOTOR CIRCUIT BREAKER CAN BE NORMALLY OPEN (NO) OR NORMALLY CLOSED (NC).

CONTACTS NORMALLY CLOSED (21 AND 22)

CONTACTS NORMALLY OPEN (13 AND 14)

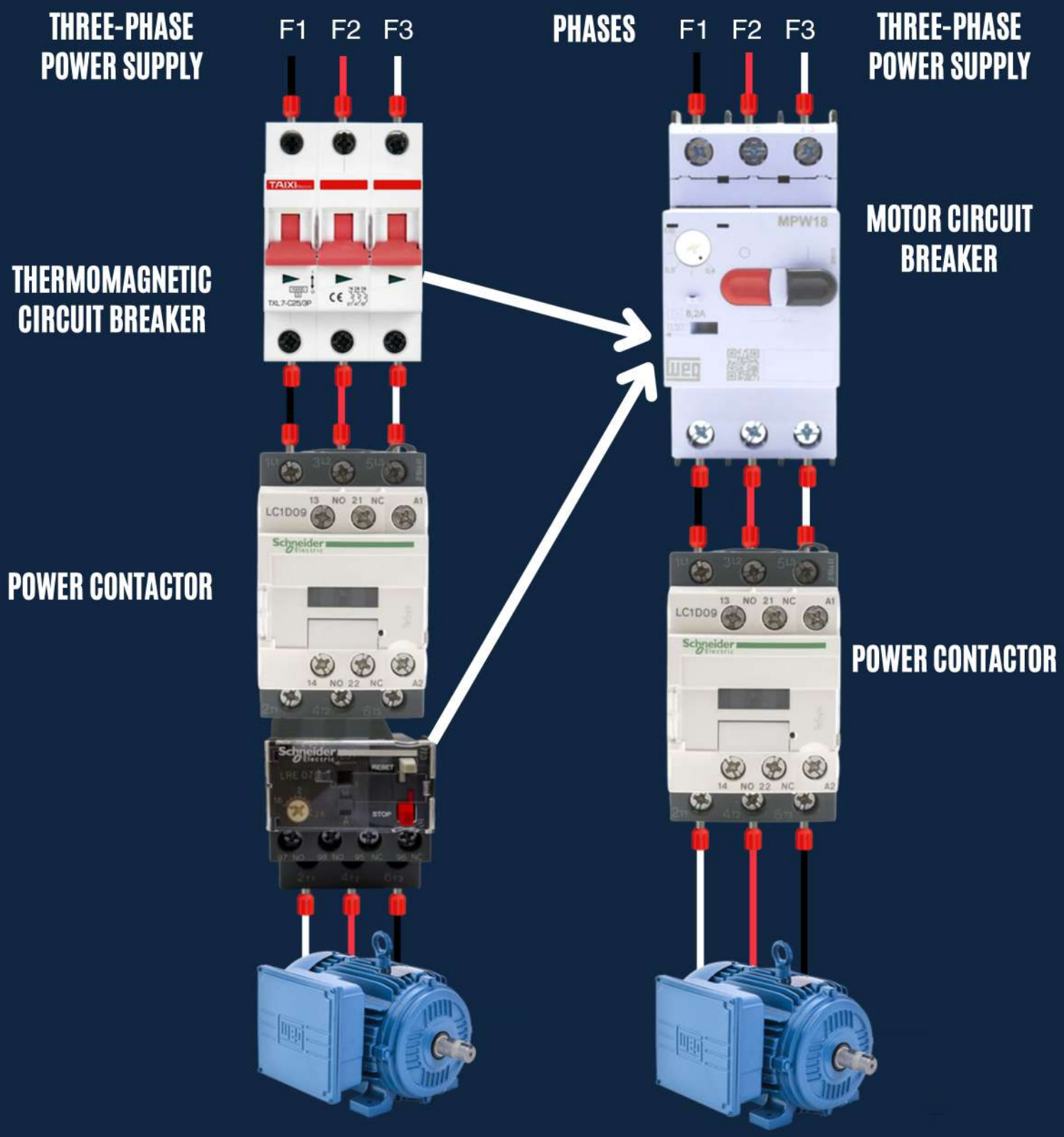
ADVANTAGES OF USING THE MOTOR CIRCUIT BREAKER

POSSIBILITY OF STARTING AT FULL VOLTAGE. YES, THEY CAN SUPPORT A STARTING OF 8X TO 10X THE NOMINAL CURRENT OF A MOTOR. EVEN IF THIS MOTOR IS SUBJECT TO A HIGH STARTING TORQUE, MOTOR CIRCUIT BREAKERS ARE MANUFACTURED TO WITHSTAND THIS MOMENTARY OVERLOAD DURING THE MOTOR STARTING, WITHOUT AFFECTING THE EFFICIENT PROTECTION OF THE CIRCUIT. A COMMON CIRCUIT BREAKER WOULD OPEN THE CIRCUIT AT THE TIME OF STARTING, WHICH WOULD REQUIRE OVERSIZING IT, CAUSING THE CIRCUIT TO NOT BE WELL SIZED, LOSING THE EFFICIENT PROTECTION.

PRACTICAL APPLICATION

IMPORTANT NOTE: WHEN A MOTOR CIRCUIT BREAKER IS USED IN THE CIRCUIT, IT IS NOT NECESSARY TO USE A THERMAL RELAY, AS THE MOTOR CIRCUIT BREAKER ALREADY PERFORMS ITS FUNCTION. THEREFORE, YOU USE ONE OR THE OTHER, NEVER BOTH IN THE SAME CIRCUIT!

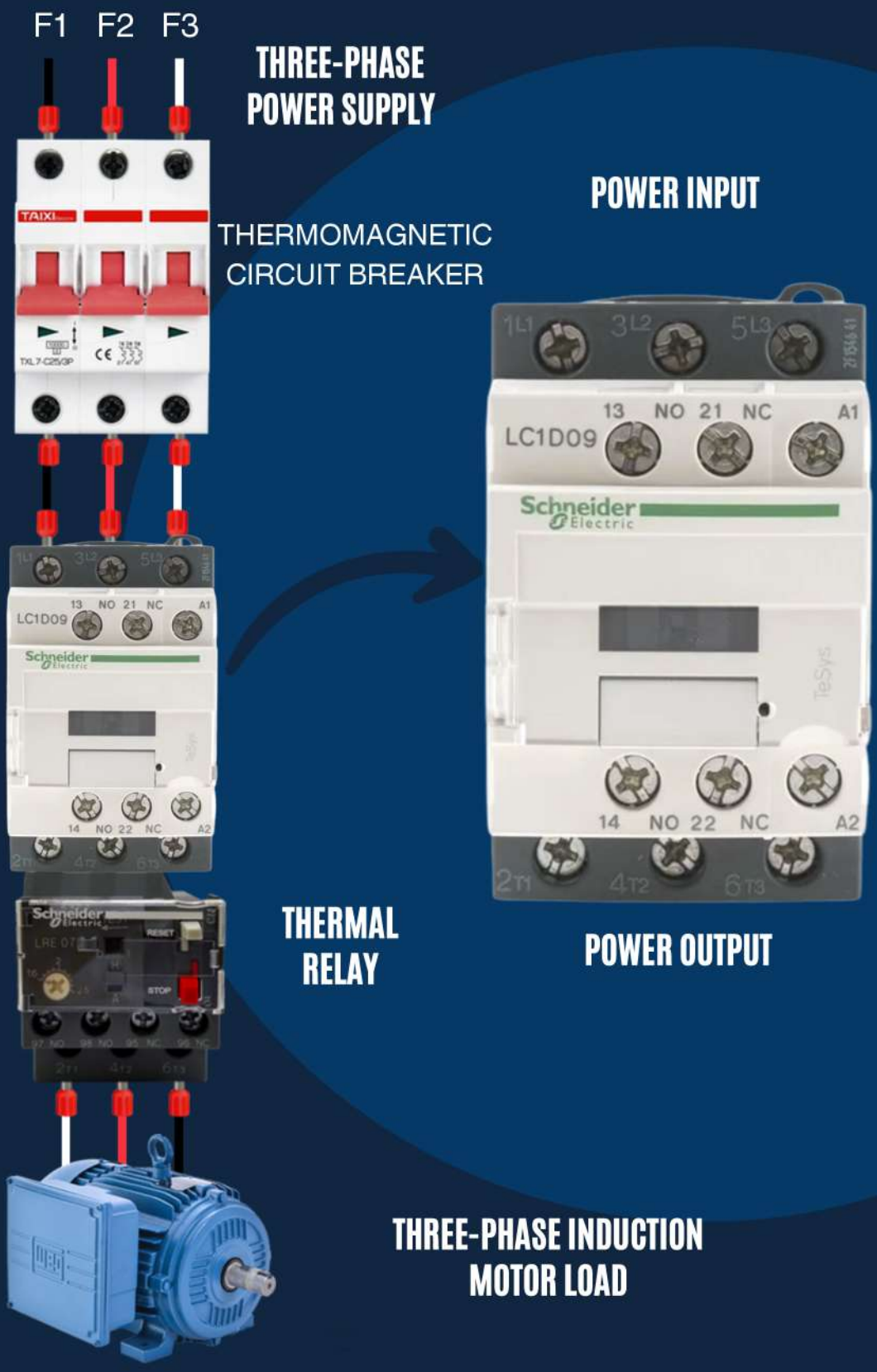
IN YOUR PROJECT, YOU CAN CHOOSE TO USE THE MOTOR CIRCUIT BREAKER INSTEAD OF THE THERMAL RELAY AND THERMOMAGNETIC CIRCUIT BREAKER, AS THE MOTOR CIRCUIT BREAKER REPLACES THE FUNCTIONS OF BOTH.



WITH THIS, YOU REDUCE SPACE ON YOUR PANEL AND THE NUMBER OF CONNECTIONS

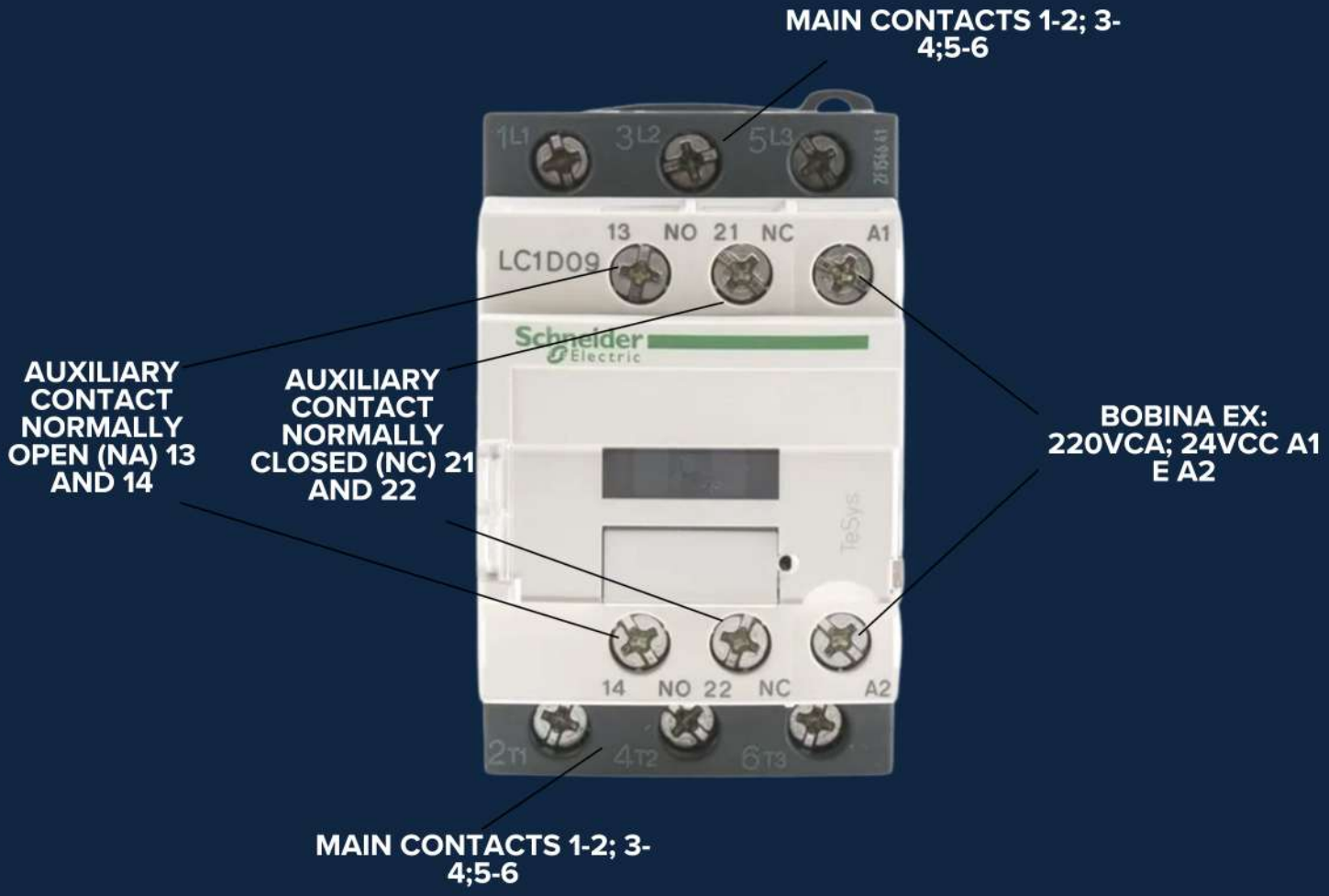
POWER CONTACTOR

THE CONTACTOR IS A MANEUVERING DEVICE ACTIVATED ELECTROMAGNETICALLY BY A COIL, WHICH IS USED TO CONTROL, THAT IS, TO TURN ON OR OFF, VARIOUS LOADS IN INDUSTRIAL INSTALLATIONS, SUCH AS ELECTRIC MOTORS, LIGHTING AND HEATING DEVICES, AMONG OTHERS.



THE POWER CONTACTOR HAS MAIN AND AUXILIARY CONTACTS MAIN CONTACTS: THEY SUPPORT THE NOMINAL CURRENT OF THE LOAD (MOTOR), AS THE POWER PASSES THROUGH THESE CONTACTS

AUXILIARY CONTACTS: THEY SUPPORT A LOWER CURRENT AND ARE USED TO ACTIVATE THE CONTROL AND SIGNALING CIRCUIT



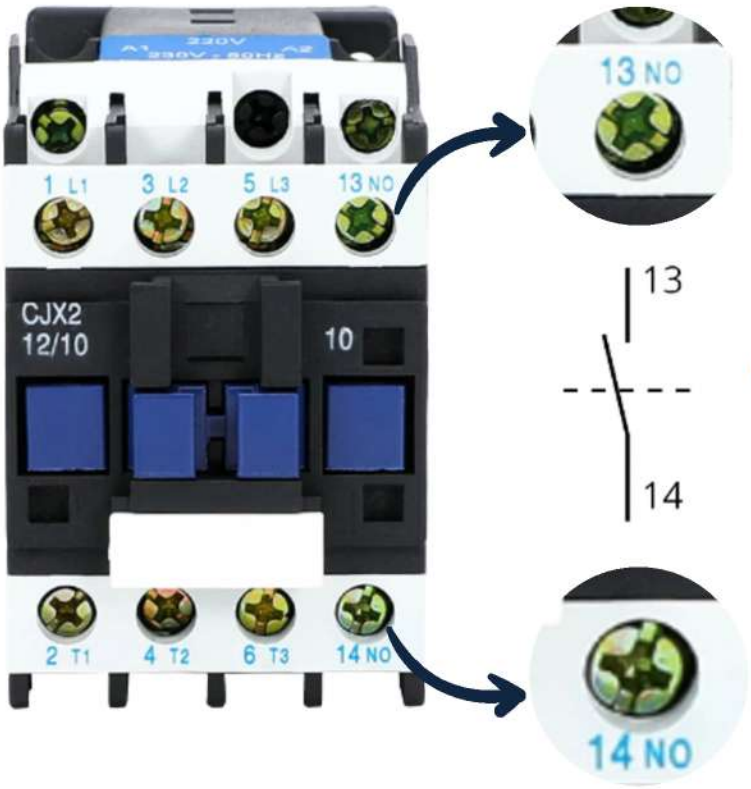
IN THE MAIN CONTACTS, THE NUMBERING IS WITH ONLY 1 DIGIT, WITH THE POWER INPUT IN THE ODD NUMBERS (1 (L1) - 3 (L2) - 5 (L3)) AND THE OUTPUT IN THE EVEN NUMBERS (2 (T1) - 4 (T2) - 6 (T3)). THE MAIN CONTACTS ARE ALWAYS NORMALLY OPEN (NO).

AUXILIARY CONTACTS ARE IDENTIFIED WITH 2-DIGIT NUMBERS. IF THE CONTACT NUMBERING END WITH 1 AND 2 (11-12,21-22,31-32, ETC.), THEY WILL BE NORMALLY CLOSED CONTACTS - NC AND IF THEY END WITH 3 AND 4 (13-14, 23-24, 33-34, ETC.), THEY WILL BE NORMALLY OPEN CONTACTS - NO.

COIL TERMINALS CAN BE INDICATED BY A1 AND A2

AUXILIARY CONTACTS

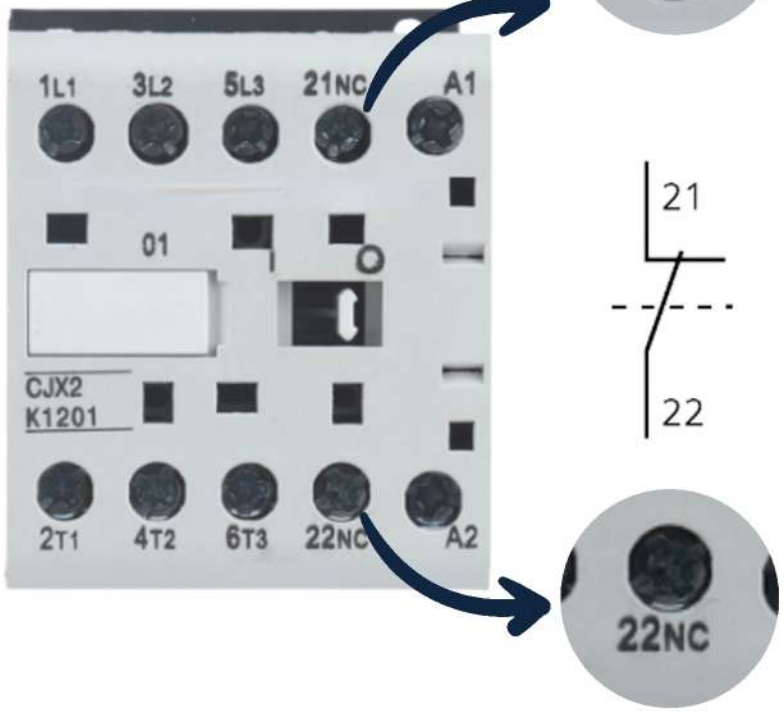
POWER CONTACTOR



AUXILIARY CONTACT

NORMALLY OPEN (NO) CONTACT, WITH TERMINATION 3 AND 4
OTHER EXAMPLES: 23 AND 24 43 AND 44 63 AND 64

MINI POWER CONTACTOR



AUXILIARY CONTACT

NORMALLY CLOSED (NC) CONTACT, WITH TERMINATION 1 AND 2
OTHER EXAMPLES: 31 AND 22 41 AND 42 61 AND 62

IN THE TWO CONTACTORS SHOWN ABOVE, CONTACT BLOCKS CAN BE ADDED, WITH NORMALLY OPEN (NO) AND NORMALLY CLOSED (NC) CONTACTS

AUXILIARY CONTACTS BLOCK

POWER CONTACTOR

THIS SLOT IS FOR FITTING THE CONTACT BLOCK

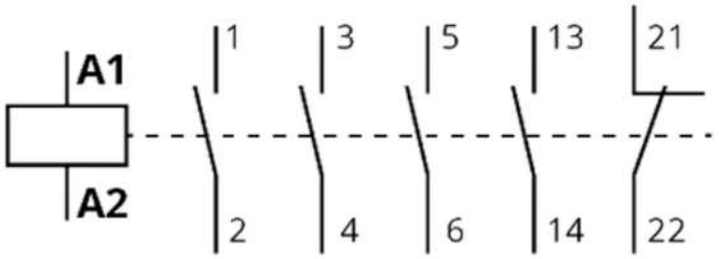
AUXILIARY CONTACTS BLOCK

AUXILIARY CONTACT BLOCK

THE CONTACT BLOCK SHOWN ON THE RIGHT HAS TWO NORMALLY OPEN (NO) CONTACTS (53 AND 54 / 83 AND 84) AND TWO NORMALLY CLOSED (NC) CONTACTS (81 AND 82 / 71 AND 72)

THERE IS ALSO A MODEL WITH TWO AUXILIARY CONTACTS, THE MOST COMMON ONE, WITH A NORMALLY OPEN CONTACT (NO) AND A NORMALLY CLOSED CONTACT (NC)

SYMBOLISMS USED FOR POWER CONTACTORS

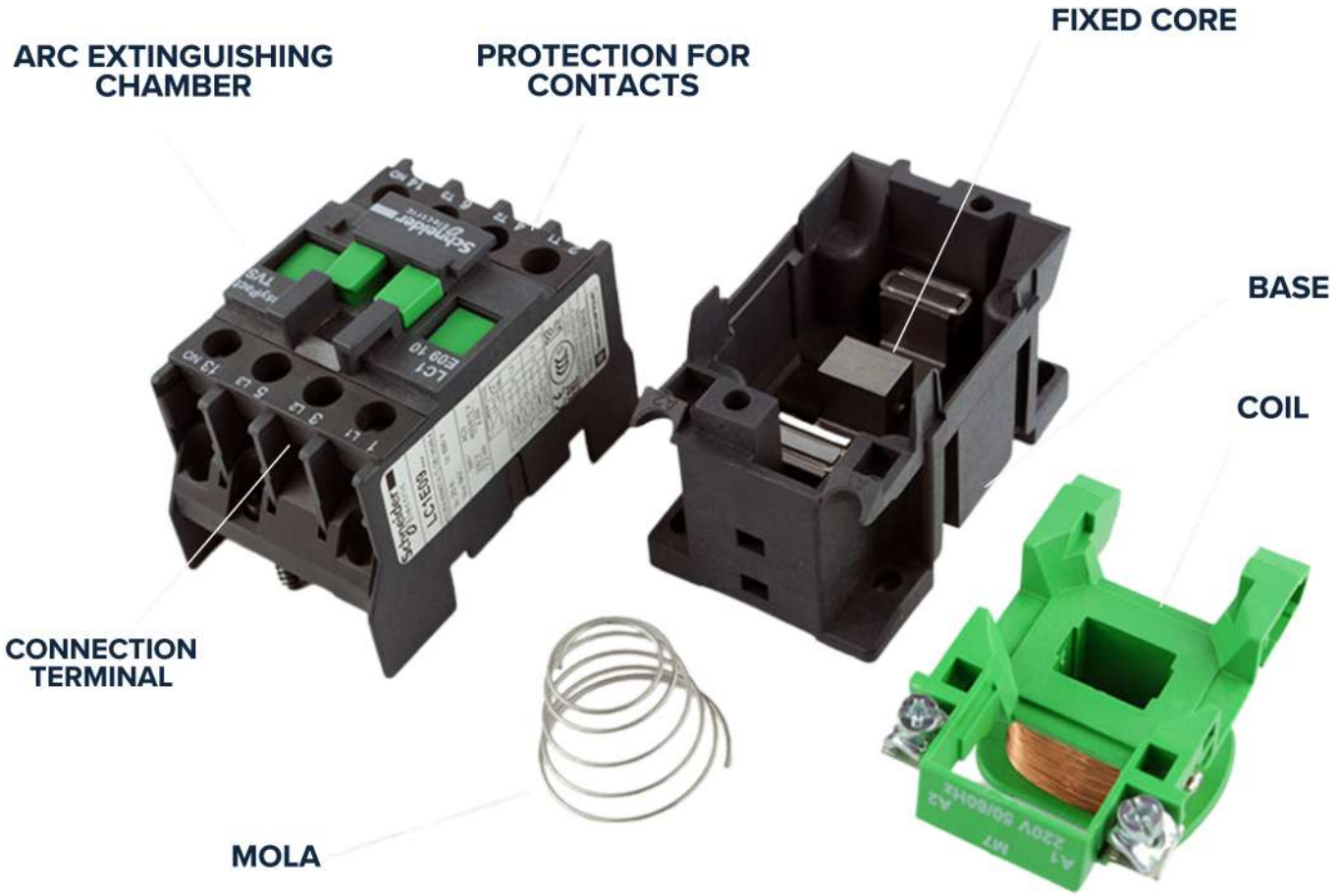


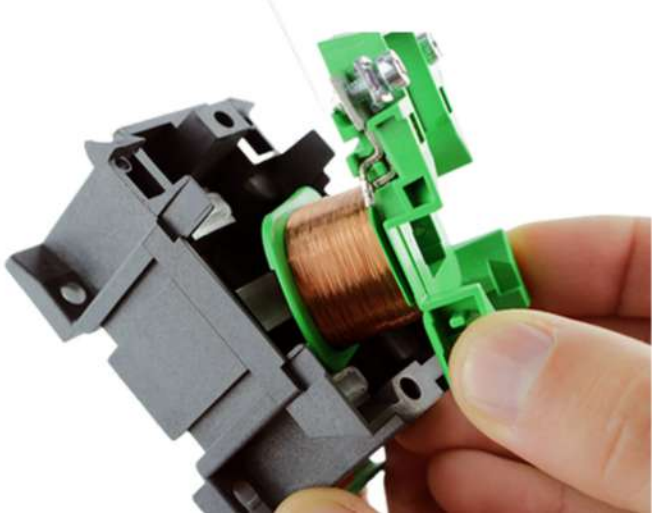
COIL

MAIN CONTACTS

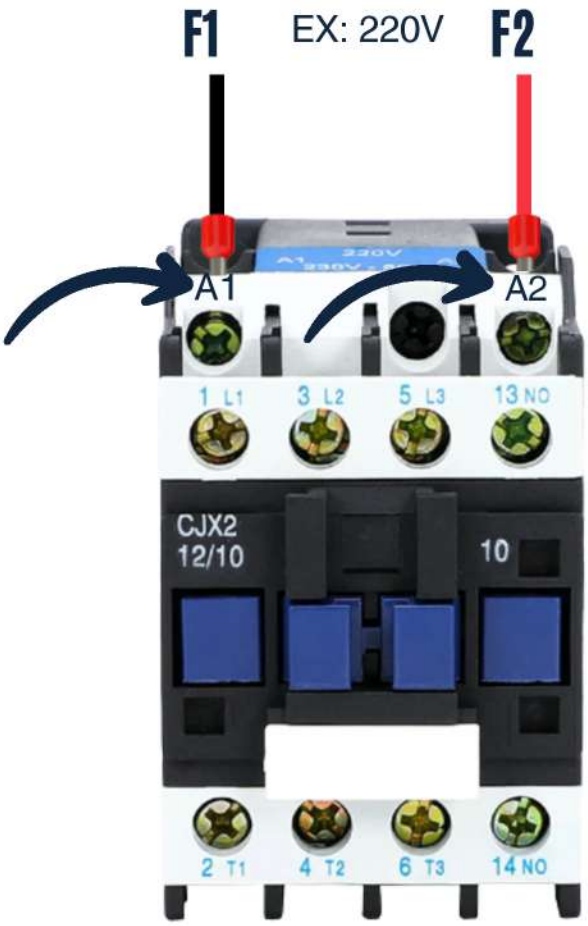
AUXILIARY CONTACTS

CONTACTOR INSIDE

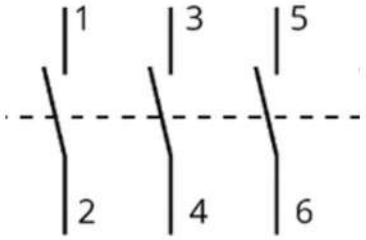




HOW DOES A CONTACTOR WORK?



HOW A CONTACTOR WORKS IS VERY SIMPLE TO UNDERSTAND. WHEN YOU SUPPLY ELECTRICITY TO THE COIL OF CONTACTOR A1 AND A2, IT ACTIVATES MAGNETICALLY AND CLOSES THE CONTACTS THAT WERE NORMALLY OPEN (NO) AND OPENS THE CONTACTS THAT WERE NORMALLY CLOSED (NC). WHEN YOU TURN OFF THE COIL, THE CONTACTS RETURN TO ITS ORIGINAL STATE.



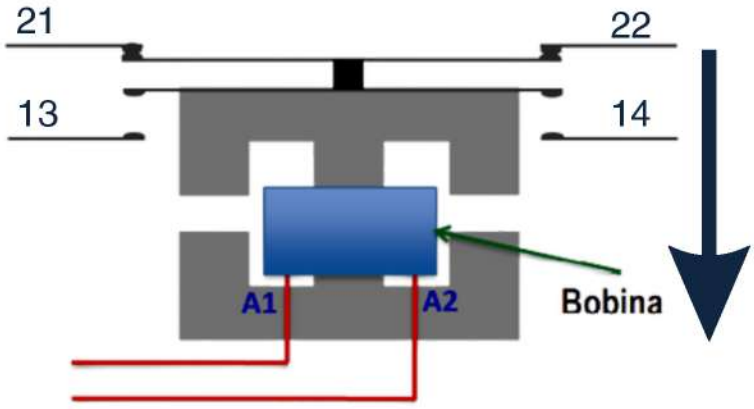
MAIN CONTACTS

FOR EXAMPLE: IN THE MAIN CONTACTS (1 AND 2 / 3 AND 4 / 5 AND 6) THEY ARE NORMALLY OPEN, AT THE MOMENT THE COIL IS ENERGIZED

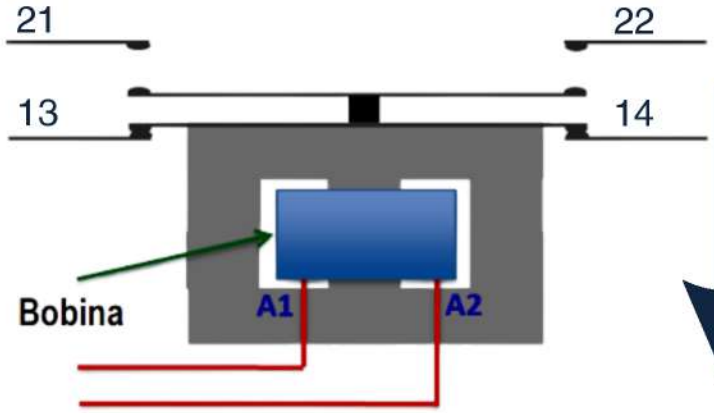
MAIN CONTACTS ARE CLOSED.

DE-ENERGIZE THE COIL AND THEY WILL OPEN AGAIN

POWER CONTACTOR



INITIALLY THE COIL IS NOT POWERED, SO CONTACTS 13 AND 14 ARE OPEN AND CONTACTS 21 AND 22 ARE CLOSED. THE CONTACTOR COIL CAN BE POWERED BY ALTERNATING OR DIRECT CURRENT DEPENDING ON THE MODEL (EX: 220VAC) OR (24VDC), IN THE CASE OF THE 24 VDC MODEL IT WILL NEED A POWER SUPPLY.



NOTICE THAT WHEN THE COIL IS POWERED, IT CREATES A MAGNETIC FIELD AND ATTRACTS THE MOBILE CORE CAUSING CONTACT 13 AND 14 TO CLOSE AND THE

CONTACT 21 AND 22
ABRA

ADVANTAGES OF USING THE CONTACTOR

THEY CAN BE CONTROLLED REMOTELY AND CAN CONTROL LOADS (MOTORS) FROM SEVERAL DIFFERENT LOCATIONS; IN THE EVENT OF A POWER OUTAGE, THE LOAD WILL ONLY SWITCH ON AGAIN IF THE OPERATOR ACTIVATES THE CIRCUIT AGAIN; IT ALLOWS THE ASSEMBLY OF SEVERAL DIFFERENT CIRCUITS, WITH SEMI-AUTOMATIC OR AUTOMATIC CONTROLS, AMONG OTHERS.

JOB CATEGORY OF CONTACTORS

THESE CATEGORIES ARE NAMED AC (ALTERNATING CURRENT), FOR INDUCTION MOTORS

AC 1 – INTENDED FOR RESISTIVE LOADS AND ALL ALTERNATING CURRENT DEVICES WITH A POWER FACTOR GREATER THAN 95%.

AC 2 – FOR STARTING RING MOTORS, WITH AND WITHOUT COUNTERCURRENT BRAKING.

AC 3 – FOR STARTING INDUCTION MOTORS AND SHORT-CUT ROTORS. ENGINE STARTING AND STOPPING IN NORMAL OPERATION.

AC 4 – FOR STARTING INDUCTION MOTORS WITH SHORT-CIRCUIT ROTORS, HOWEVER WITH INTERMITTENT CONNECTION, COUNTER-CURRENT BRAKING AND REVERSAL.

PRACTICAL APPLICATION

CONTROL PANEL

AUXILIARY CONTACTOR

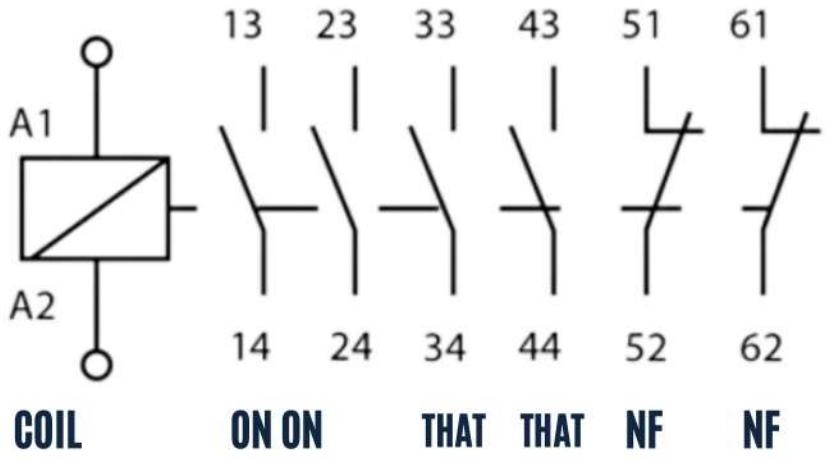
ALSO KNOWN AS COMMAND CONTACTORS, THEY ARE INTENDED TO CONTROL SMALL LOADS (COILS, SIGNALING, VALVES, ETC.) AND ARE USED IN AUXILIARY OR COMMAND CIRCUITS

AUXILIARY
CONTACTOR

THE OPERATION OF THE AUXILIARY CONTACTOR IS BASICALLY THE SAME AS THE POWER CONTACTOR, THE ONLY DIFFERENCE IS THAT IT DOES NOT HAVE MAIN CONTACTS, SUCH AS: (1 AND 2; 3 AND 4; 5 AND 6), ONLY NORMALLY OPEN (NO) AND NORMALLY CLOSED (NC) AUXILIARY CONTACTS AND COIL A1 AND A2.

IN THE AUXILIARY CONTACTOR ON THE SIDE WE HAVE TWO NORMALLY OPEN (NA) CONTACTS (13 AND 14; 43 AND 44) AND TWO NORMALLY CLOSED CONTACTS (21 AND HELP HAVE OTHER CONTACT SETTINGS 22; 31 AND 32), HOWEVER NOTHING PREVENTS THE CONTACTOR

SYMBOLISM USED FOR AUXILIARY CONTACTOR



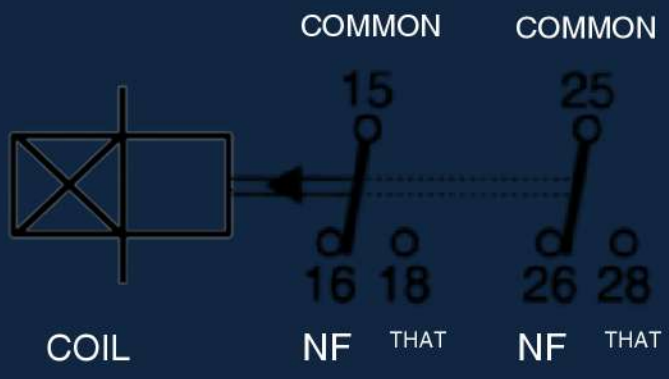
IT IS WORTH REMEMBERING THAT YOU SHOULD NOT USE THE AUXILIARY CONTACTOR CONTACTS TO POWER THE LOAD (ELECTRIC MOTOR), AS THEY ARE NOT MANUFACTURED FOR THIS PURPOSE AND MAY CAUSE PROBLEMS IN THE OPERATION OF THE MACHINE.

ON DELAY ELECTRONIC TIMER

THE TIME RELAY OR TIMER RELAY IS AN ELECTRO-ELECTRONIC DEVICE THAT HAS A TIME ADJUSTMENT, TO OPERATE WITH A DELAY IN THE ACTIVATION OF THE CIRCUIT. WIDELY USED IN AUTOMATION OF MACHINES AND INDUSTRIAL PROCESSES SUCH AS MOTOR STARTERS, CONTROL PANELS, INDUSTRIAL OVENS, INJECTION MACHINES, AMONG OTHERS.

THROUGH AN ELECTRONIC CIRCUIT, THE TIMER ACTIVATES ITS CONTACTS AFTER A PRE-DETERMINED TIME, AN ELECTROMAGNETIC COIL, WHICH WILL MOVE (OPEN AND/OR CLOSE) THE RELAY'S MOVING CONTACTS. IN THE TIMER RELAY PRESENTED ABOVE, IT HAS ONLY ONE NORMALLY OPEN CONTACT (NO - 18) AND ONE NORMALLY CLOSED CONTACT (NC - 16), BOTH INTERCONNECTED BY A COMMON POINT (15). IN OTHER MODELS IT IS POSSIBLE TO HAVE MORE THAN ONE SET OF CONTACTS FOR ACTIVATION, SUCH AS: NORMALLY OPEN CONTACT (NO - 28), NORMALLY CLOSED CONTACT (NC - 26) AND COMMON (25). TO POWER THE TIMER ACCORDING TO THE MODEL ABOVE IT IS POSSIBLE THROUGH TERMINALS A1 AND A2 WITH A VOLTAGE BETWEEN 94 VAC AND 242 VAC, OR THROUGH TERMINALS A2 AND B WITH A VOLTAGE OF 24 VAC/VDC.

SYMBOLISMS USED FOR THE ON DELAY TIMER RELAY



HOW DOES AN ON DELAY TIMER RELAY WORK?

IN THE REST POSITION (RELAY OFF), ITS CONTACTS 15-16 AND 25-26 ARE CLOSED (NC) AND CONTACTS 15-18 AND 25-28 ARE OPEN. WHEN POWERING THE COIL (RELAY ENERGIZED), THE RELAY WILL START COUNTING THE TIME FOR WHICH IT WAS PROGRAMMED AND AT THE END OF THIS TIME, THE CONTACTS WILL CHANGE POSITION, WHERE CONTACTS 15-16 AND 25-26 OPEN AND CONTACTS 15-18 AND 25-28 CLOSE. THE INSTANT THE RELAY IS TURNED OFF, CONTACTS 15-16 AND 25-26 RETURN TO THEIR INITIAL NORMALLY CLOSED (NC) POSITION AND CONTACTS 15-18 AND 25-28 RETURN TO THEIR NORMALLY OPEN (NO) POSITION.

PRACTICAL APPLICATION

PHASE LACK RELAY

THE PHASE FAILURE RELAY IS AN ELECTRONIC DEVICE USED TO MONITOR THREE-PHASE, THREE-WIRE (L1-L2-L3) AND FOUR-WIRE (L1-L2-L3-N) SYSTEMS AGAINST A PHASE FAILURE.

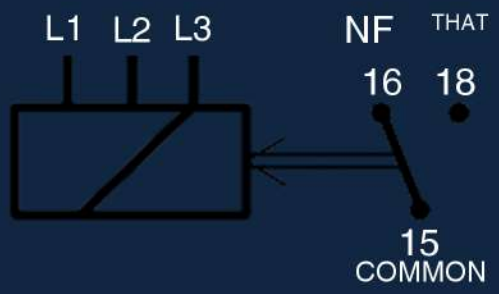
INSTALLATION IS DONE BY CONNECTING THE RELAY DIRECTLY TO THE 3 PHASES, CONNECTING THE RELAY TERMINALS L1, L2 AND L3 TO THE ELECTRICAL GRID THAT YOU WANT TO MONITOR.

THERE ARE RELAYS THAT, IN ADDITION TO THE TERMINALS FOR MONITORING THE PHASES, HAVE A TERMINAL FOR CONNECTING THE NEUTRAL AND THUS MONITOR THE FOUR-WIRE SYSTEM.

HOW DOES A PHASE LOSS RELAY WORK?

WHEN ENERGIZING THE RELAY WITH THE THREE PHASES (L1-L2-L3), IT WILL SWITCH THE CONTACTS TO THE OPERATING POSITION, CLOSING CONTACTS 15-18 AND OPENING CONTACTS 15-16. THE INDICATIVE LEDS WILL LIGHT UP. IF A DROP IN ONE OF THE PHASES TO A VALUE BELOW THE PERCENTAGE LIMIT, WHICH WAS SET ON THE SELECTOR, THE RELAY WILL TURN OFF, OPENING CONTACTS 15-18 AND CLOSING CONTACTS 15-16. THE LED THAT INDICATES POWER FAILURE WILL TURN OFF.

SYMBOLISMS USED FOR THE PHASE LACK RELAY



SENSITIVITY ADJUSTMENT

ON THE FRONT OF THE PHASE LOSS RELAY, IN ADDITION TO THE LEDS THAT INDICATE OPERATION, THERE IS A TRIMMER THAT ADJUSTS THE RELAY'S SENSITIVITY. THIS ADJUSTMENT SERVES TO IDENTIFY WHEN A VARIATION IN THE ELECTRICITY VOLTAGE OF THE MAINS OCCURS, SO THE PHASE LOSS RELAY WILL ALSO BE READY TO DEACTIVATE THE CIRCUIT IF NECESSARY.

TO MAKE THE ADJUSTMENT, ENERGIZE THE PHASE LOSS RELAY IN AN ELECTRICAL CIRCUIT, TURN THE TRIMMER SLOWLY UNTIL THE RELAY TRIPLS, TURN THE TRIMMER AGAIN IN THE OPPOSITE DIRECTION SO THAT IT GOES BACK A LITTLE BEFORE THE POINT WHERE IT TRIPLED. THIS IS THE POINT AT WHICH THE PHASE LOSS RELAY MUST HAVE ITS SENSITIVITY ADJUSTED.

PRACTICAL APPLICATION

PHASE LACK RELAY

POWER CONTACTOR

THERMAL RELAY

PHASE SEQUENCE RELAY

THE PHASE SEQUENCE RELAY IS AN ELECTRONIC DEVICE USED TO MONITOR THREE-PHASE THREE-WIRE SYSTEMS (L1-L2-L3) AGAINST PHASE SEQUENCE INVERSION

THE USE OF PHASE SEQUENCE RELAYS IS IMPORTANT TO ENSURE THE SAFETY OF ELECTRICAL EQUIPMENT, ESPECIALLY IN THREE-PHASE SYSTEMS, SUCH AS ELECTRIC MOTORS AND POWER DISTRIBUTION SYSTEMS. THEY PROTECT THIS EQUIPMENT AGAINST DAMAGE CAUSED BY PHASE LOSS OR CHANGE IN PHASE SEQUENCE, ENSURING THAT THE EQUIPMENT WORKS CORRECTLY AND AVOIDING INTERRUPTIONS IN POWER SUPPLY.

INSTALLATION IS DONE BY CONNECTING THE RELAY DIRECTLY TO THE 3 PHASES, CONNECTING THE RELAY TERMINALS L1, L2 AND L3 TO THE ELECTRICAL GRID THAT YOU WANT TO MONITOR

HOW DOES A PHASE SEQUENCE RELAY WORK?

WHEN ENERGIZING THE RELAY WITH THE THREE PHASES, IN THE CORRECT SEQUENCE, CONTACTS 15-18 CLOSES AND CONTACTS 15-16 OPENS AND THE LEDS TURN ON, INDICATING THAT THE RELAY IS IN OPERATION. IF ANY INVERSION IN THE PHASES OCCURS, THE RELAY WILL TURN OFF, OPENING CONTACTS 15-18 AND CLOSING CONTACTS 15-16. THE LED THAT INDICATES THE PHASES SEQUENCE WILL TURN OFF.

SIGNAL MAN

WE USE SIGNALS TO DRAW ATTENTION VISUALLY OR AUDIBLY TO A CERTAIN SITUATION IN THE CONTROL CIRCUIT, IN A MACHINE OR IN A SET OF MACHINES. IT IS NECESSARY TO SIGNAL WHEN A MACHINE IS IN OPERATION, A PANEL IS ENERGIZED OR WHEN AN UNEXPECTED STOP OCCURS IN THE SYSTEM.

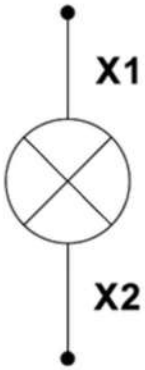
VISUAL SIGNALING

EX: 220VCA OU 24VCC

SOUND AND VISUAL SIGNALING

EX: 220VCA OU 24VCC

SYMBOLISM



X1 AND X2 ARE POWER INPUTS - EX: 220VAC OR 24VDC. THE SUPPLY VOLTAGE OF THE SIGNALS IS DESCRIBED ON THE BODY OF THE DEVICE

HOW TO IDENTIFY THE FUNCTIONS OF SIGNALERS THROUGH THEIR COLORS?

COR	FUNÇÃO
GREEN	Turn on, start, without danger (energization)
RED	Emergency, danger (turn off, de-energize)
YELLOW	Intervention, attention (reset automatic cycle)
THEREFORE	General use, except emergency
WHITE	Auxiliary functions (activating auxiliary systems)
BLUE	Auxiliary functions (activating auxiliary systems)

CONTROL BUTTONS

PUSH BUTTONS ARE MANUAL ACTIVATION DEVICES, WIDELY USED IN MACHINES AND EQUIPMENT, FOR STARTING, STOPPING AND OTHER CONTROL FUNCTIONS.

EMERGENCY BUTTON

SIMPLE BUTTON

DOUBLE BUTTON

THE MOST COMMON TYPES ARE MODULAR, COMPOSED OF PARTS THAT CAN BE COMBINED IN DIFFERENT WAYS IN ORDER TO PERFORM DIFFERENT FUNCTIONS REQUIRED BY MACHINES AND EQUIPMENT, SUCH AS:

ON AND OFF;
STOP IN CASE OF EMERGENCY:
RESTART OR RESTART A CYCLE;
INTERRUPT A CYCLE.

PARTS OF A BUTTON CHAIN

MOUNTED BUTTON PANEL

ACTUATOR

FIXING NUT

FLANGE

CONTACT BLOCK

BUTTONS THAT HAVE CONTACTS THAT CAN BE NORMALLY OPEN (NO - 3 AND 4) OR NORMALLY CLOSED (NC - 1 AND 2).

PRESSING THE BUTTON WILL CLOSE CONTACT 3 TO 4

PUSHBUTTON WITH NORMALLY OPEN CONTACT (NO)

PRESSING THE BUTTON WILL OPEN CONTACT 1 TO 2

PUSH BUTTON WITH NORMALLY CLOSED CONTACT (NC)

EACH BUTTON MAY CONTAIN ONE OR MORE CONTACT BLOCKS (NO) OR (NC)

NORMALLY OPEN (NO) CONTACT - 3 AND 4
NORMALLY CLOSED (NC) CONTACT - 1 AND 2

AS FOR THE ACTIVATION SYSTEM, THE BUTTONS CAN BE OF TWO TYPES: PUSH CONTROL BUTTONS (PRESSURE) OR SWITCH CONTROL BUTTONS

THRUST (PRESSURE)

WHEN IT IS POSSIBLE TO PRESS A CERTAIN BUTTON, WHICH CAN BE WITH SPRING RETURN (PUSHBUTTON TYPE) OR RETENTIVE (WHEN PRESSING THE BUTTON IT DOES NOT RETURN, UNLESS YOU PRESS IT AGAIN)

COMMUTATION

THESE BUTTONS ARE THOSE WHICH ARE OPERATIONALLY OBTAINED BY TURNING LEVERS, KNOBS OR SWITCHES. THEY CAN BE WITH SPRING RETURN (PUSHBUTTON TYPE) OR RETENTIVE (WHEN YOU PRESS THE BUTTON IT DOES NOT RETURN, UNLESS YOU PRESS IT AGAIN)

EXEMPLO DE BOTÕES DE COMANDO

IMAGEM	NOMENCLATURA	FUNÇÃO
	BOTÃO POR IMPULSÃO SEM RETENÇÃO "NF" (NOMALMENTE FECHADO)	OFF BUTTON (NORMALLY CLOSED - NC) WHEN PRESSED: BLOCKS THE FLOW OF ELECTRIC CURRENT. WHEN RELEASED: RETURNS TO ITS ORIGINAL POSITION. EXAMPLE: OFF BUTTON.
	BOTÃO POR IMPULSÃO SEM RETENÇÃO "NA" (NORMALMENTE ABERTO)	ON BUTTON (NORMALLY OPEN - NO) WHEN PRESSED: ALLOWS THE FLOW OF ELECTRIC CURRENT. WHEN RELEASED: RETURNS TO ITS ORIGINAL POSITION. EXAMPLE: ON BUTTON.
	BOTÃO POR IMPULSÃO COM RETENÇÃO "NA" (NORMALMENTE ABERTO)	ON BUTTON (LATCHING - TOGGLE SWITCH) WHEN PRESSED: ALLOWS THE FLOW OF ELECTRIC CURRENT. TO TURN OFF: MUST BE PRESSED AGAIN. EXAMPLE: ON BUTTON.
	BOTÃO POR IMPULSÃO COM RETENÇÃO "NF" (NORMALMENTE FECHADO)	EMERGENCY BUTTON (TWIST OR PULL TO RESET) WHEN PRESSED: BLOCKS THE FLOW OF ELECTRIC CURRENT. TO RESET: MUST BE TWISTED OR PULLED. EXAMPLE: EMERGENCY BUTTON.
	BOTÃO POR IMPULSÃO COM RETENÇÃO E CHAVE "NF" (NORMALMENTE FECHADO)	ALÉM DAS FUNÇÃO DO BOTÃO DE EMERGÊNCIA ANTERIOR, SÓ SERÁ POSSIVEL RETORNAR A POSIÇÃO ORIGINAL AO DESTRANCAR COM CHAVE. EX: BOTÃO DE EMERGÊNCIA
	BOTÃO POR COMUTAÇÃO COM RETENÇÃO "NA" (NORMALMENTE ABERTO)	AO GIRAR O BOTÃO PARA UM DOS LADOS, ELE PERMITE A PASSAGEM DA CORRENTE ELÉTRICA. AO GIRAR PARA O OUTRO LADO, ELE RETORNA A POSIÇÃO ORIGINAL. EX: MANUAL E AUTOMÁTICO
	BOTÃO POR IMPULSÃO LIGA E DESLIGA "NA E NF"	É POSSIVEL LIGAR E DESLIGAR UM DETERMINADO CIRCUITO COM UM BOTÃO CONJUGADO. EX: LIGA E DESLIGA

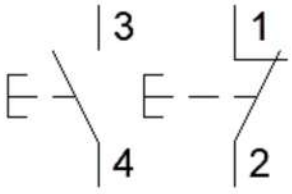
CONTROL BUTTON CONTACTS

CONTROL BUTTON CONTACTS CAN BE REMOVED, ADDED, MODIFIED (NORMALLY OPEN - (NO) TO NORMALLY CLOSED - (NC) AND VICE-VERSA)

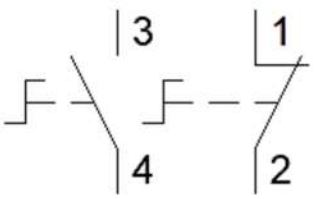
HOW TO IDENTIFY THE FUNCTIONS OF THE CONTROL BUTTONS THROUGH THEIR COLORS?

COR	FUNÇÃO
GREEN	Turn on, start, without danger (energization)
RED	Emergency, danger (turn off, de-energize)
YELLOW	Intervention, attention (reset automatic cycle)
THEREFORE	General use, except emergency
WHITE	Auxiliary functions (activating auxiliary systems)
BLUE	Auxiliary functions (activating auxiliary systems)

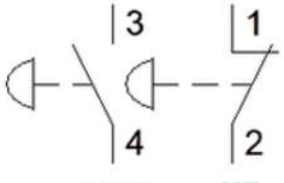
CONTROL BUTTON SYMBOLISM



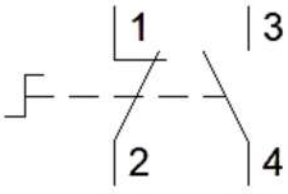
IN NF PULSIVE PUSH BUTTON



THAT NF RETENTIVE PUSH BUTTON



THAT NF MUSHROOM TYPE PUSH BUTTON



THAT NF RETENTIVE SWITCHING BUTTON

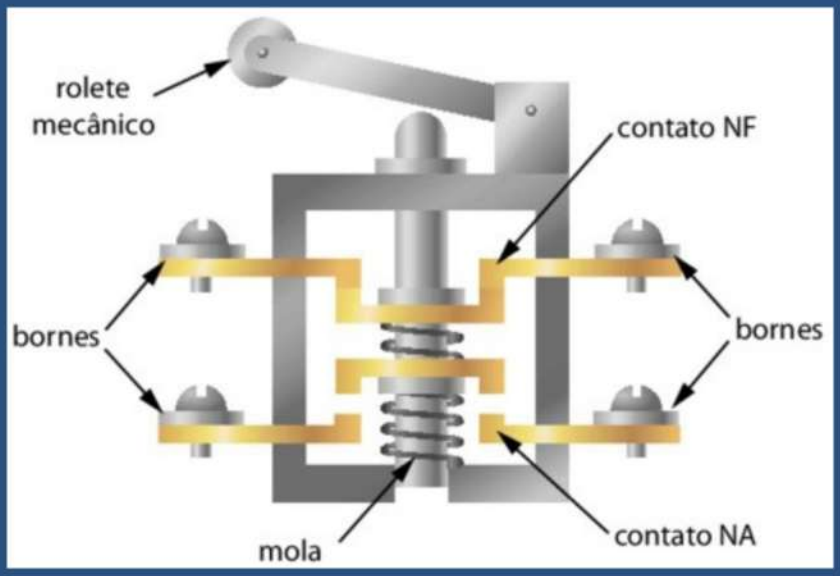
PRACTICAL APPLICATION

CONTROL PANEL

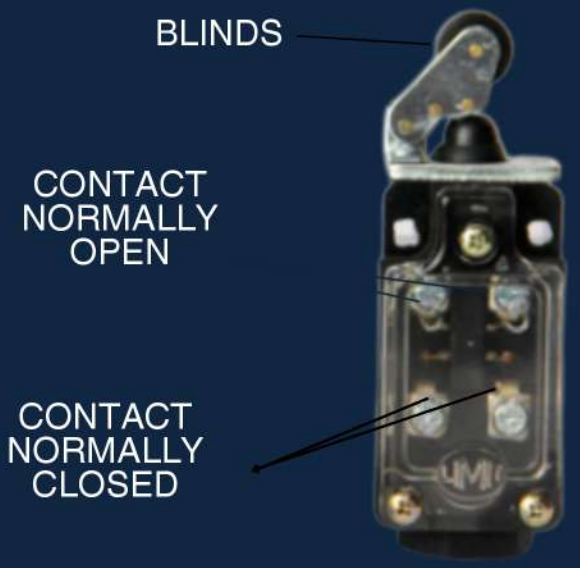
CONTROL PANEL

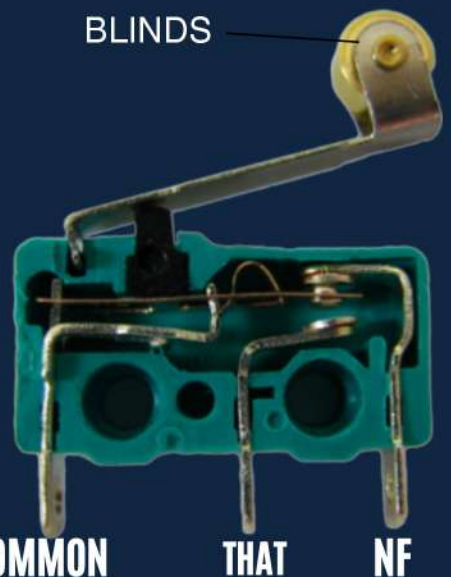
END OF COURSE KEY

LIMIT SWITCHES ARE MECHANICAL DEVICES THAT SERVE AS END-OF-STROKE SENSORS. THEY ARE USED TO DETECT THE EXACT POSITION OF A MOVING PART OR TO STOP THE MOVEMENT OF A MACHINE WHEN A CERTAIN POSITION IS REACHED. LIMIT SWITCHES ARE USUALLY COMPRISED OF A BODY WITH A LEVER THAT CAN BE ACTIVATED BY A MOVING MECHANISM, SUCH AS A GEAR OR PULLEY.



WHEN THE LEVER IS OPERATED, AN ELECTRICAL CONTACT IS CLOSED OR OPENED, SENDING A SIGNAL TO THE CONTROL SYSTEM TO INDICATE THAT THE DESIRED POSITION HAS BEEN REACHED. LIMIT SWITCHES ARE USED IN MANY INDUSTRIAL APPLICATIONS, SUCH AS MACHINERY AUTOMATION, MATERIAL HANDLING EQUIPMENT, CONSTRUCTION EQUIPMENT, AND MANY OTHERS.



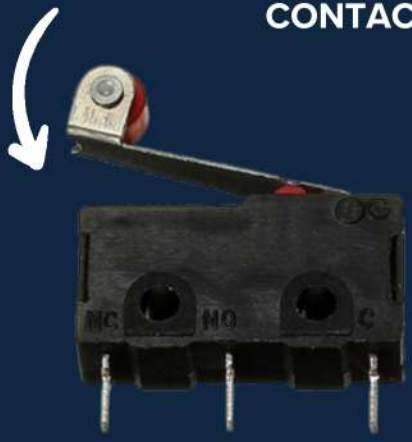


END OF COURSE SENSOR

SINGLE DIRECTION OF MOVEMENT

TWO DIRECTIONS OF MOVEMENT

PRESSING THE ROLLER WILL OPEN THE NC CONTACT AND CLOSE THE NA CONTACT

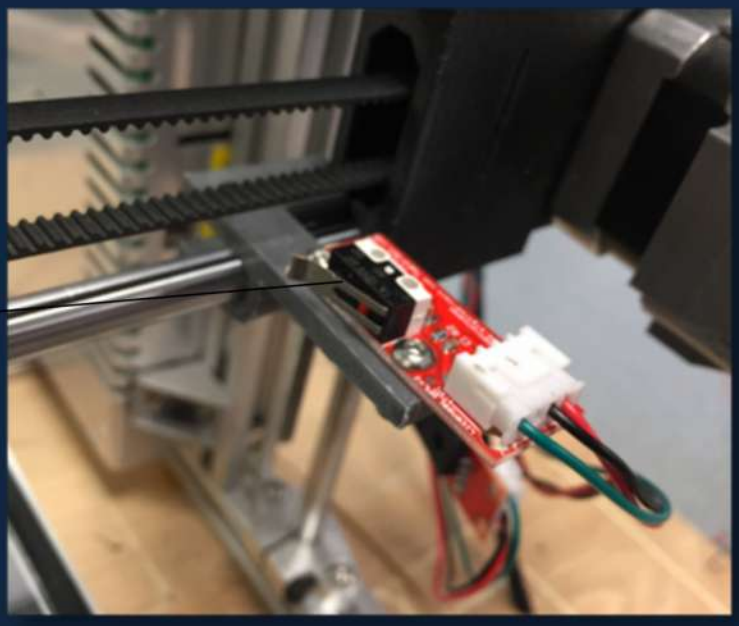


SINGLE DIRECTION OF MOVEMENT

HOW DOES A LIMIT SWITCH WORK?

THE WORKING PRINCIPLE OF LIMIT SWITCHES IS QUITE SIMILAR TO A PUSH BUTTON. WHEN YOU PRESS THE ROLLER, THE BEHAVIOR OF THE CONTACTS CHANGES INTERNALLY, WHERE THE NORMALLY OPEN CONTACTS CLOSE AND THE NORMALLY CLOSED CONTACTS OPEN.

PRACTICAL APPLICATION

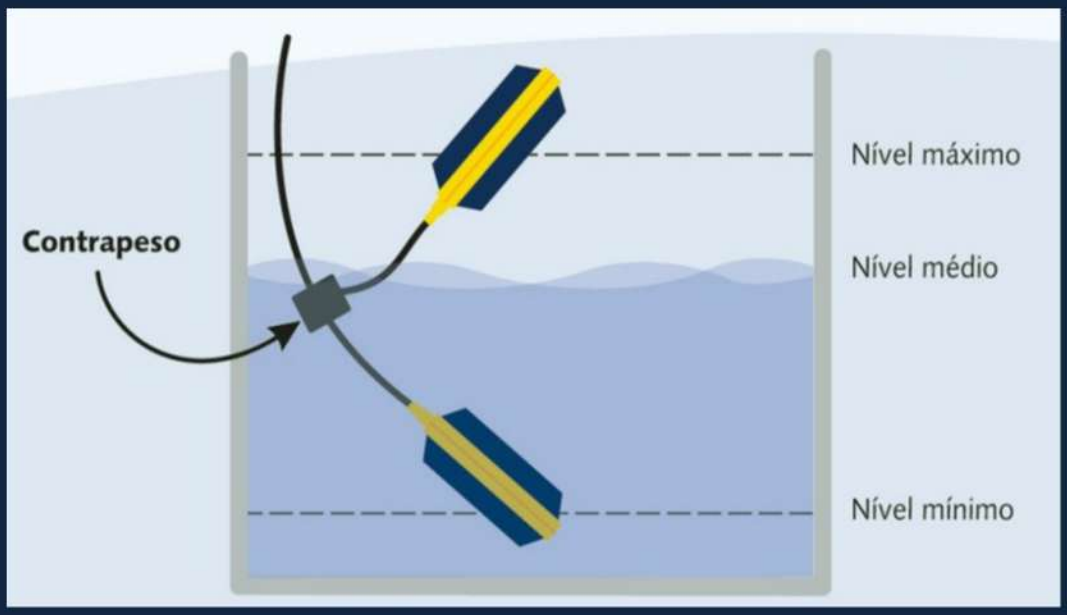


END OF COURSE KEY

ELECTRIC FLOAT (FLOAT SWITCH)

THE LEVEL FLOAT OR FLOAT SWITCH WORKS AS A LEVEL SENSOR. WHEN THE FLOAT SENDS THAT THE LEVEL OF A RESERVOIR IS LOW OR HIGH, IT SENDS A SIGNAL TO THE HYDRAULIC PUMP, TO TURN IT ON (PUMP WATER) OR TO TURN IT OFF (STOP PUMPING WATER).

ITS MAIN APPLICATIONS ARE IN: WELLS, TANKS, RESIDENTIAL RESERVOIRS (WATER TANK OR CISTERN), AMONG OTHER APPLICATIONS.



THE FLOAT CONTROLS THE MAXIMUM LEVEL SO THAT THE RESERVOIR DOES NOT OVERFLOW AND THE MINIMUM LEVEL SO THAT THE HYDRAULIC PUMP DOES NOT WORK WITHOUT WATER. THEREFORE, WHEN MOVING THE FLOAT (FLOATATION) INTERNALLY, IT OPENS OR CLOSES A CONTACT, ALLOWING OR NOT THE HYDRAULIC PUMP TO OPERATE

ELECTRIC BUOY

IN RESIDENCES, BUILDINGS AND CONDOMINIUMS IT IS VERY COMMON TO USE FLOAT SWITCHES, CONTAINING AT LEAST ONE FLOAT SWITCH IN THE CISTERN (LOWER RESERVOIR) AND ANOTHER IN THE WATER TANK (UPPER RESERVOIR).

ALL FLOAT SWITCHES, BY STANDARD, HAVE: A COMMON CONTACT, A NORMALLY OPEN CONTACT - (NO) AND A NORMALLY CLOSED CONTACT - (NC)

NOTE: THE COLORS OF THE BUOY WIRES ARE MERELY ILLUSTRATIVE, AS THEY MAY VARY ACCORDING TO THE MANUFACTURER.

IN GENERAL, THE FLOAT OF THE LOWER RESERVOIR (CISTERN) WILL BE CONNECTED IN SERIES

WITH THE FLOAT OF THE UPPER RESERVOIR (WATER TANK), HOWEVER USING DIFFERENT

CONTACTS.

THUS ALLOWING A CONNECTION PATTERN WHERE FOR THE UPPER RESERVOIR THE FLOAT SWITCH CONTACT MUST CLOSE WHEN THE FLOAT SWITCH IS DOWN, AND FOR THE LOWER RESERVOIR THE FLOAT SWITCH CONTACT MUST CLOSE WHEN THE FLOAT SWITCH IS UP. WITH THE HELP OF A MULTIMETER ON THE CONTINUITY SCALE IT IS POSSIBLE TO VERIFY THIS ACTION. BY MOVING THE FLOAT SWITCH BY HAND, IT IS POSSIBLE TO PERFORM THE TEST.

FLOAT SWITCH INSIDE

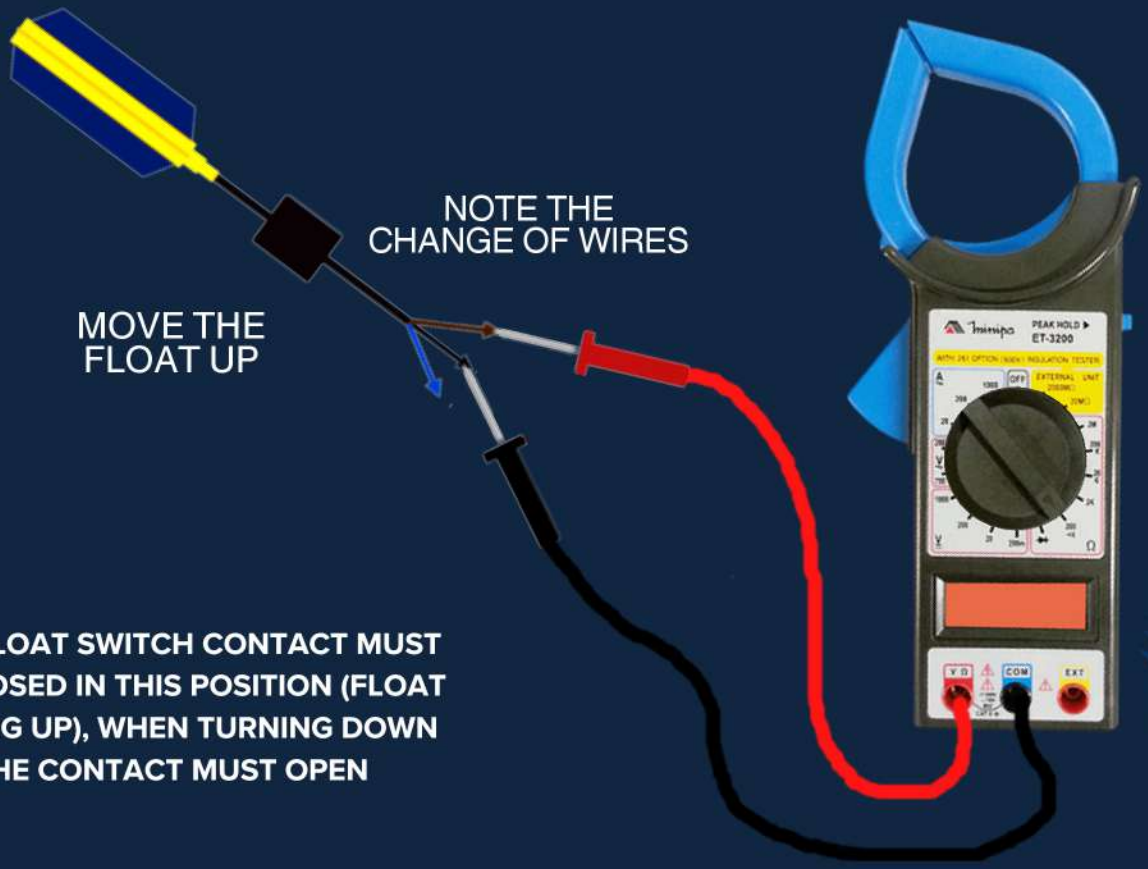
THE BALL MOVES ACCORDING TO THE FLOTATION OF THE BUOY, TOUCHING THE SWITCH, OPENING AND CLOSING.

SWITCH, WITH CONTACT NORMALLY OPEN - (NA) AND NORMALLY CLOSED - (NC)

UPPER RESERVOIR FLOAT SWITCH TEST

THE FLOAT SWITCH CONTACT MUST BE CLOSED IN THIS POSITION (FLOAT FACING DOWN), WHEN TURNING UP THE CONTACT MUST OPEN

LOWER RESERVOIR FLOAT SWITCH TEST

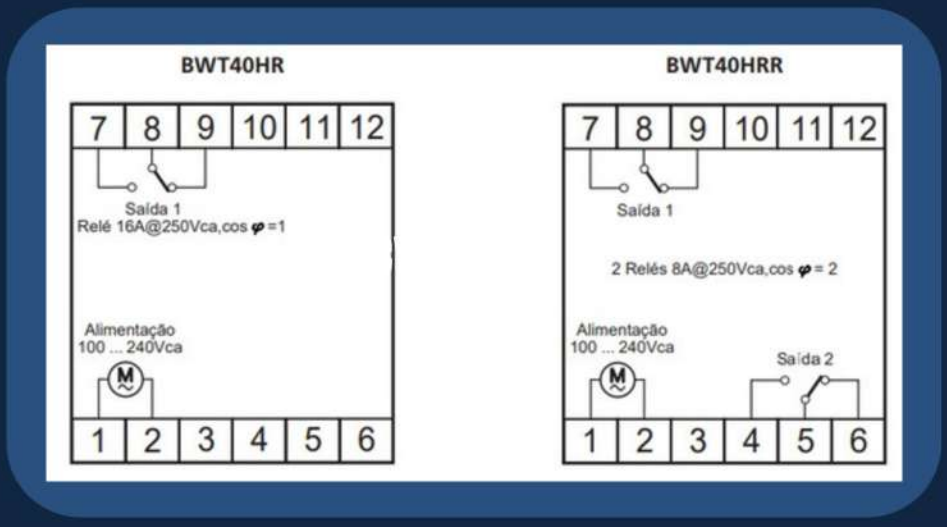


THE FLOAT SWITCH CONTACT MUST BE CLOSED IN THIS POSITION (FLOAT FACING UP), WHEN TURNING DOWN THE CONTACT MUST OPEN

TIMER

THE TIME PROGRAMMER IS A DEVICE THAT ALLOWS ANY ELECTRICAL EQUIPMENT TO BE TURNED ON AND OFF ACCORDING TO PRE-SET TIMES VIA ITS OWN DISPLAY. THE DIGITAL TIME PROGRAMMER IS MANUFACTURED WITH AN LCD DISPLAY AND KEYS FOR PROGRAMMING. THE DIGITAL PROGRAMMER HAS ONE OR MORE RELAY OUTPUTS FOR CONTROLLING EQUIPMENT ACCORDING TO THE ESTABLISHED PROGRAMS. IN GENERAL, IT IS POSSIBLE TO CONFIGURE SEVERAL PROGRAMS TO CONTROL THE EQUIPMENT CONNECTED TO THE INSTRUMENT OUTPUT, WITH EACH DEVICE HAVING A MINIMUM TIME INTERVAL BETWEEN PROGRAMS.

INTERNAL DIAGRAM OF TIME PROGRAMMER



DEPENDING ON THE MODEL, THE TIMER MAY HAVE ONE OR TWO SETS OF RELAY OUTPUT, WITH NORMALLY OPEN CONTACT (NO) AND NORMALLY CLOSED CONTACT (NC)

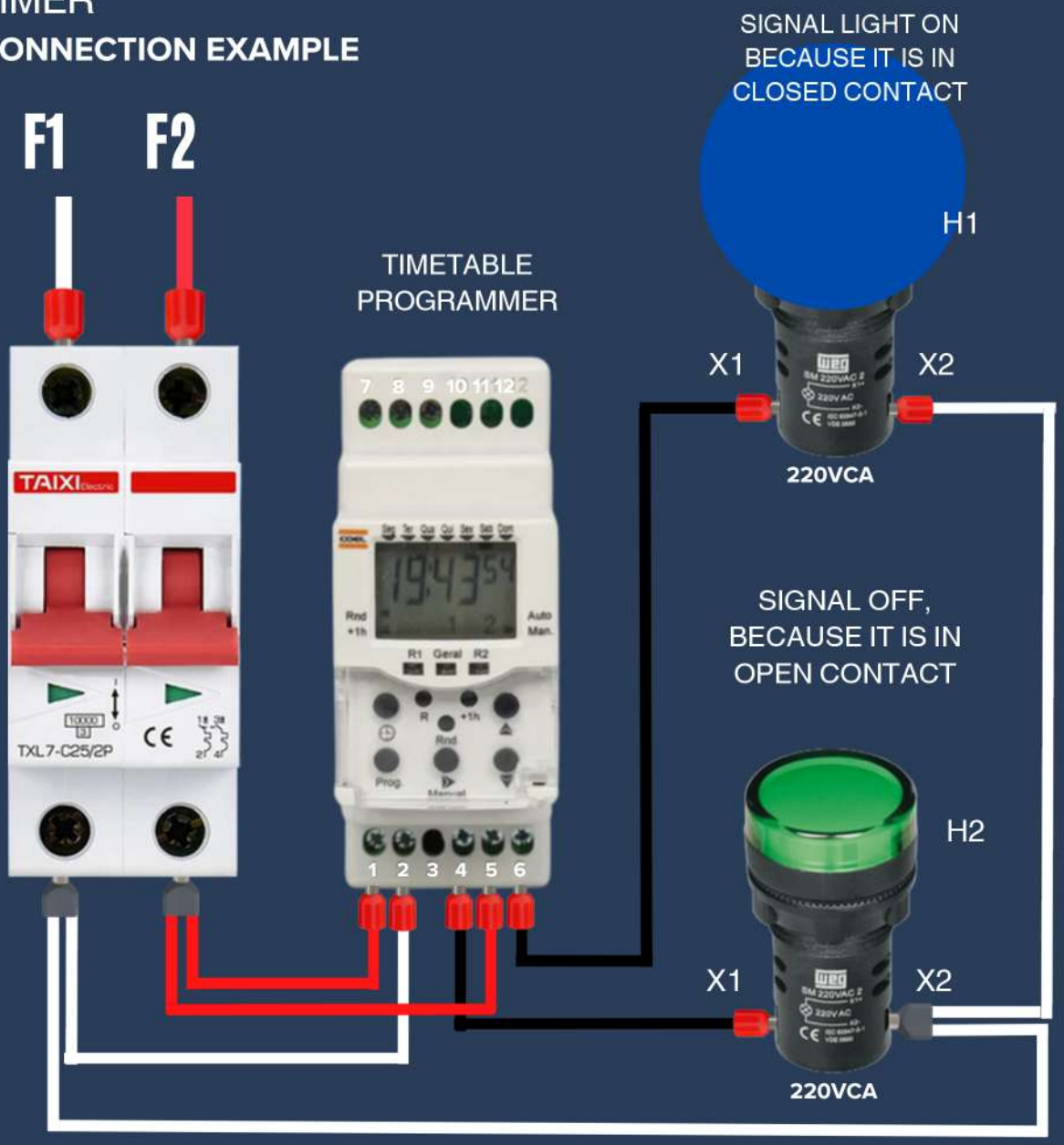
USING THE TIME PROGRAMMER IT IS POSSIBLE TO PROGRAM COMBINATIONS OF DAYS OF THE WEEK IN WHICH THE DEVICE WILL TURN THE LOAD ON OR OFF. FOR EXAMPLE: A TIME PROGRAMMER INSTALLED TO CONTROL THE LIGHTING OF A STORE SIGN DURING THE NIGHT. IT IS POSSIBLE TO PROGRAM IT TO TURN ON FROM MONDAY TO FRIDAY, FROM 7:00 PM TO 12:00 AM. IN THIS CASE, ON SATURDAY AND SUNDAY THE SIGN WOULD BE OFF, AS WELL AS THE OTHER NON-PROGRAMMED TIMES.

NOTE: THE MODELS USED IN THIS MATERIAL ARE FROM THE MANUFACTURER COEL.

HOWEVER, THERE ARE SEVERAL OTHER MODELS ON THE MARKET.

TIMER

CONNECTION EXAMPLE

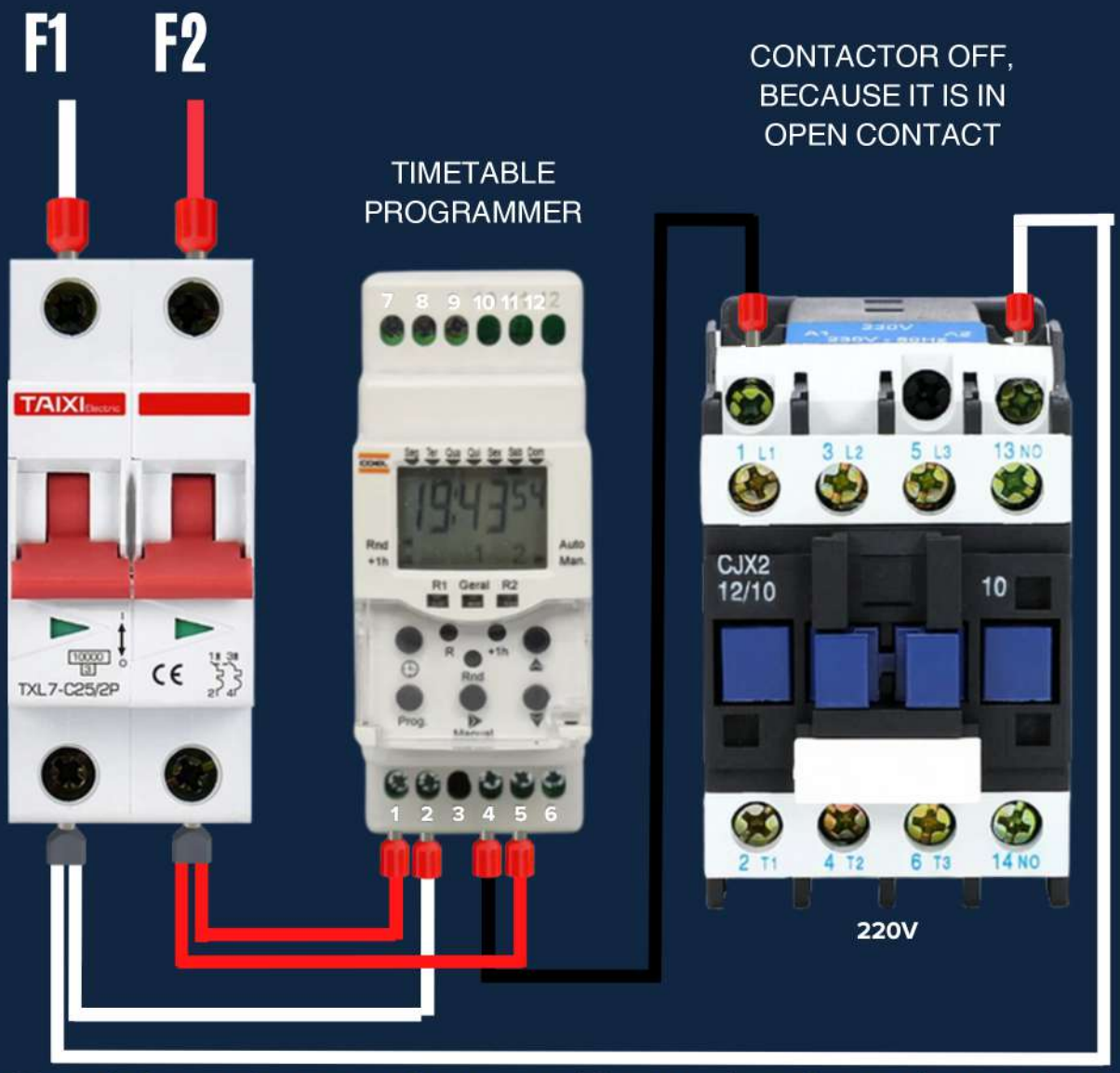


IN THIS EXAMPLE WE USE ONLY ONE OUTPUT, THE RELAY. ENTERING THE PHASE IN THE COMMON CONTACT (5), IN THE NORMALLY CLOSED CONTACT (6) IS THE SIGNAL H1, AND IN THE NORMALLY OPEN CONTACT IS THE SIGNAL H2. AFTER PROGRAMMING THE DAYS AND TIMES YOU WANT TO TURN ON AND OFF IN THE TIME PROGRAMMER AND THE MOMENT COMES WHEN SUCH PROGRAMMING WILL START WORKING IN THE TURN ON MODE, THE NORMALLY CLOSED CONTACT (5 AND 6) WILL OPEN, TURNING OFF THE SIGNAL H1, AND WILL CLOSE THE NORMALLY OPEN CONTACT (5 AND 4), TURNING ON H2. AFTER THE PROGRAMMED TIME TO SWITCH OFF REACHES, THE CONTACTS RETURN TO THEIR ORIGIN STATE, NORMALLY CLOSED (5 AND 6), H1 ON, AND NORMALLY OPEN (5 AND 4), H2 OFF.

IT IS NOT NECESSARILY NECESSARY TO USE BOTH CONTACTS. IN MANY CASES, ONLY THE NORMALLY OPEN CONTACT IS USED WHEN YOU WANT TO CONNECT A LOAD.

TIMER

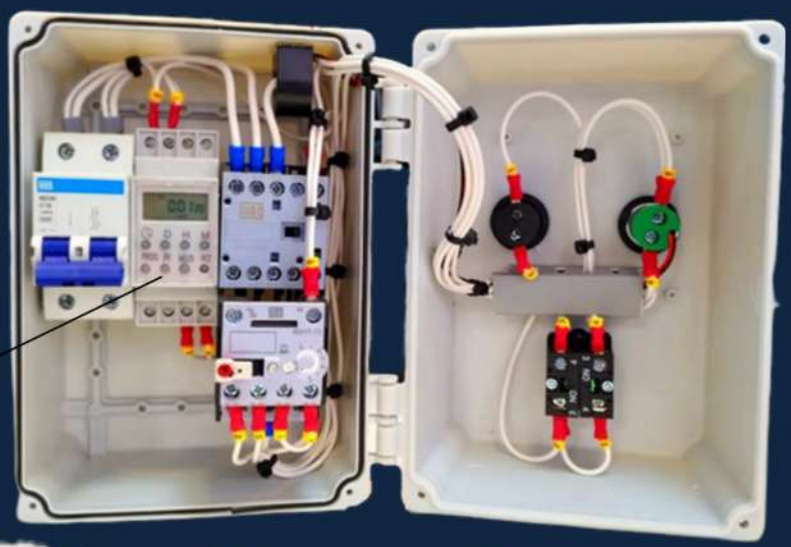
EXAMPLE OF A SIMPLIFIED CONNECTION OF A TIME PROGRAMMER ACTIVATING A CONTACTOR



THE CONTACTOR WILL ONLY TURN ON AFTER PROGRAMMING THE ON AND OFF TIME ON THE TIMER, WE WILL INSTALL THE LOAD ON THE MAIN CONTACTS OF THE CONTACTOR.

PRACTICAL APPLICATION

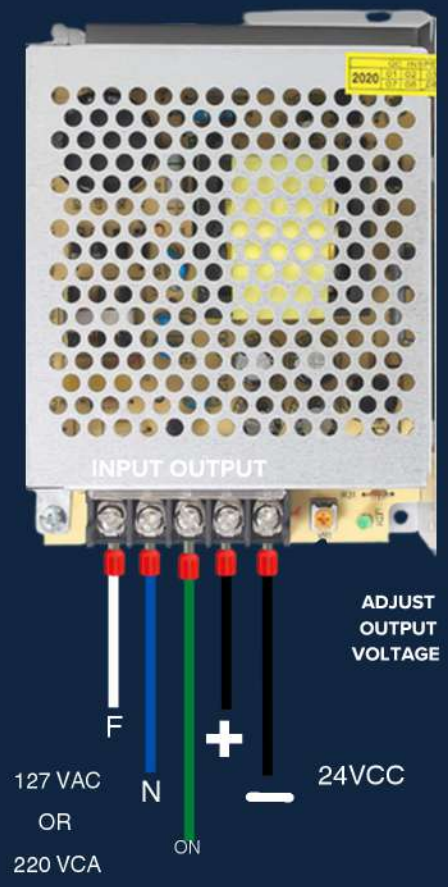
CONTROL PANEL



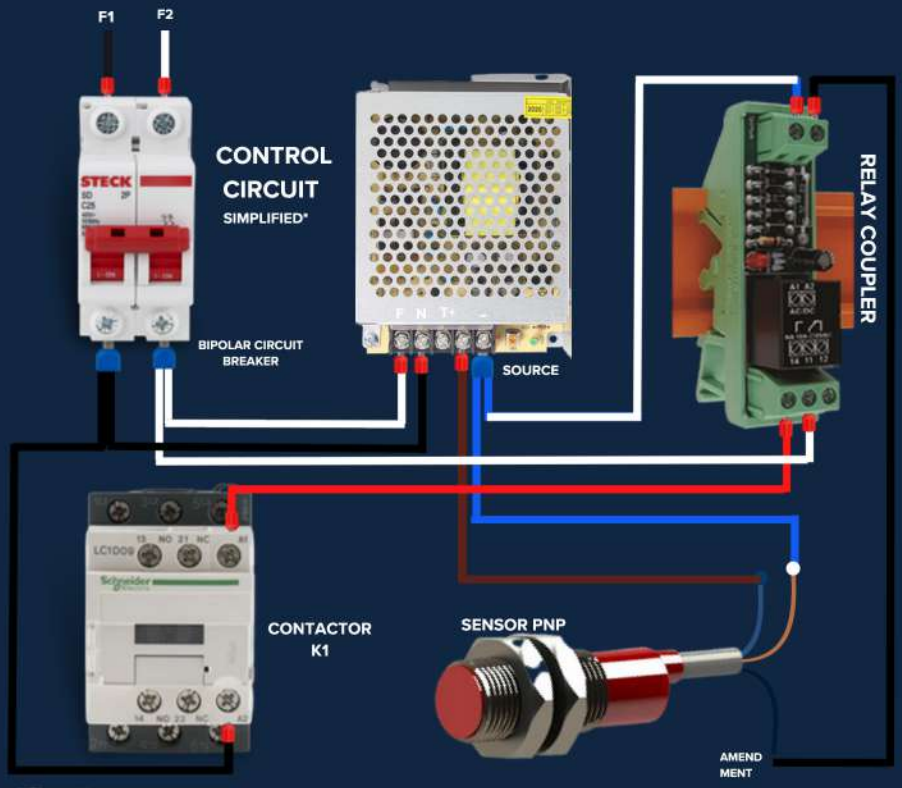
TIMETABLE PROGRAMMER

POWER SUPPLY

THE POWER SUPPLY, OR HONEY POWER SUPPLY, TRANSFORMS THE POWER SUPPLY THAT IS IN ALTERNATING CURRENT (AC) TO DIRECT CURRENT (DC). THIS COMPONENT IS WIDELY USED IN POWERING SENSORS, CONTACTORS, RELAYS AND PLCS, AMONG OTHER APPLICATIONS.



EXAMPLE OF CIRCUIT WITH POWER SUPPLY



TYPES OF FOOD

ELECTRICAL VOLTAGE LEVELS THE VOLTAGE LEVELS FOUND IN BRAZIL ARE 115 VOLTS, 127 VOLTS, 220 VOLTS, 230 VOLTS, 240 VOLTS, 254 VOLTS, 380 VOLTS AND 440 VOLTS.

HOWEVER, SOME QUESTIONS ARISE: WHAT IS THE PHASE TO NEUTRAL VOLTAGE?
WHAT IS THE VOLTAGE FROM PHASE TO PHASE?
AND THREE-PHASE, WHAT IS THE ELECTRICAL VOLTAGE?

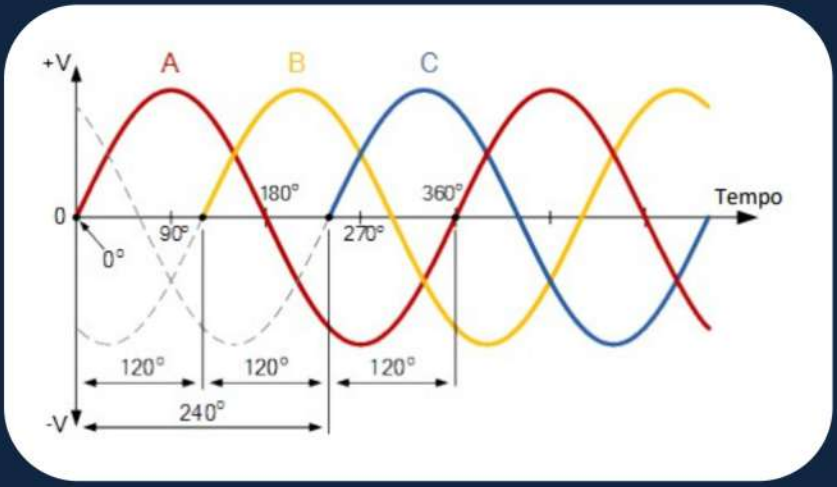
IN FACT THIS DEPENDS ON EACH LOCATION, ON THE TRANSFORMER THAT IS REDUCING THE VOLTAGE

TO LOWER LEVELS. DON'T WORRY, WE WILL EXPLAIN EVERYTHING IN DETAIL AND IN A SIMPLIFIED WAY.

FOR EXAMPLE: THE THREE-PHASE POWER SUPPLY OF AN ELECTRICAL PANEL IS 220V, HOW TO FIND 127V?

AND IF THE POWER SUPPLY IS 380V THREE-PHASE, HOW CAN I FIND 220V? AND IF THE POWER SUPPLY IS 760V THREE-PHASE, HOW TO FIND 380V?

THREE-PHASE NETWORK, ALSO CALLED THREE-PHASE POWER CIRCUIT, IS SUPPLIED BY AN AC (ALTERNATING CURRENT) GENERATOR THAT PRODUCES THREE DISTINCT PHASES WITH EQUAL VOLTAGE, BUT SEPARATED (120 DEGREES OUT OF PHASE FROM EACH OTHER).



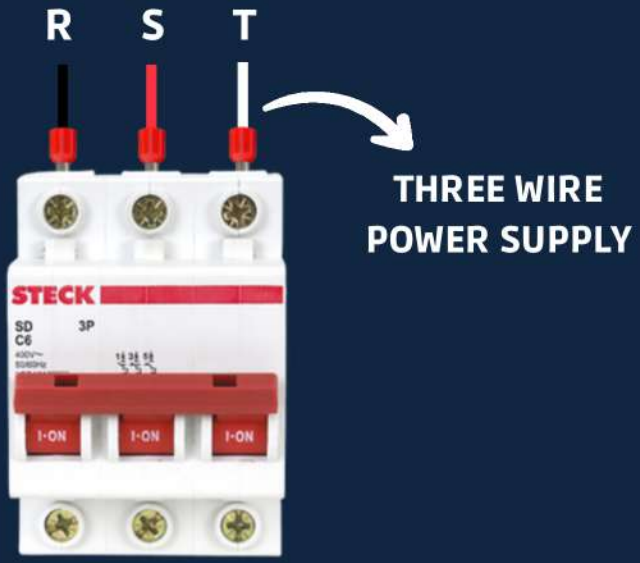
ALTHOUGH SINGLE-PHASE CIRCUITS ARE WIDELY USED, MOST OF THE GENERATION AND DISTRIBUTION IS THREE-PHASE, BECAUSE THREE-PHASE GENERATION AND DISTRIBUTION REQUIRE CONDUCTORS WITH A SMALLER CROSS-SECTION

CONSEQUENTLY LIGHTER, FOR THE SAME POWER SPECIFICATION; THE THREE-PHASE NETWORK ALSO ALLOWS FLEXIBILITY IN CHOOSING VOLTAGES, AND CAN BE USED FOR SINGLE-PHASE LOADS. THREE-PHASE EQUIPMENT HAS SMALLER DIMENSIONS, IS LIGHTER AND MORE EFFICIENT THAN SINGLE-PHASE MACHINES OF THE SAME CAPACITY.

CHARACTERISTICS OF THREE-PHASE NETWORKS

1. ABOUT THE NUMBER OF DRIVERS

THREE WIRES, WITH THREE DIFFERENT PHASES, REPRESENTED BY THE LETTERS R–S–T OR L1–L2– L3 TO IDENTIFY THEM.



FOUR WIRES, WITH THREE DIFFERENT PHASES AND THE NEUTRAL CONDUCTOR, REPRESENTED BY THE LETTERS R– S–T–N

FOUR WIRE POWER SUPPLY

2. ABOUT NOMINAL VOLTAGE

NOMINAL VOLTAGE VALUES ARE SPECIFIED BY ELECTRICITY CONCESSIONAIRES. THE MOST USUAL VALUES FOR THE GRIDS ARE: 220V, 380V, 440V, 660V, 760V.

THESE VALUES ARE OBTAINED BY MEASURING TWO DIFFERENT PHASES, THAT IS, BETWEEN (R-S), (S-T) AND (T-R). THE VOLTAGE MEASURED BETWEEN TWO PHASES IS CALLED LINE VOLTAGE.

WHEN WE MEASURE THE RESPECTIVE PHASES WITH THE NEUTRAL, THAT IS (R-N), (S-N) AND (T-N), WE HAVE A VOLTAGE VALUE LOWER THAN THE VOLTAGE MEASURED BETWEEN TWO PHASES. THE VOLTAGE MEASURED BETWEEN PHASE AND NEUTRAL IS CALLED PHASE VOLTAGE.

E1IC =V E =f
x7 3 6 W3 √‾

1CV = 736W√3

If= He

EI = Line voltage Ef = Phase voltage

EXAMPLE: GIVEN A CIRCUIT WHICH MEASURING WITH THE MULTIMETER FROM PHASE TO PHASE IS MARKING 220V (LINE VOLTAGE), WHAT IS THE VOLTAGE VALUE FROM PHASE TO NEUTRAL (PHASE VOLTAGE)?

Ef= The √‾3

If= 220

1,73

Ef= 127,2V

Phase to phase voltage

Phase to neutral voltage

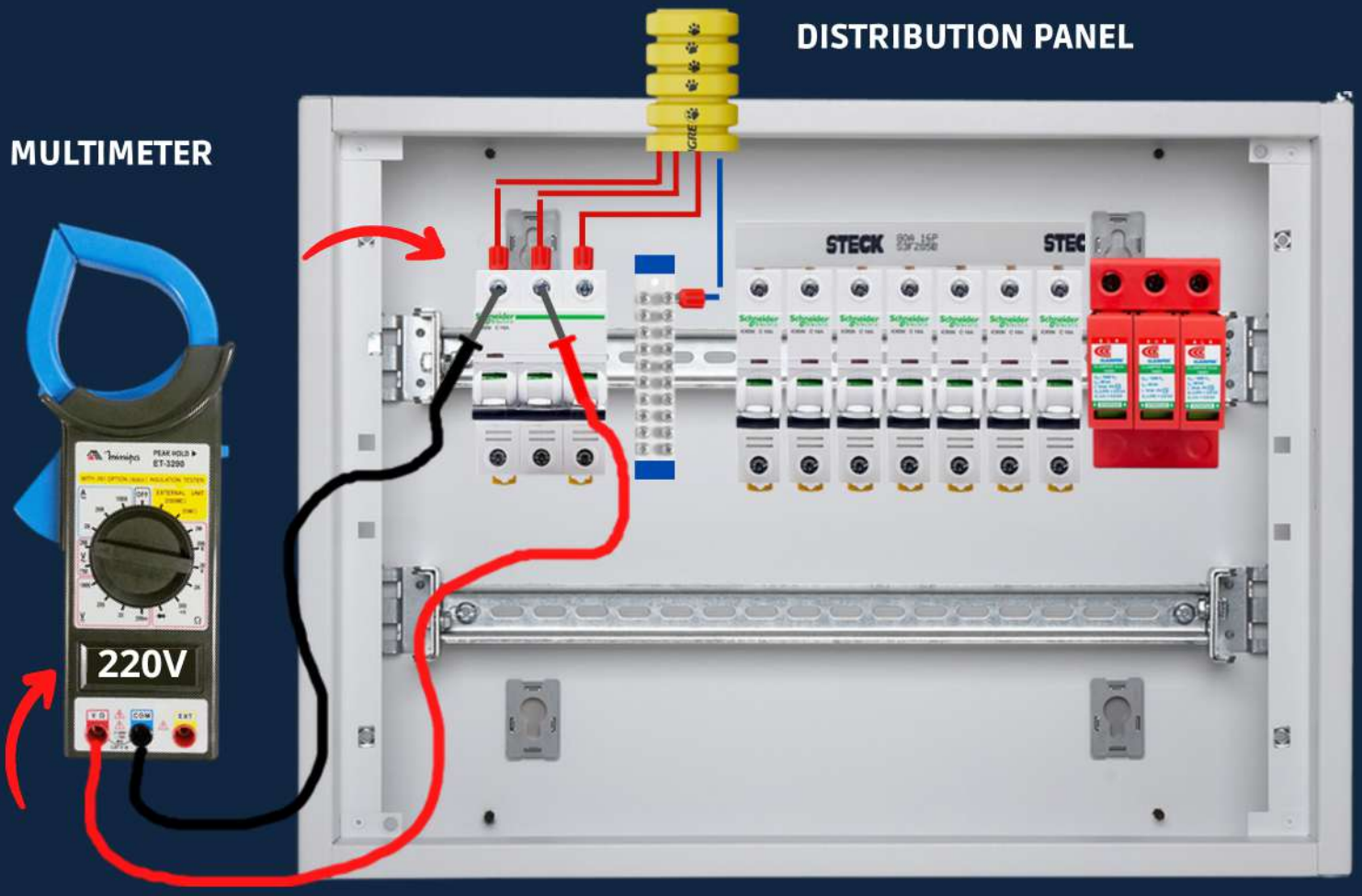
3. ABOUT FREQUENCY

THE FREQUENCY OF THE STANDARDIZED THREE-PHASE GRID IN BRAZIL IS 60HZ. (HZ = HERTZ, UNIT OF MEASUREMENT OF ELECTRICAL FREQUENCY).

CHECKING THE SUPPLY VOLTAGE

THREE-PHASE POWER SUPPLY WITH 220V

IN A CERTAIN DISTRIBUTION PANEL WHERE THE ELECTRICAL VOLTAGE MEASURED FROM PHASE TO PHASE IS 220V, HOW TO FIND 127V?



YES, IN SOME LOCATIONS IN BRAZIL IT IS POSSIBLE TO HAVE 220V BETWEEN PHASE AND PHASE.

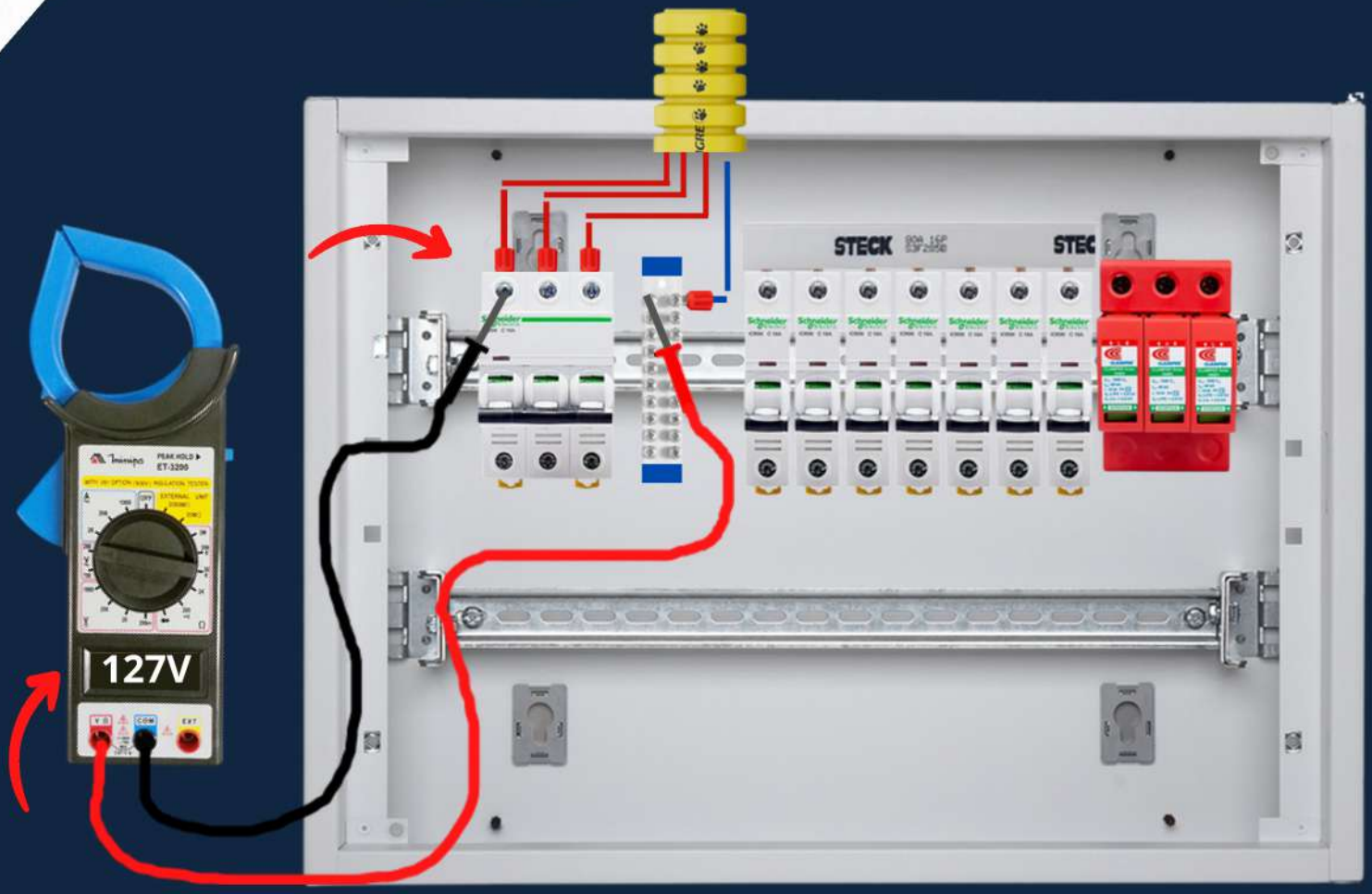
NOTE THAT THE MULTIMETER IS ON THE ALTERNATING VOLTAGE SCALE, AND ITS TEST LEADS ARE TOUCHING EACH PHASE (R AND S)

WHEN WE MEASURE FROM (R-S), (R-T) AND (S-T), WE WILL GET THE SAME 220V

WE CAN ALSO SAY THAT THE POWER SUPPLY CIRCUIT IS 220V THREE-PHASE

IF WE CHOOSE TO MEASURE BETWEEN (R-N), (S-N) AND (T-N) IN THIS FRAME, WHAT WILL BE THE VOLTAGE VALUE FOUND?

MAKING THE MEASUREMENT BETWEEN PHASE AND NEUTRAL



WE OBSERVE THAT THE MULTIMETER REMAINS ON THE ALTERNATING VOLTAGE SCALE, AND THE TEST LEADS (PROBE), ONE IS TO THE R PHASE AND THE OTHER IS TO THE NEUTRAL. THIS VALUE OF 127V IS FOUND EXACTLY BY DIVISION OF THE ELECTRIC VOLTAGE BETWEEN PHASE AND PHASE BY ROOT OF 3, WHICH IS APPROXIMATELY 1.73. SO WE WILL HAVE:

$$\text{The } Ef = \frac{If = 220}{\sqrt{3}} \quad \frac{If = 220}{1,73} \quad Ef = 127,2V$$

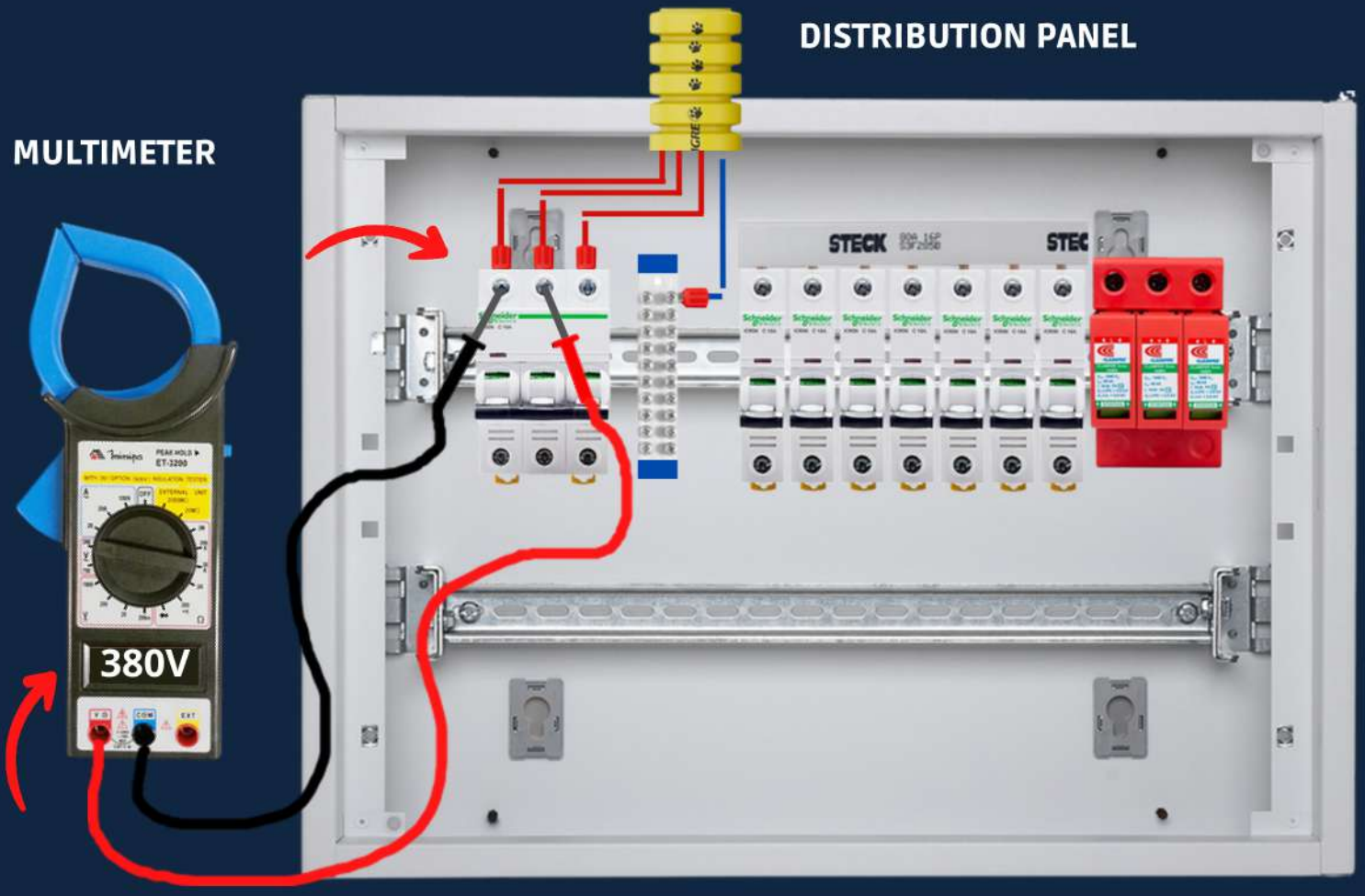
Phase to phase voltage

Phase to neutral voltage

VERY SIMILAR TO THE ONE PRESENTED PREVIOUSLY

THREE-PHASE POWER SUPPLY WITH 380V

IN A CERTAIN DISTRIBUTION PANEL WHERE THE ELECTRICAL VOLTAGE MEASURED FROM PHASE TO PHASE IS 380V, HOW TO FIND 220V?



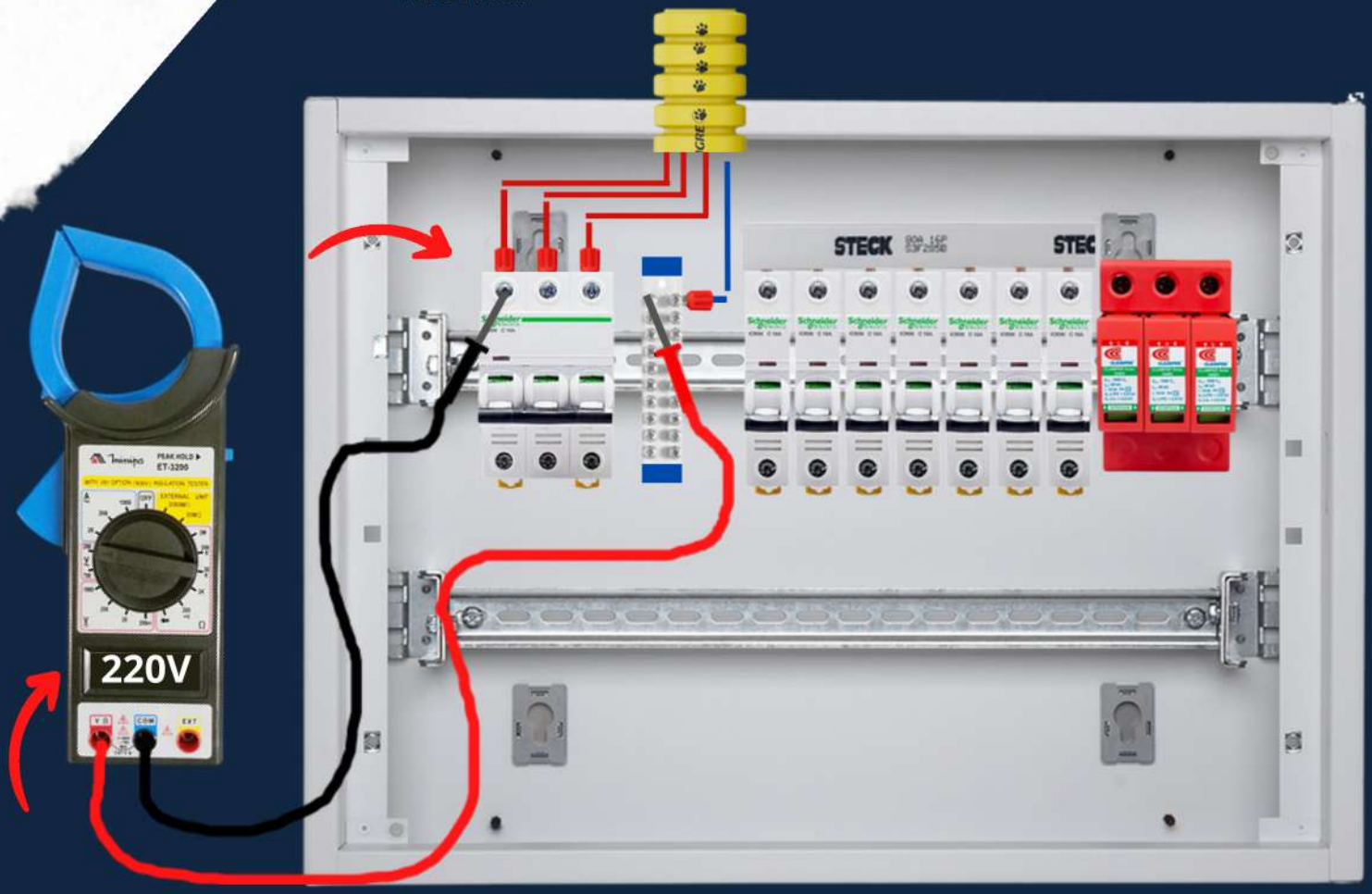
NOTE THAT THE MULTIMETER IS ON THE ALTERNATING VOLTAGE SCALE, AND ITS TEST LEADS ARE TOUCHING EACH PHASE (R AND S)

WHEN WE MEASURE FROM (R-S), (R-T) AND (S-T), WE WILL GET THE SAME 380V

WE CAN ALSO SAY THAT THE POWER SUPPLY CIRCUIT IS 380V THREE-PHASE

IF WE CHOOSE TO MEASURE BETWEEN (R-N), (S-N) AND (T-N) IN THIS FRAME, WHAT WILL BE THE VOLTAGE VALUE FOUND?

MAKING THE MEASUREMENT BETWEEN PHASE AND NEUTRAL



WE OBSERVE THAT THE MULTIMETER REMAINS ON THE ALTERNATING VOLTAGE SCALE, AND THE TEST LEADS (PROBE), ONE IS TO THE R PHASE AND THE OTHER IS TO THE NEUTRAL. THIS VALUE OF 127V IS FOUND EXACTLY BY DIVISION OF THE ELECTRIC VOLTAGE BETWEEN PHASE AND PHASE BY ROOT OF 3, WHICH IS APPROXIMATELY 1.73. SO WE WILL HAVE:

The $Ef = \frac{If = 380}{\sqrt{3}}$ → **Phase to phase voltage**

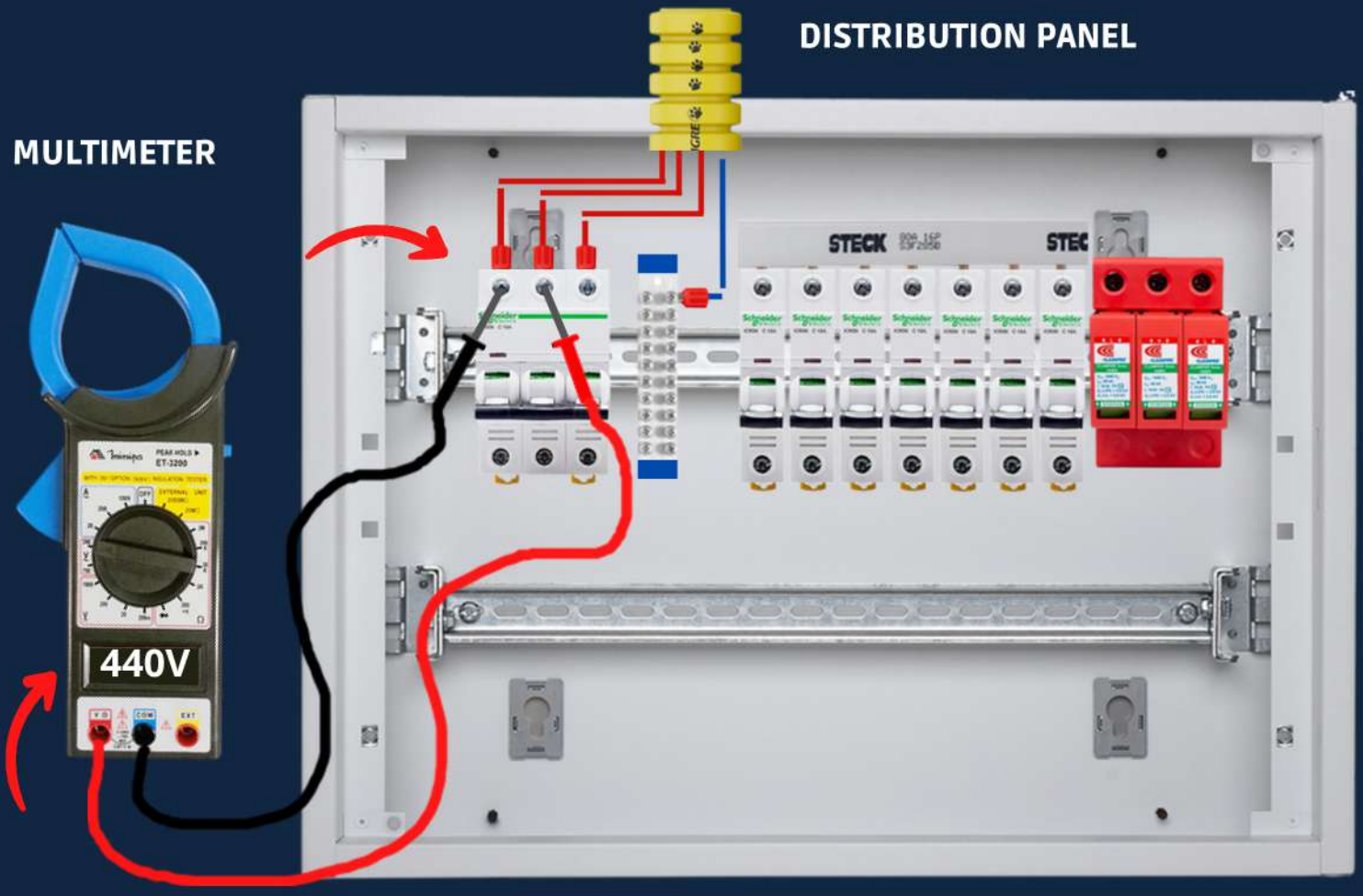
$If = \frac{380}{1,73}$ → **Phase to neutral voltage**

$Ef = 219,65V$

THEREFORE, THE ELECTRICAL VOLTAGE BETWEEN PHASE AND NEUTRAL IN THIS PANEL IS 220V, BECAUSE FROM PHASE TO PHASE IT IS 380V.

THREE-PHASE POWER SUPPLY WITH 440V

IN A CERTAIN DISTRIBUTION PANEL WHERE THE ELECTRICAL VOLTAGE MEASURED FROM PHASE TO PHASE IS 440V, WHAT IS THE VALUE BETWEEN PHASE AND NEUTRAL?



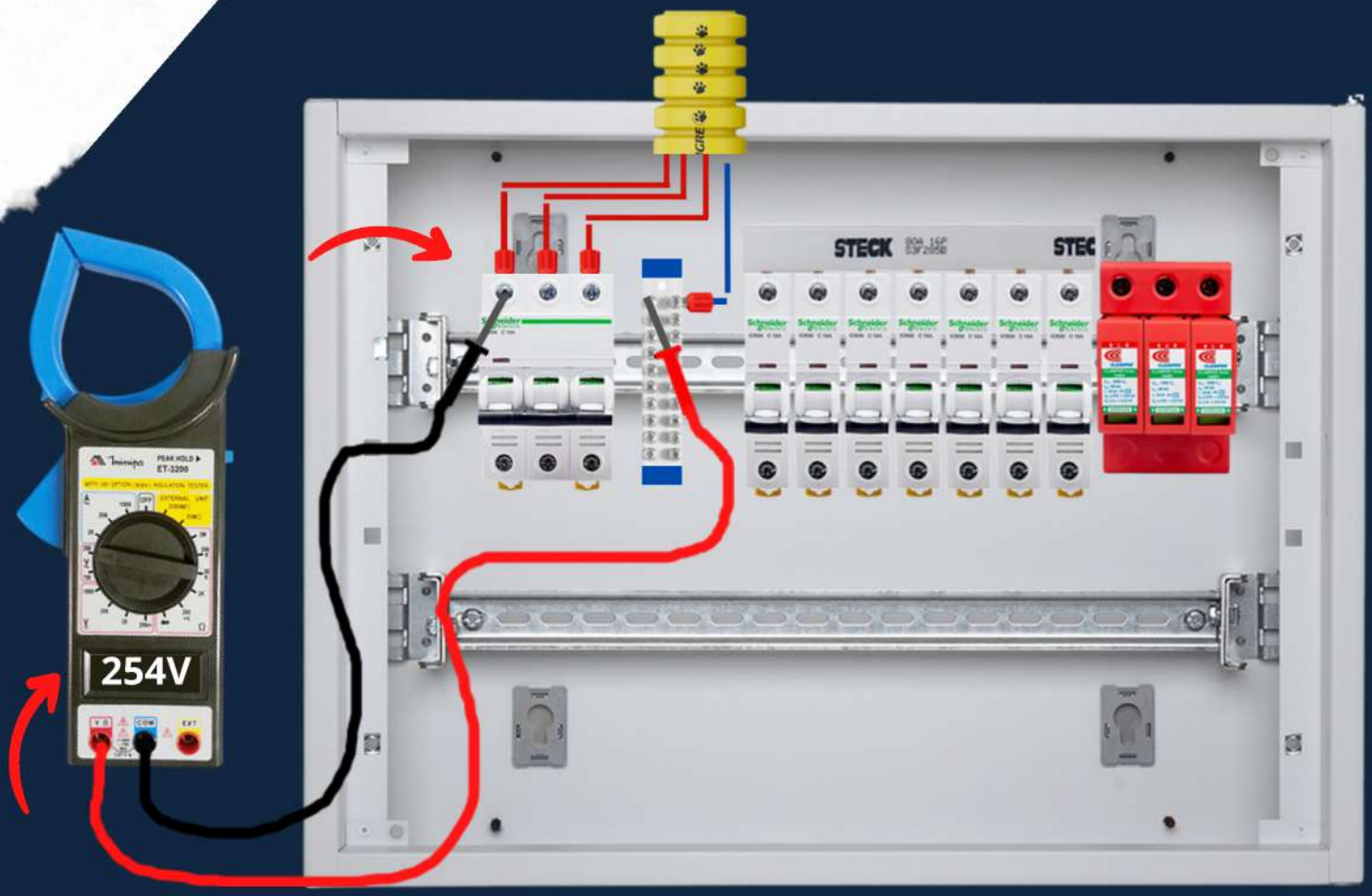
NOTE THAT THE MULTIMETER IS ON THE ALTERNATING VOLTAGE SCALE, AND ITS TEST LEADS ARE TOUCHING EACH PHASE (R AND S)

WHEN WE MEASURE FROM (R-S), (R-T) AND (S-T), WE WILL GET THE SAME 440V

WE CAN ALSO SAY THAT THE POWER SUPPLY CIRCUIT IS 440V THREE-PHASE

IF WE CHOOSE TO MEASURE BETWEEN (R-N), (S-N) AND (T-N) IN THIS FRAME, WHAT WILL BE THE VOLTAGE VALUE FOUND?

MAKING THE MEASUREMENT BETWEEN PHASE AND NEUTRAL



WE OBSERVE THAT THE MULTIMETER REMAINS ON THE ALTERNATING VOLTAGE SCALE, AND THE TEST LEADS (PROBE), ONE IS TO THE R PHASE AND THE OTHER IS TO THE NEUTRAL. THIS VALUE OF 254V IS FOUND EXACTLY BY DIVISION OF THE ELECTRIC VOLTAGE BETWEEN PHASE AND PHASE BY ROOT OF 3, WHICH IS APPROXIMATELY 1.73. SO WE WILL HAVE:

The $Ef = \frac{If = 440}{\sqrt{3}}$ → **Phase to phase voltage**

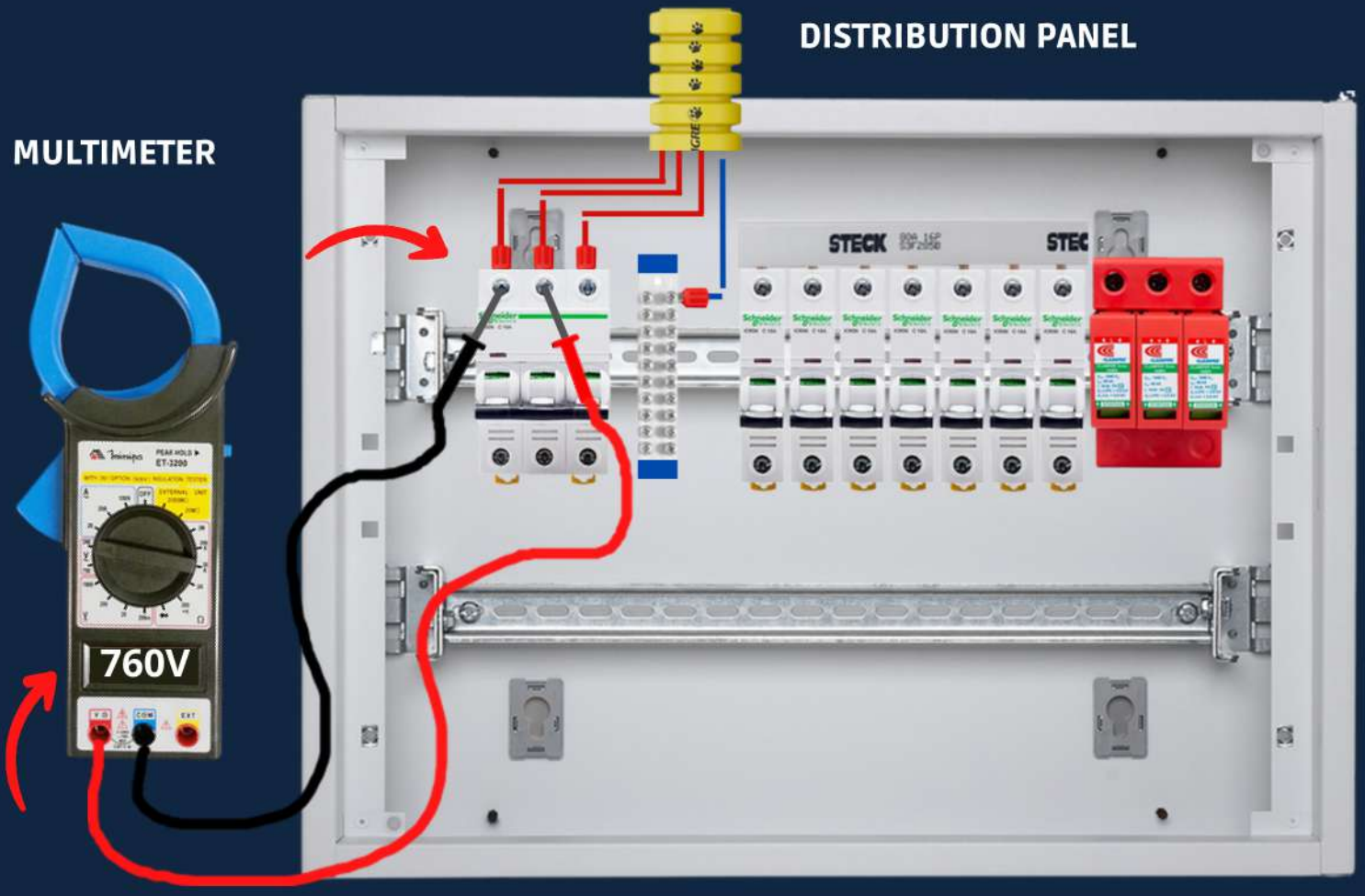
$\frac{If = 440}{1,73}$ → **Phase to neutral voltage**

$Ef = 254,33V$

THEREFORE, THE ELECTRICAL VOLTAGE BETWEEN PHASE AND NEUTRAL IN THIS PANEL IS 254.33V, BECAUSE FROM PHASE TO PHASE IT IS 440V.

THREE-PHASE POWER SUPPLY WITH 760V

IN A CERTAIN DISTRIBUTION PANEL WHERE THE ELECTRICAL VOLTAGE MEASURED FROM PHASE TO PHASE IS 440V, WHAT IS THE VALUE BETWEEN PHASE AND NEUTRAL?



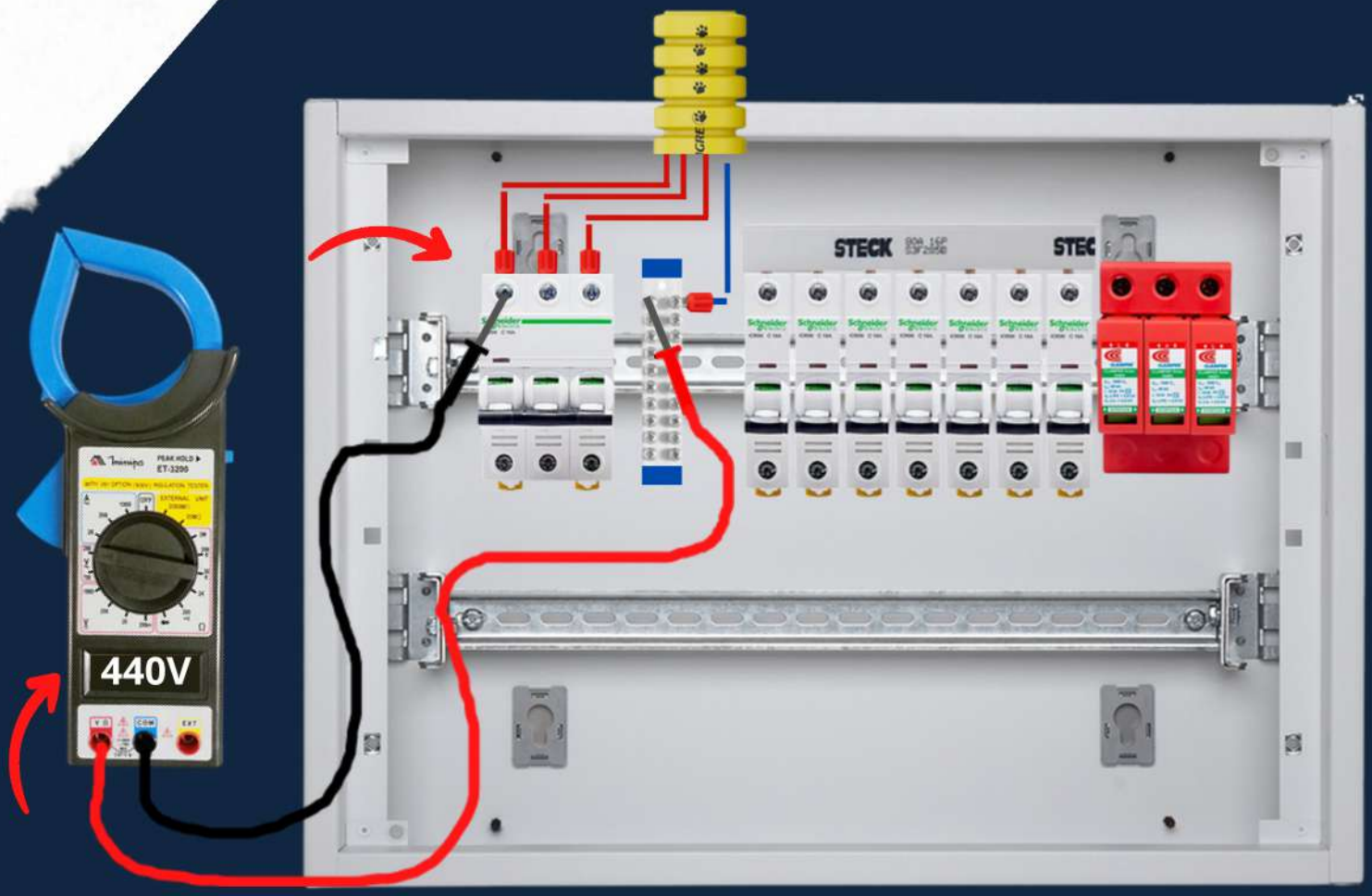
NOTE THAT THE MULTIMETER IS ON THE ALTERNATING VOLTAGE SCALE, AND ITS TEST LEADS ARE TOUCHING EACH PHASE (R AND S)

WHEN WE MEASURE FROM (R-S), (R-T) AND (S-T), WE WILL OBTAIN THE SAME 760V

WE CAN ALSO SAY THAT THE POWER SUPPLY CIRCUIT IS 760V THREE-PHASE

IF WE CHOOSE TO MEASURE BETWEEN (R-N), (S-N) AND (T-N) IN THIS FRAME, WHAT WILL BE THE VOLTAGE VALUE FOUND?

MAKING THE MEASUREMENT BETWEEN PHASE AND NEUTRAL



WE OBSERVE THAT THE MULTIMETER REMAINS ON THE ALTERNATING VOLTAGE SCALE, AND THE TEST LEADS (PROBE), ONE IS TO THE R PHASE AND THE OTHER IS TO THE NEUTRAL. THIS VALUE OF 440V IS FOUND EXACTLY BY DIVISION OF THE ELECTRIC VOLTAGE BETWEEN PHASE AND PHASE BY ROOT OF 3, WHICH IS APPROXIMATELY 1.73. SO WE WILL HAVE:

The $Ef = \frac{}{\sqrt{3}}$ → **Phase to phase voltage**

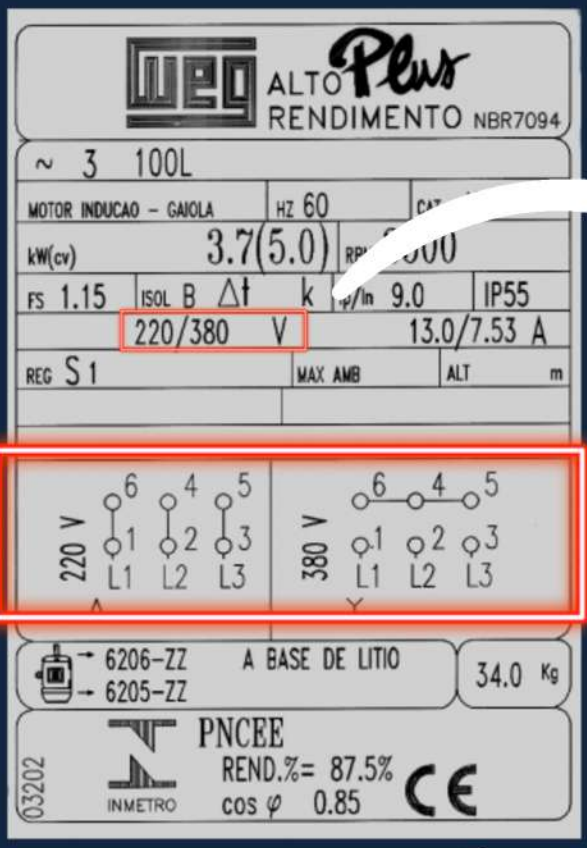
$If = \frac{760}{1,73}$ → **Phase to neutral voltage**

$If = 440V$

THEREFORE, THE ELECTRICAL VOLTAGE BETWEEN PHASE AND NEUTRAL IN THIS PANEL IS 440V, BECAUSE FROM PHASE TO PHASE IT IS 760V.

ELECTRICAL VOLTAGE TO CONNECT A THREE-PHASE MOTOR WITH 6 TERMINALS

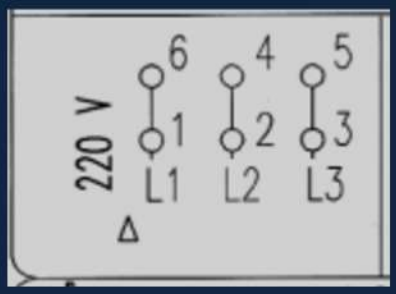
ENGINE PLATE



THIS MOTOR CAN BE CONNECTED TO TWO VOLTAGES 220V OR 127V

BEFORE TURNING ON ANY TYPE OF MOTOR, IT IS NECESSARY TO CHECK ON THE PLATE THE TYPE OF CLOSING THAT SHOULD BE DONE

CONNECTING THE MOTOR TO 220V THREE-PHASE

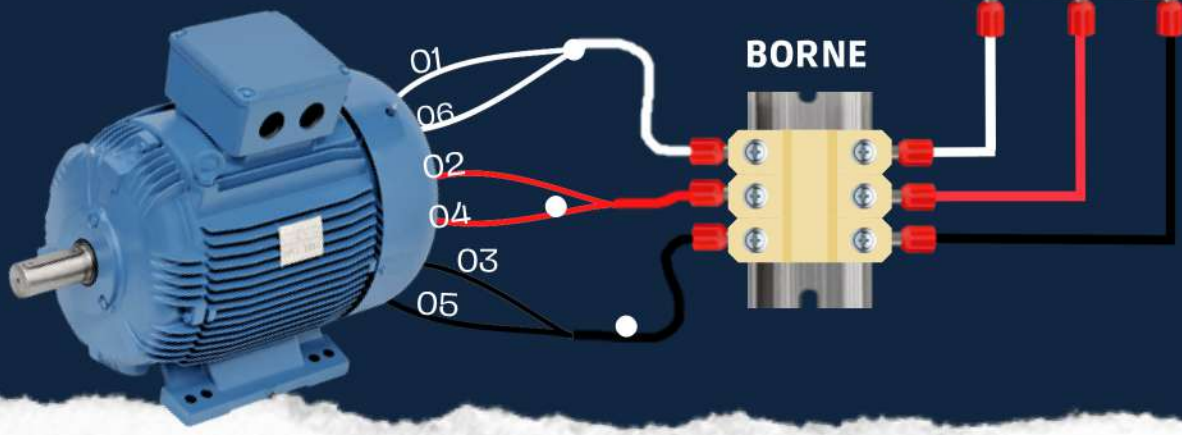


CLOSED TRIANGLE ENGINE

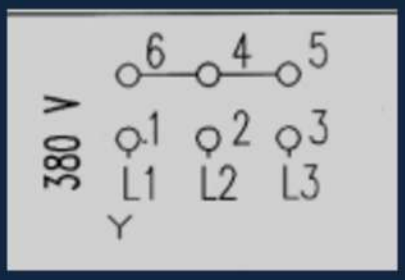
THREE-PHASE 220V POWER SUPPLY

R S T

BORNE

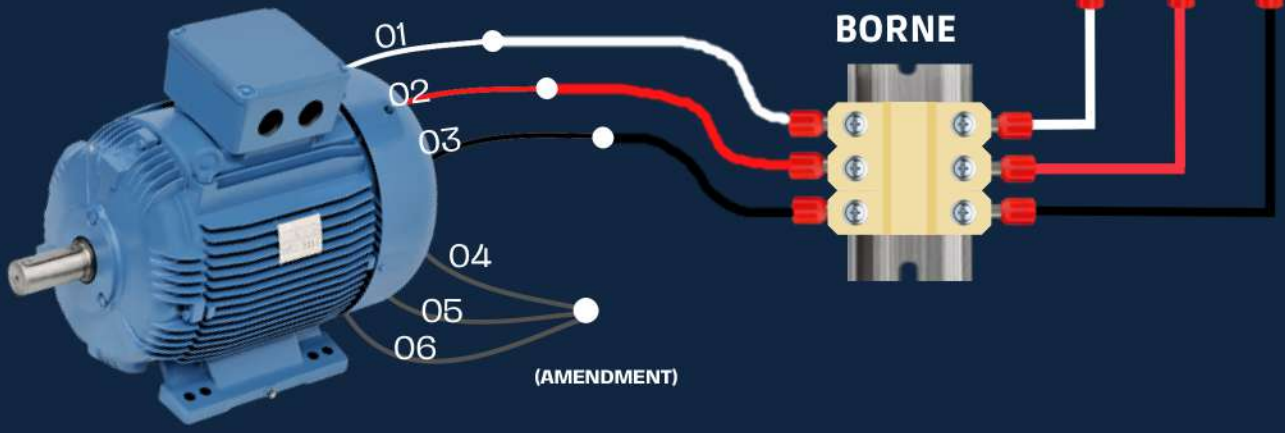


CONNECTING THE MOTOR TO 380V THREE-PHASE

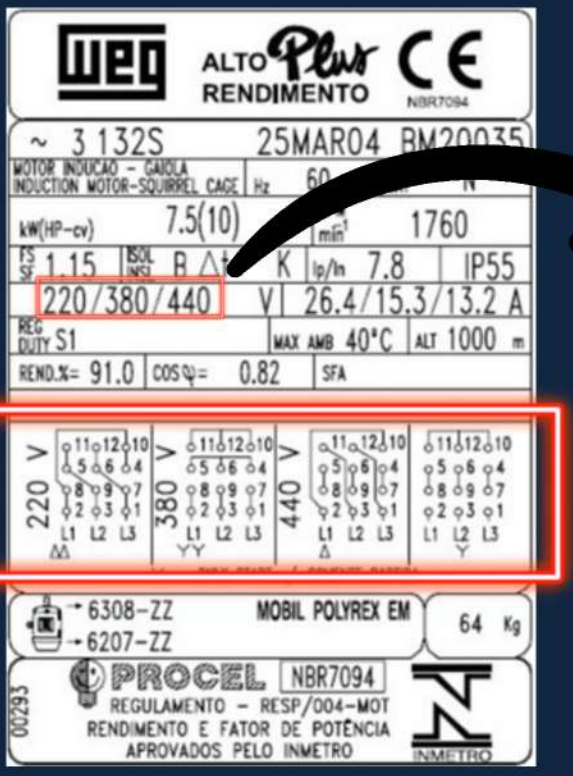


STAR CLOSED MOTOR

THREE-PHASE 380V POWER SUPPLY



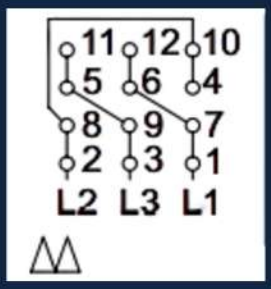
ELECTRICAL VOLTAGE TO CONNECT A THREE-PHASE MOTOR WITH 12 TERMINALS



THIS MOTOR CAN BE CONNECTED TO UP TO 4 VOLTAGES 220V, 380V, 440V AND 760V

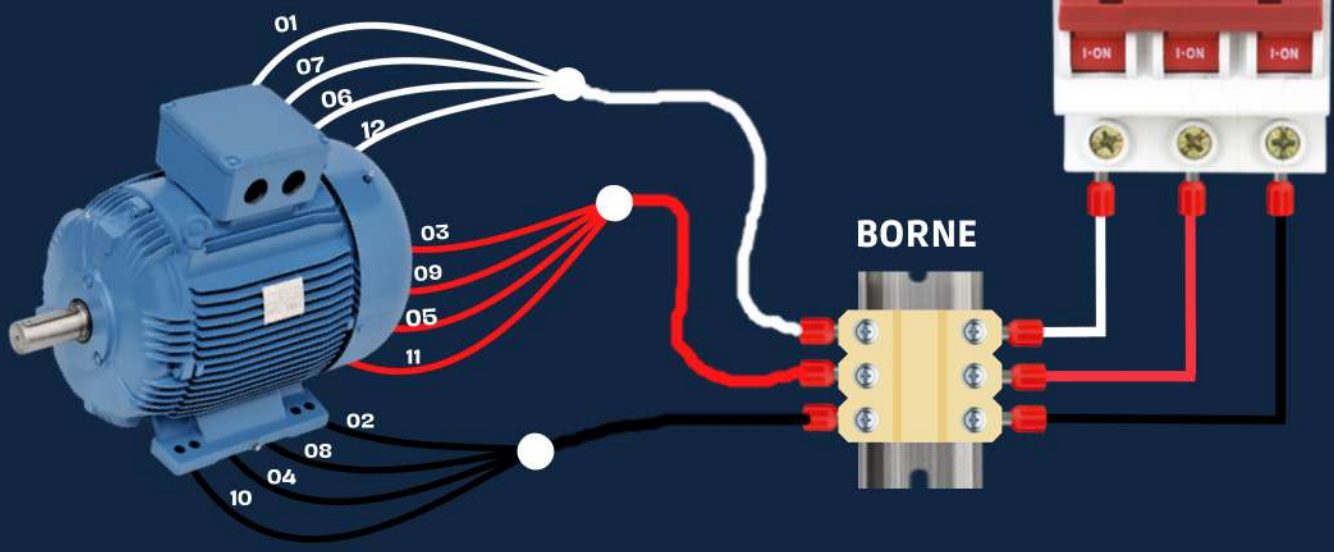
BEFORE TURNING ON ANY TYPE OF MOTOR, IT IS NECESSARY TO CHECK ON THE PLATE THE TYPE OF CLOSING THAT SHOULD BE DONE

CONNECTING THE MOTOR TO 220V THREE-PHASE

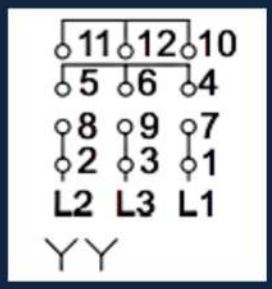


ENGINE CLOSED IN
DOUBLE TRIANGLE

THREE-PHASE 220V
POWER SUPPLY



CONNECTING THE MOTOR TO 380V THREE-PHASE



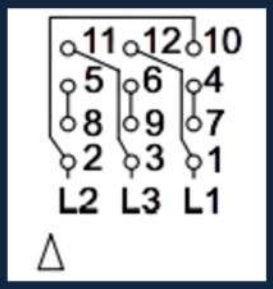
ENGINE CLOSED IN
DOUBLE STAR

THREE-PHASE 380V
POWER SUPPLY

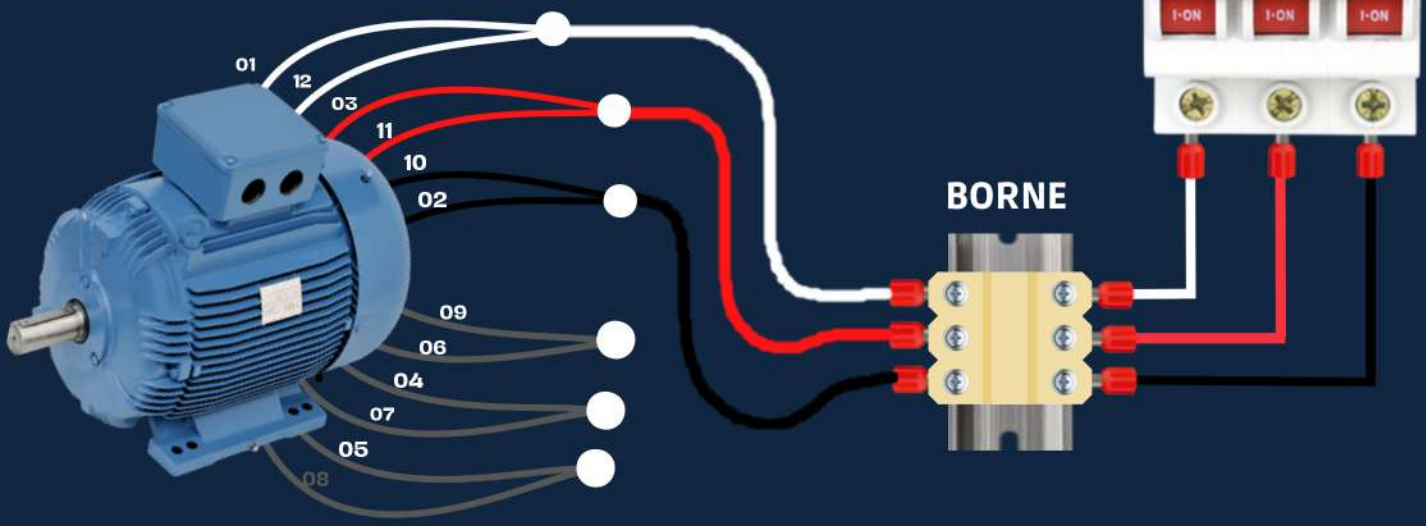
CONNECTING THE MOTOR TO 440V THREE-PHASE

THREE-PHASE 440V POWER SUPPLY

R S T



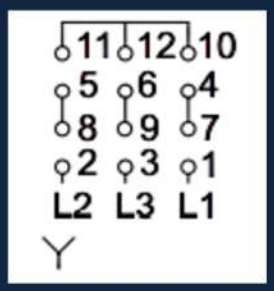
ENGINE CLOSED IN TRIANGLE



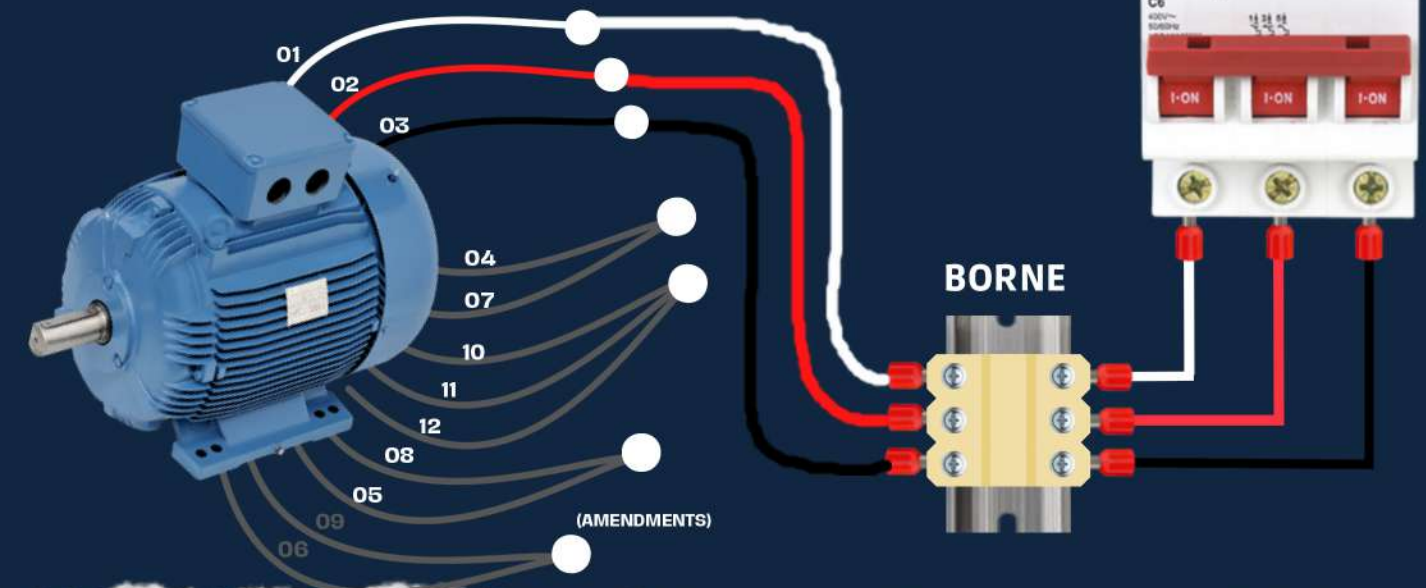
CONNECTING THE MOTOR TO 760V THREE-PHASE

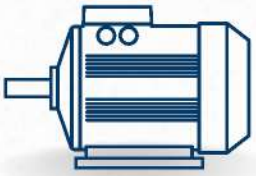
THREE-PHASE 760V POWER SUPPLY

R S T



ENGINE CLOSED IN STAR





ENGINE PARTIES

INTRODUCTION TO ELECTRIC MOTOR STARTING SYSTEMS

ELECTRIC MOTOR STARTING SYSTEMS ARE DEVICES DESIGNED TO START AND CONTROL THE OPERATION OF LARGE AND SMALL ELECTRIC MOTORS. THEY ARE ESSENTIAL IN MANY INDUSTRIAL AND COMMERCIAL APPLICATIONS, SUCH AS PUMPS, COMPRESSORS, FANS, CONVEYORS, AND POWER GENERATING SYSTEMS.

IN ADDITION, THESE SYSTEMS ARE ALSO WIDELY USED IN RESIDENTIAL APPLICATIONS SUCH AS AIR CONDITIONING SYSTEMS, GENERATORS, AND ELECTRIC APPLIANCES. THERE ARE SEVERAL TYPES OF ELECTRIC MOTOR STARTING SYSTEMS, EACH DESIGNED TO MEET THE SPECIFIC NEEDS OF THE MOTOR AND THE SYSTEM IN WHICH IT IS INSTALLED. SOME OF THE MOST COMMON INCLUDE DIRECT STARTER, DIRECT STARTER WITH REVERSING, AND STARTING STARTER. EACH TYPE OF STARTING SYSTEM IS DESIGNED TO PROVIDE A LIMITED STARTING CURRENT TO THE MOTOR, THUS MINIMIZING HIGH VOLTAGES AND CURRENTS THAT COULD DAMAGE THE MOTOR.

CHOOSING THE RIGHT STARTING SYSTEM IS CRUCIAL TO ENSURE RELIABLE AND SAFE PERFORMANCE OF YOUR ELECTRIC MOTOR. IN ADDITION, ELECTRIC MOTOR STARTING SYSTEMS ARE ALSO IMPORTANT TO EXTEND THE LIFE OF THE MOTOR AND TO ENSURE THAT IT RUNS EFFICIENTLY, MAXIMIZING ITS ENERGY EFFICIENCY. TO ENSURE OPTIMAL PERFORMANCE, IT IS IMPORTANT THAT YOU ARE A QUALIFIED PROFESSIONAL WHO CAN INSTALL THE RIGHT STARTING SYSTEM FOR EACH CUSTOMER'S N OR E NEEDS.

APPLICATIONS

ELECTRIC MOTOR STARTERS ARE COMMONLY USED IN A VARIETY OF APPLICATIONS, INCLUDING:

1. INDUSTRY: MOTOR STARTERS ARE WIDELY USED IN INDUSTRIAL MACHINES SUCH AS PUMPS, FANS, COMPRESSORS, MILLS AND PROCESSING EQUIPMENT. BUILDINGS: MOTOR STARTERS ARE USED
2. IN AIR CONDITIONING SYSTEMS, ELEVATORS, LIGHTING SYSTEMS, EMERGENCY GENERATORS AND VENTILATION SYSTEMS.

3.TRANSPORTATION SYSTEMS: MOTOR STARTERS ARE USED IN ELECTRIC VEHICLES, TRAINS, SUBWAYS, BARGES AND PLANES.

4.WIND AND SOLAR GENERATORS: MOTOR STARTERS ARE USED IN GENERATORS RENEWABLE ENERGY SYSTEMS, SUCH AS WIND AND SOLAR GENERATORS.

5. POWER GENERATION SYSTEMS: MOTOR STARTERS ARE USED IN POWER PLANTS, EMERGENCY GENERATORS, AND POWER DISTRIBUTION SYSTEMS.
6. AGRICULTURE: MOTOR STARTERS ARE USED IN AGRICULTURAL EQUIPMENT, SUCH AS TRACTORS, HARVESTERS, AND BRUSH CUTTERS. OTHER
7. APPLICATIONS: MOTOR STARTERS ARE ALSO USED IN MARINE, RAILWAY, AVIATION, AND WATER TRANSPORTATION SYSTEMS, AMONG OTHERS.

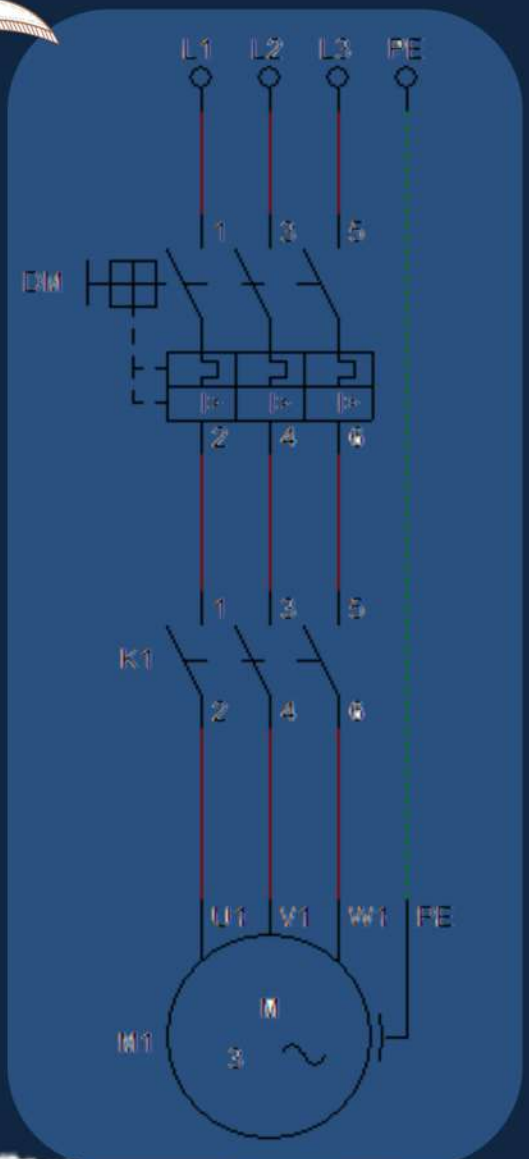
WIRING DIAGRAM

IT IS A TECHNICAL DRAWING THAT SHOWS THE ELECTRICAL CONNECTION OF THE COMPONENTS OF AN ELECTRIC MOTOR STARTING SYSTEM. IT PROVIDES AN OVERVIEW OF THE ELECTRICAL CIRCUIT, INCLUDING THE POSITION AND FUNCTION OF EACH COMPONENT, SUCH AS CONTACTORS, RELAYS, PUSHBUTTONS, SIGNALS AND OTHER ELECTRICAL DEVICES. THE ELECTRIC MOTOR STARTING DIAGRAM MAY ALSO INCLUDE INFORMATION ABOUT THE TYPE OF MOTOR, THE TYPE OF STARTING SYSTEM, THE POWER SUPPLY AND OTHER IMPORTANT DATA.

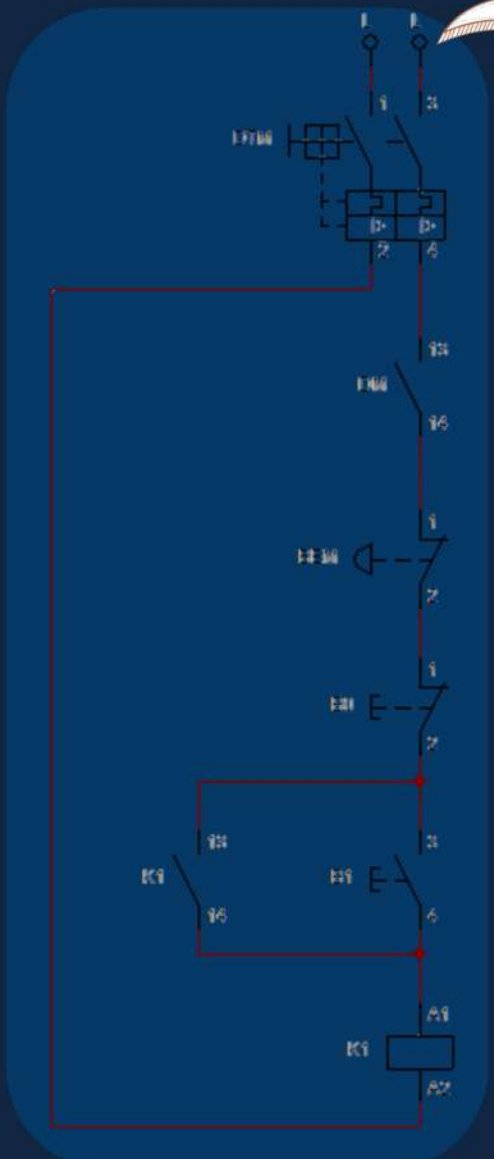
THEY ARE IMPORTANT TO HELP UNDERSTAND HOW AN ELECTRIC MOTOR STARTING SYSTEM WORKS AND TO ENSURE THE CORRECT INSTALLATION AND MAINTENANCE OF THE COMPONENTS. THEY ARE FREQUENTLY USED BY ENGINEERS, TECHNICIANS AND ELECTRICIANS INVOLVED IN THE DESIGN, INSTALLATION AND MAINTENANCE OF ELECTRIC MOTOR STARTING SYSTEMS. IN ADDITION, ELECTRIC MOTOR STARTING DIAGRAMS ARE ALSO USEFUL FOR TROUBLESHOOTING TECHNICAL PROBLEMS AND FOR PLANNING FUTURE IMPROVEMENTS OR UPGRADES TO THE SYSTEM.

EXAMPLE OF WIRING DIAGRAM

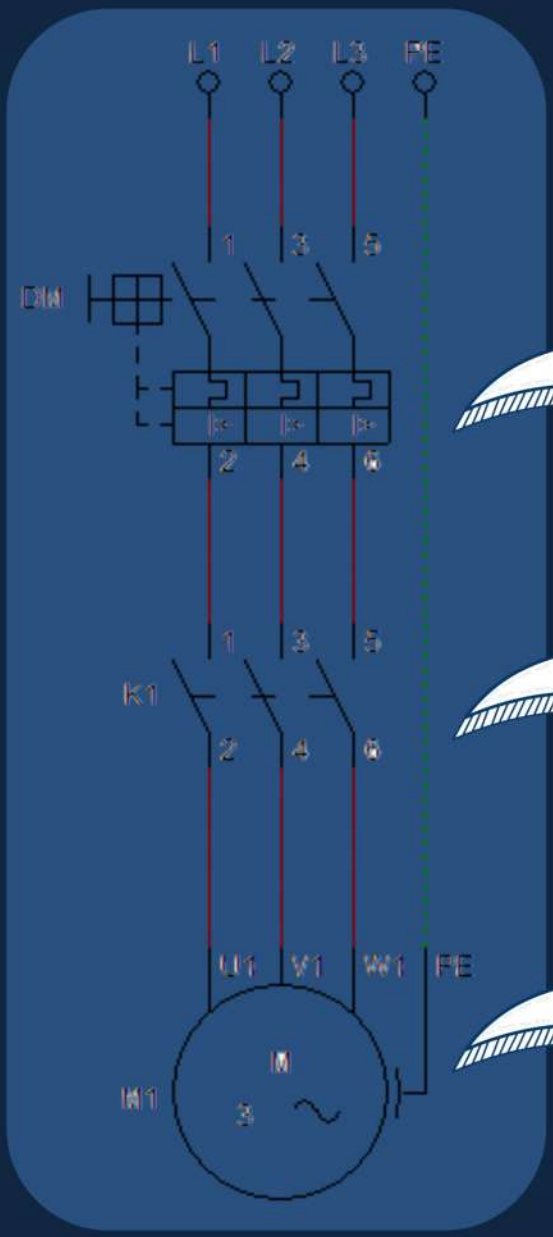
POWER CIRCUIT



CONTROL CIRCUIT



POWER CIRCUIT



MOTOR CIRCUIT BREAKER

POWER CONTACTOR

ENGINE OF INDUCTION THREE-PHASE

THE POWER CIRCUIT IS AN IMPORTANT PART OF AN ELECTRICAL SYSTEM THAT SUPPLIERS ELECTRIC ENERGY TO THE ELECTRIC MOTOR. IT COMPRISES A POWER SOURCE, SUCH AS A BATTERY OR GENERATOR, ELECTRIC WIRES, AND PROTECTION DEVICES, SUCH AS CIRCUIT BREAKERS AND FUSES. THE POWER CIRCUIT IS DESIGNED TO PROVIDE CONSTANT AND STABLE ELECTRIC CURRENT TO THE MOTOR, ENSURING ITS CORRECT AND SAFE OPERATION. IT IS RESPONSIBLE FOR SUPPLYING THE ELECTRIC CURRENT NECESSARY TO ACTUATE THE ELECTRIC MOTOR STARTING SYSTEM, AS WELL AS MONITORING AND PROTECTING THE ELECTRIC SYSTEM AGAINST OVERLOAD, SHORT CIRCUITS AND OTHER ABNORMAL CONDITIONS. CORRECT INSTALLATION AND MAINTENANCE OF THE POWER CIRCUIT IS FUNDAMENTAL TO ENSURE THE RELIABLE AND SAFE PERFORMANCE OF THE ELECTRIC MOTOR.

CONTROL CIRCUIT

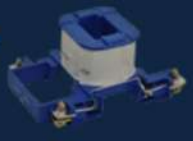
BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER

AUXILIARY CONTACT OF THE MOTOR CIRCUIT BREAKER

EMERGENCY PUSHBUTTON

PUSHBUTTON SWITCH OFF NC CONTACT

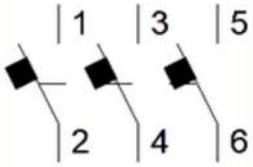
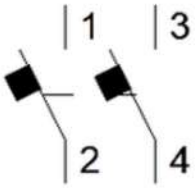
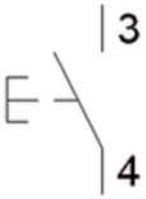
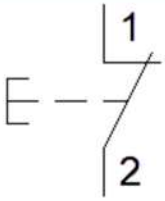
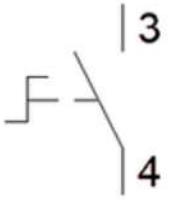
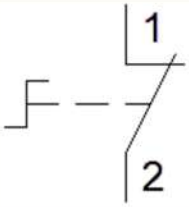
BUTTON SWITCH ON CONTACT NA



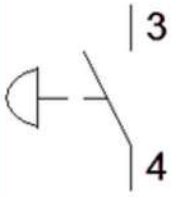
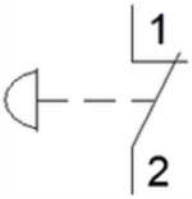
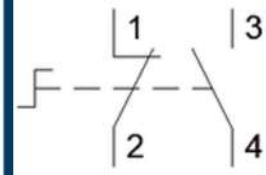
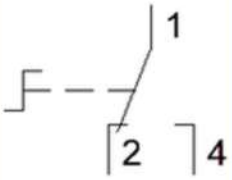
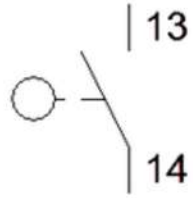
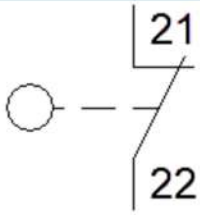
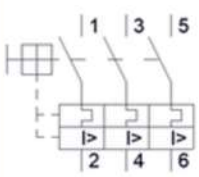
INTERNAL COIL OF THE CONTACTOR A1 TO A2

THE CONTROL CIRCUIT IS AN IMPORTANT PART OF AN ELECTRIC MOTOR STARTING SYSTEM THAT CONTROLS THE OPERATION OF THE MOTOR. IT IS COMPRISED OF ELECTRICAL COMPONENTS, SUCH AS PUSHBUTTONS, SELECTOR SWITCHES, LIMIT SWITCHES, SWITCHES AND SENSORS, AND MONITORS THE CONDITIONS OF THE ELECTRICAL SYSTEM TO START AND STOP THE MOTOR IN A SAFE AND CONTROLLED MANNER. THE CONTROL CIRCUIT IS FUNDAMENTAL TO ENSURE THE RELIABLE AND SAFE PERFORMANCE OF THE ELECTRIC MOTOR STARTING SYSTEM.

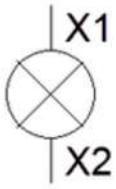
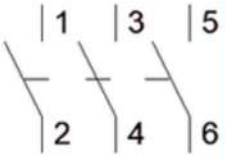
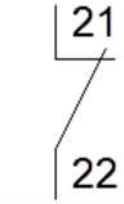
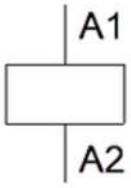
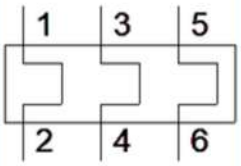
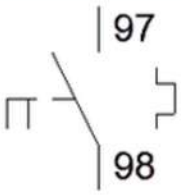
LIST OF SYMBOLS

IMAGE	NOMENCLATURE	SYMBOL	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER		RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	DISJUTOR TERMOMAGNÉTICO BIPOLAR		RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	SINGLE-POLAR THERMOMAGNETIC CIRCUIT BREAKER		RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	PULSING PUSH BUTTON ON		RESPONSIBLE FOR SWITCHING THE CIRCUIT ON AND OFF
	NF PULSING PUSH BUTTON		RESPONSIBLE FOR SWITCHING THE CIRCUIT ON AND OFF
	RETENTIVE BUTTON ON		RESPONSIBLE FOR SWITCHING THE CIRCUIT ON AND OFF
	NF RETENTIVE PUSHBUTTON		RESPONSIBLE FOR SWITCHING THE CIRCUIT ON AND OFF

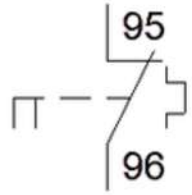
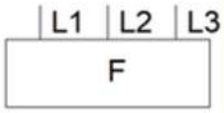
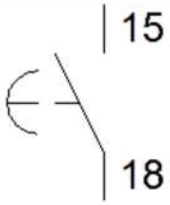
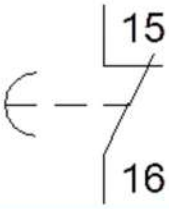
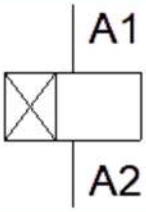
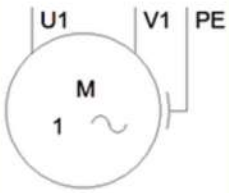
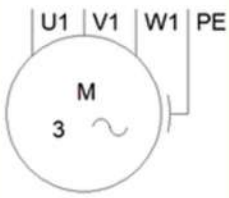
LIST OF SYMBOLS

IMAGE	NOMENCLATURE	SYMBOL	FUNCTION
	EMERGENCY BUTTON ON		WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	NC EMERGENCY BUTTON		EMERGENCY BUTTON WHEN PRESSED: IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN TURNED OR PULLED: IT RETURNS TO ITS ORIGINAL POSITION.
	NO AND NC SELECTOR SWITCH		ROTARY SWITCH BY TURNING THE KNOB TO ONE SIDE: IT ALLOWS ELECTRIC CURRENT TO PASS. FUNCTION: RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	NO AND NC SELECTOR SWITCH		RESPONSIBLE FOR LIMITING, TURNING THE CIRCUIT ON OR OFF
	LIMIT SWITCH (S1) - NA		BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	LIMIT SWITCH (S1) - NC		RESPONSIBLE FOR LIMITING, TURNING THE CIRCUIT ON OR OFF
	MOTOR CIRCUIT BREAKER		RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.

LIST OF SYMBOLS

IMAGE	NOMENCLATURE	SYMBOL	FUNCTION
	SIGNAL MAN		RESPONSIBLE FOR INDICATING THE OPERATION OF THE ENGINE
	CONTACTOR OF POWER - CONTACTS MAIN CONTACTORS		RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	OF POWER - CONTACT ASSIST IN		RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	CONTACTOR OF POWER - CONTACT NF ASSISTANT		RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	POWER CONTACTOR - COIL		RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY - MAIN CONTACTS		RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	THERMAL RELAY - CONTACT US		RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.

LIST OF SYMBOLS

IMAGE	NOMENCLATURE	SYMBOL	FUNCTION
	THERMAL RELAY - NC CONTACT		RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	PHASE LACK RELAY		RESPONSIBLE FOR MONITORING THE SEQUENCE AND LACK OF PHASE. IN CASE OF ABNORMALITY IT WILL DISCONNECT THE CIRCUIT.
	ON DELAY TIMER RELAY - NA		RESPONSIBLE FOR TURNING THE LOAD ON OR OFF AFTER A CERTAIN TIME PRE-PROGRAMMED IN THE RELAY ITSELF.
	TIMER RELAY ON DELAY - NF		RESPONSIBLE FOR TURNING THE LOAD ON OR OFF AFTER A CERTAIN TIME PRE-PROGRAMMED IN THE RELAY ITSELF.
	ON DELAY TIMER RELAY - COIL		RESPONSIBLE FOR TURNING THE LOAD ON OR OFF AFTER A CERTAIN TIME PRE-PROGRAMMED IN THE RELAY ITSELF.
	SINGLE-PHASE ELECTRIC MOTOR (M1)		RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.
	THREE-PHASE ELECTRIC MOTOR (M1)		RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

1. DIRECT START WITH SELECTOR SWITCH

1.1 WIRING DIAGRAM

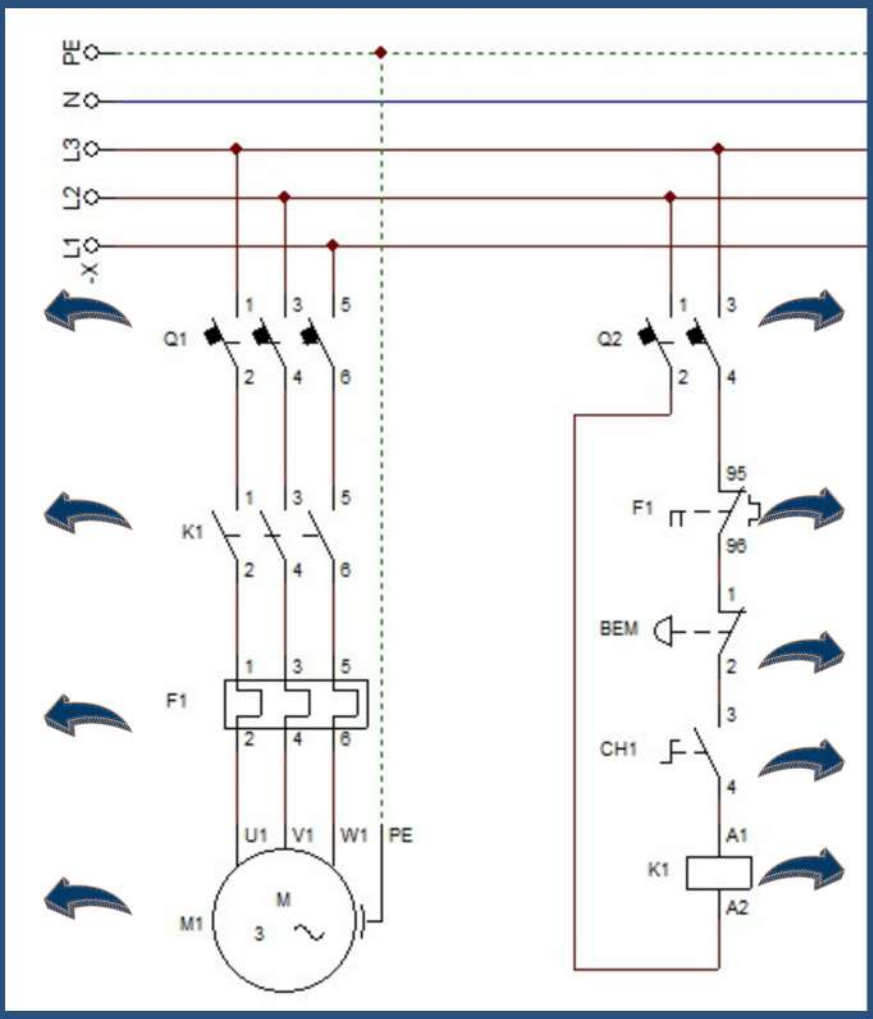
Food

Three-pole circuit breaker

Contactor power contacts

Thermal relay

Three-phase motor



Bipolar circuit breaker

Thermal relay contact

Emergency pushbutton Selector switch Contactor coil

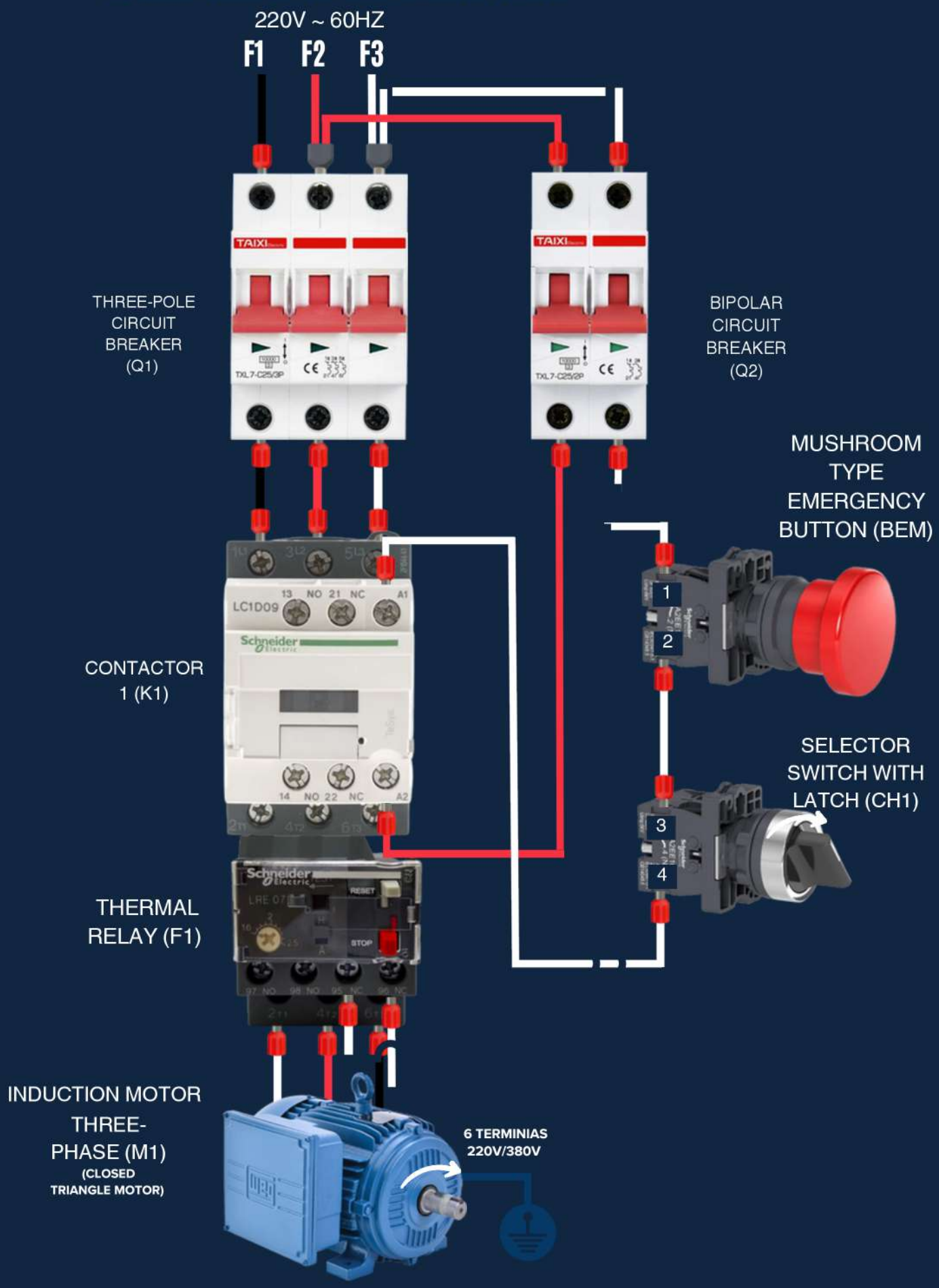
1.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO TURN ON CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN TURNING THE KEY (CH1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT.

SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT THERMAL RELAY (F1): TURNS OFF THE CIRCUIT IN CASE OF OVERLOAD SELECTOR SWITCH (CH1): TURNS THE CIRCUIT ON AND OFF

1.3 DIRECT START LAYOUT WITH SELECTOR SWITCH

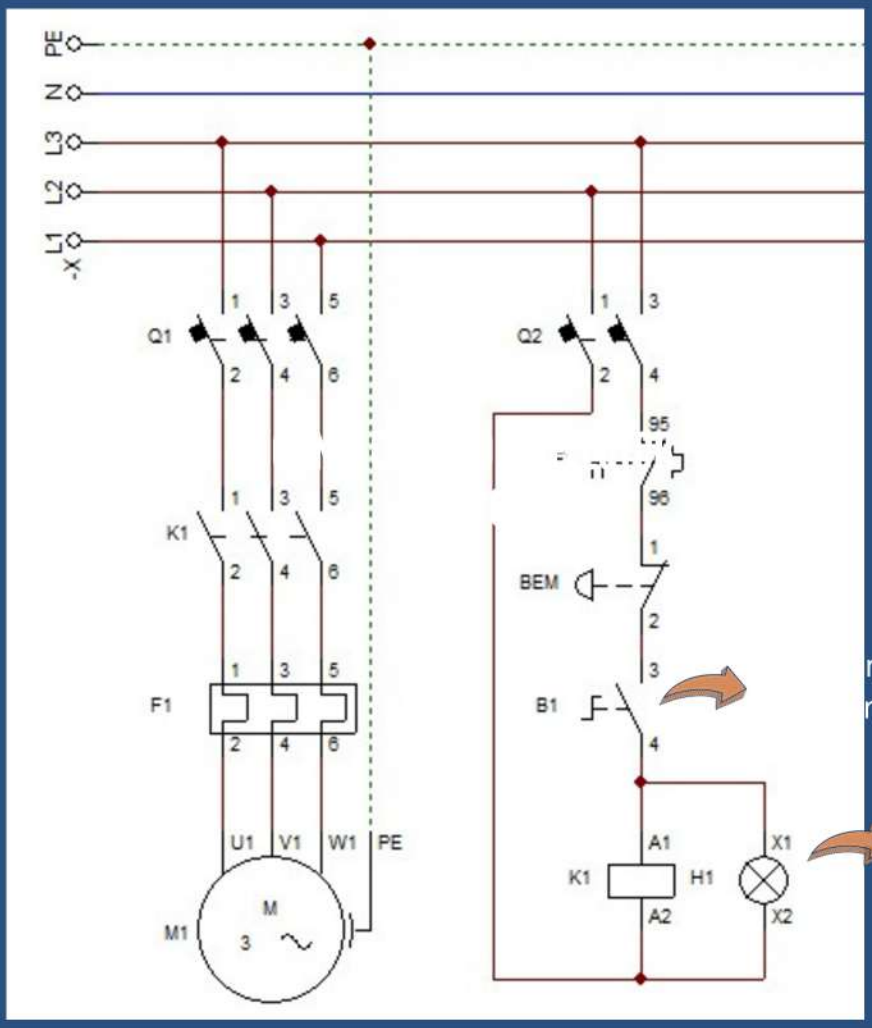


1.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1) - NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON - NF (BEM) - NF	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH - NO (CH1) - NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

2. DIRECT START WITH RETENTIVE PUSHBUTTON AND SIGNALING

2.1 WIRING DIAGRAM



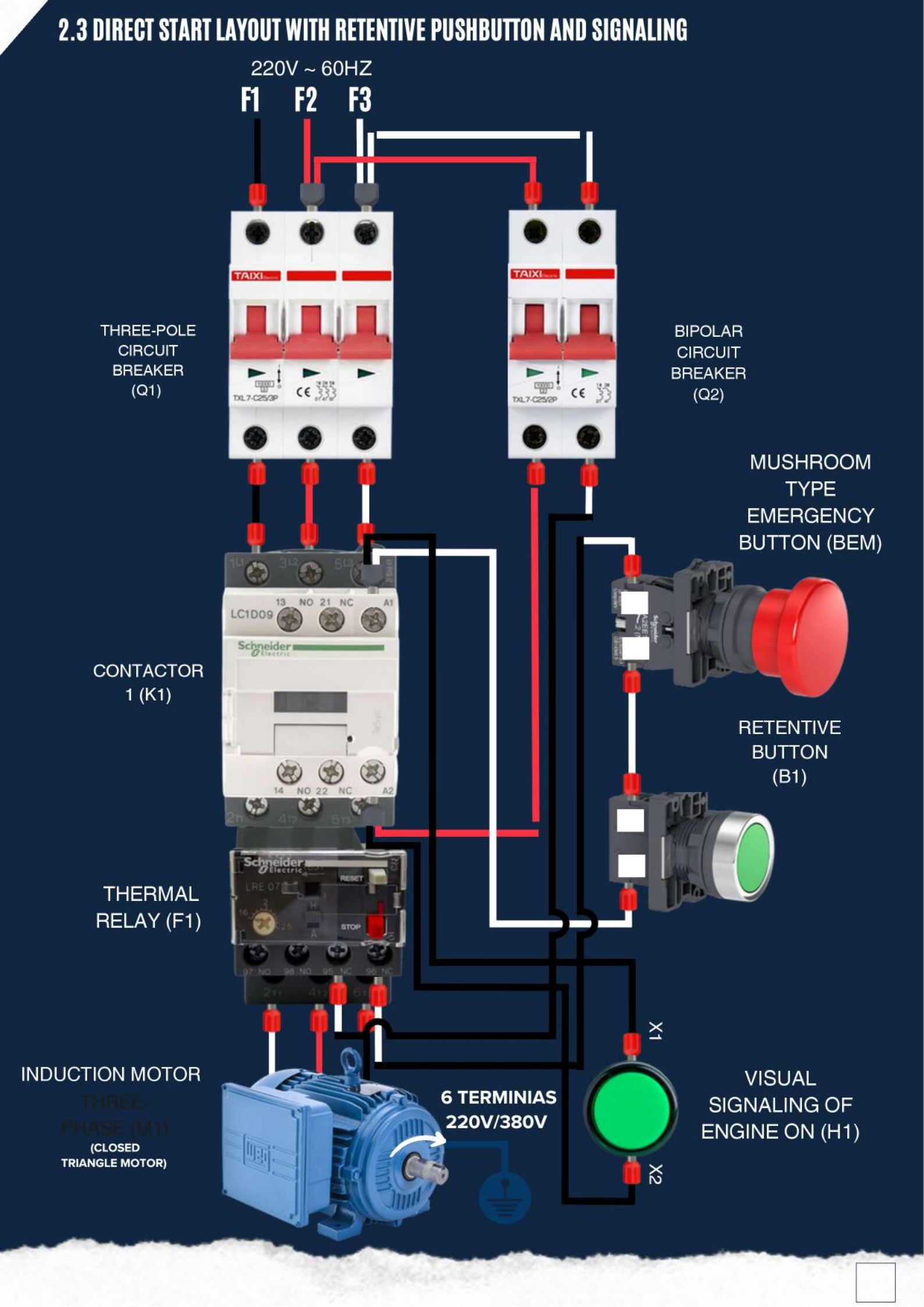
2.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN PRESSING THE BUTTON (B1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. SIGNAL LIGHT H1 WILL LIGHT UP INDICATING THE "MOTOR ON" STATE. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO TURNS OFF THE CIRCUIT.

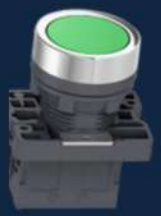
SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT THERMAL RELAY (F1): TURNS OFF THE CIRCUIT IN CASE OF OVERLOAD RETENTIVE PUSHBUTTON (B1): TURNS ON AND OFF THE SIGNAL CIRCUIT (H1) : SIGNALS THAT THE ENGINE IS ON

2.3 DIRECT START LAYOUT WITH RETENTIVE PUSHBUTTON AND SIGNALING



2.4 MATERIALS USED

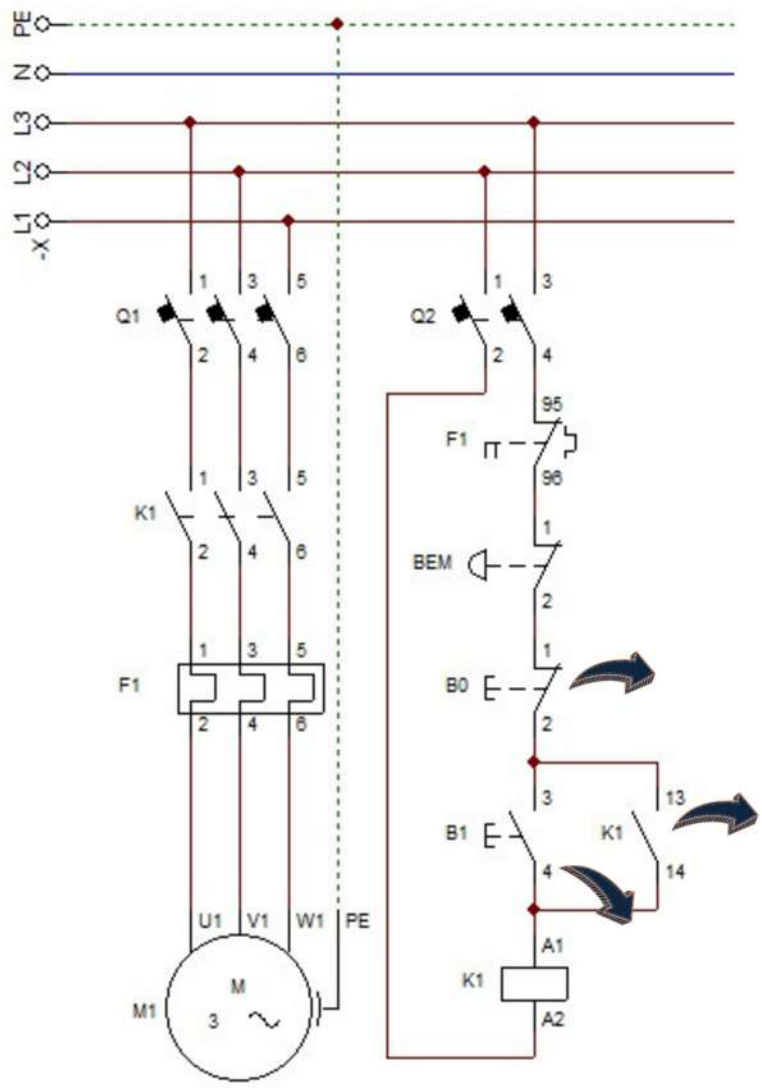
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	THERMOMAGNETIC CIRCUIT BREAKER BIPOLAR (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1) -NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON - NF (BEM) - NF	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	RETENTIVE PUSHBUTTON (B1) - NA	RESPONSIBLE FOR SWITCHING THE CIRCUIT ON AND OFF
	SIGNAL MAN (H1)	RESPONSIBLE FOR INDICATING ENGINE OPERATION (ON)

2.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

3. DIRECT START WITH PULSING PUSH BUTTON AND SEAL CONTACT

3.1 WIRING DIAGRAM

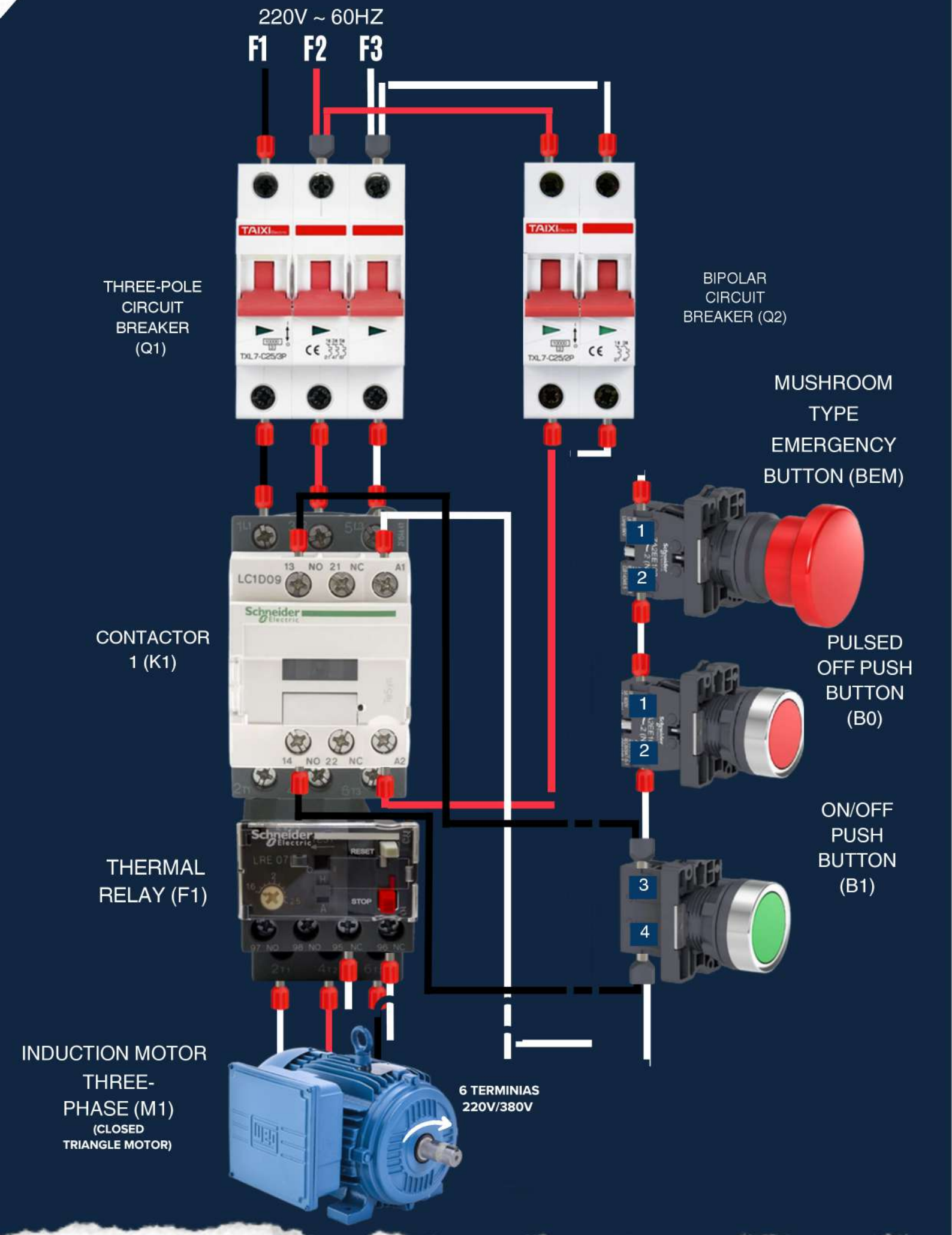


3.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN PRESSING THE BUTTON (B1) THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, THE COIL WILL REMAIN ENERGIZED EVEN IF THE BUTTON (B1) RETURNS TO ITS INITIAL STATE, THROUGH THE SEAL CONTACT (13 AND 14). IN CASE OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE BUTTON (B0) SWITCHES OFF THE CIRCUIT AND THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT IN CASE OF EMERGENCY. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT THERMAL RELAY (F1): TURNS OFF THE CIRCUIT IN CASE OF OVERLOAD PUSHBUTTON (B1): TURNS ON THE CIRCUIT PUSHBUTTON (B0): TURNS OFF THE CIRCUIT

3.3 DIRECT START LAYOUT WITH PULSED PUSH BUTTON AND SEAL CONTACT



3.4 MATERIALS USED

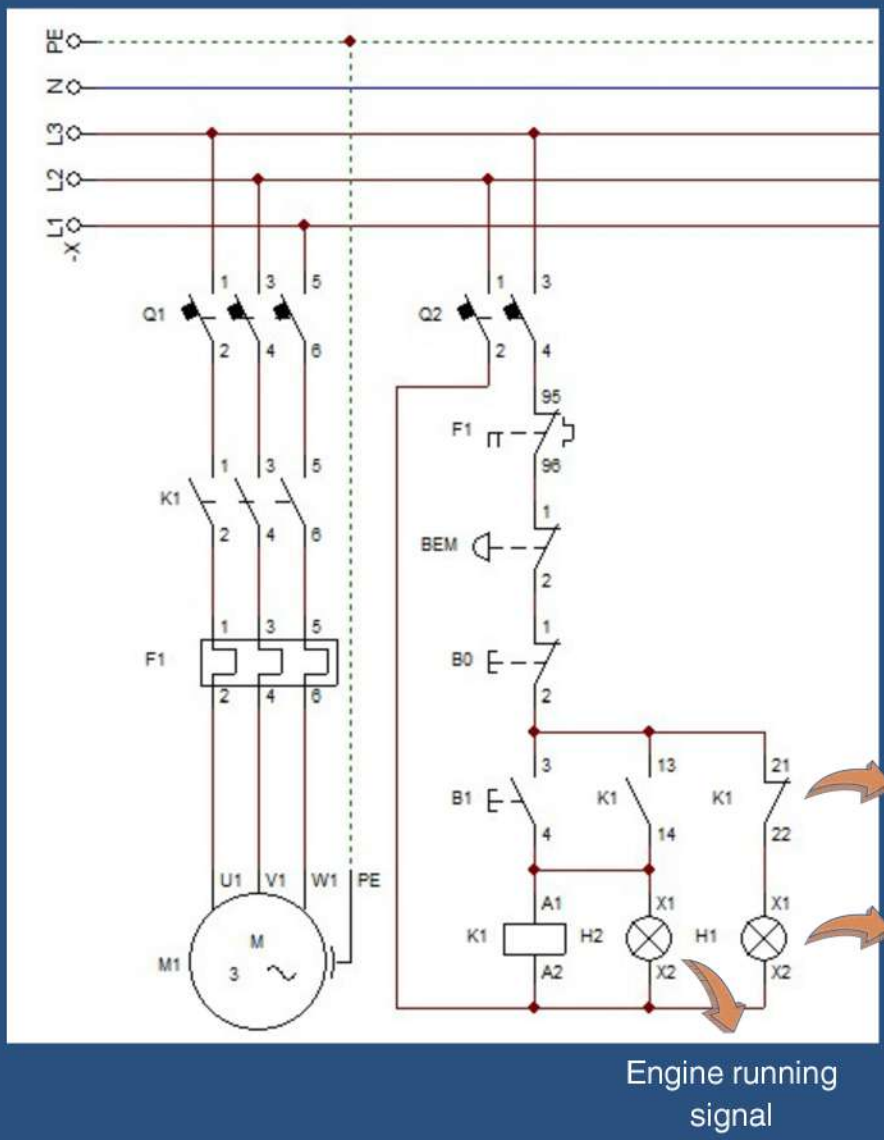
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETI C CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1) - NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	PULSING PUSH BUTTON (B1) - NO	RESPONSIBLE FOR CONNECTING THE CIRCUIT
	PULSING PUSH BUTTON (B0) - NC	RESPONSIBLE FOR DISCONNECTING THE CIRCUIT

3.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

4. DIRECT START WITH PULSING PUSH BUTTON, SEAL CONTACT AND SIGNALING

4.1 WIRING DIAGRAM



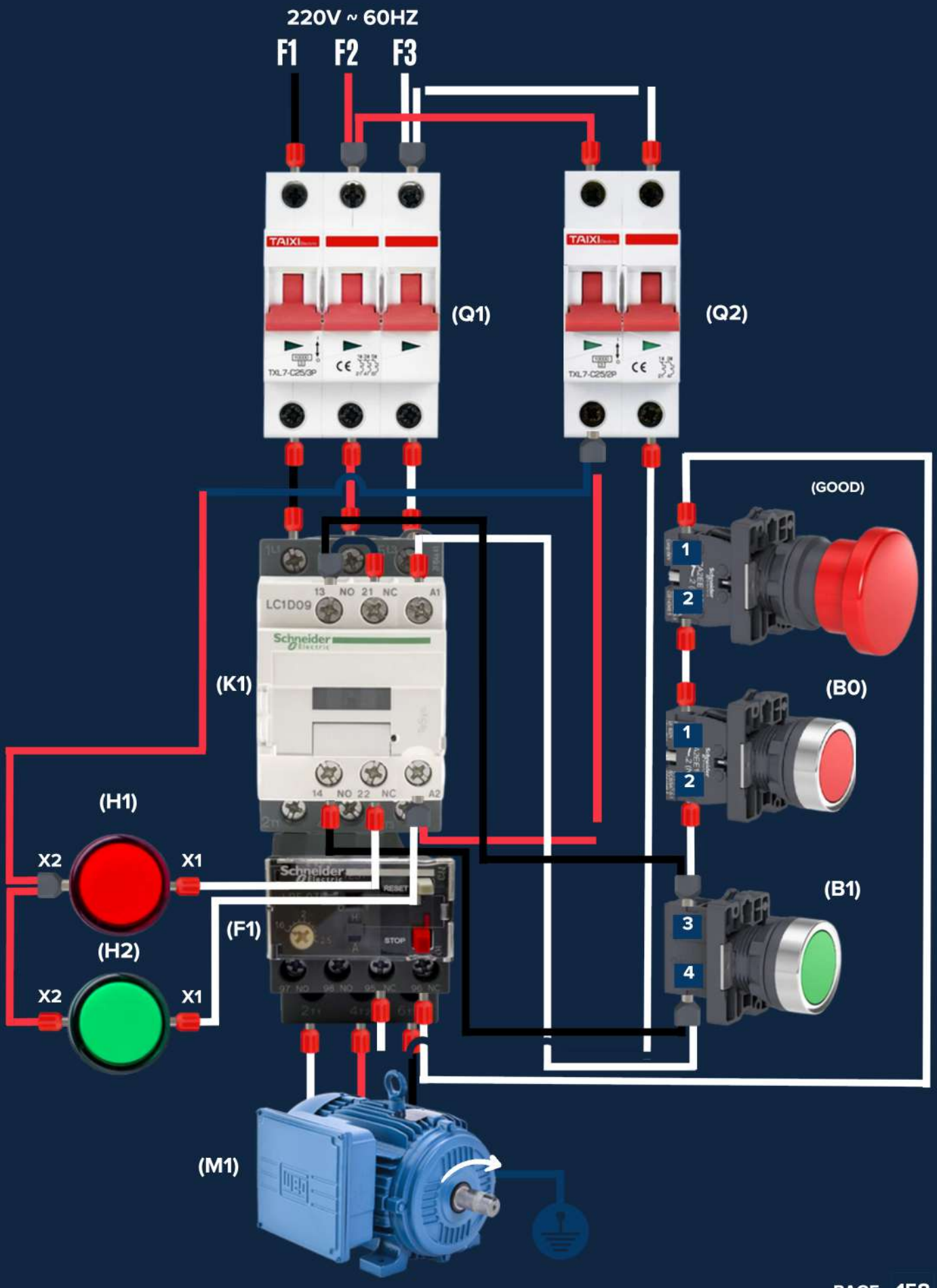
4.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN PRESSING THE BUTTON (B1) THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, THE COIL WILL REMAIN ENERGIZED EVEN IF THE BUTTON (B1) RETURNS TO ITS INITIAL STATE, THROUGH THE SEAL CONTACT (13 AND 14). IN CASE OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE BUTTON (B0) SWITCHES OFF THE CIRCUIT AND THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT IN CASE OF EMERGENCY. (H1) SIGNALS MOTOR OFF AND (H2) MOTOR ON.

SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM) AND PUSHBUTTON PANEL (B0): TURN OFF THE CIRCUIT THERMAL RELAY (F1): TURN OFF THE CIRCUIT IN CASE OF OVERLOAD PUSHBUTTON PANEL (B1): TURN ON CIRCUIT SIGNAL LIGHT (H1) AND (H2): SIGNALS MOTOR OFF SIGNAL LIGHT (H2): SIGNALS MOTOR ON

4.3 DIRECT START LAYOUT WITH PULSED PUSH BUTTON, SEAL CONTACT AND SIGNALING



4.4 MATERIALS USED

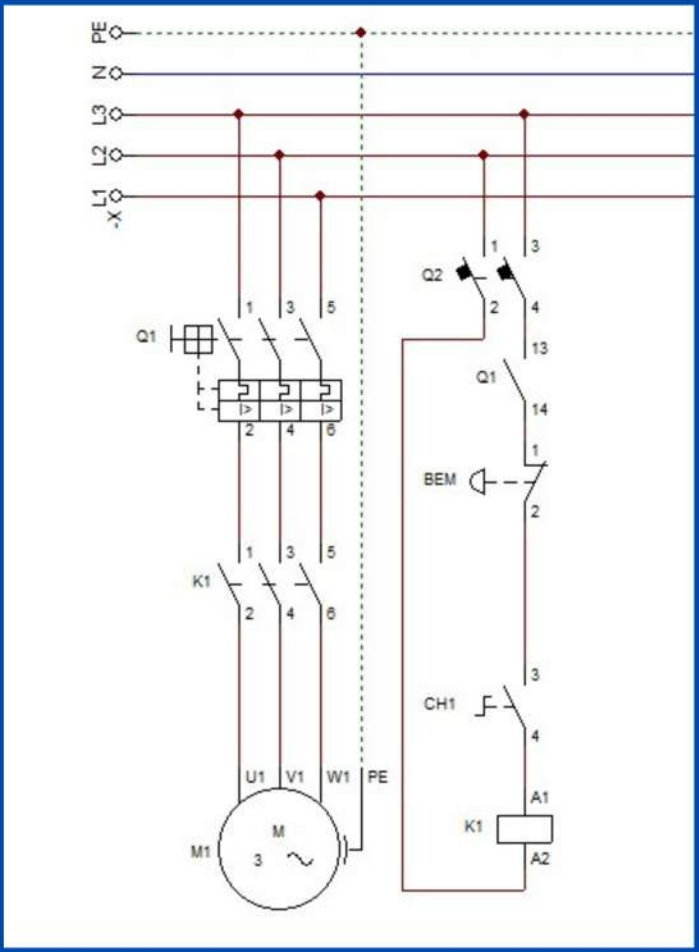
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1) - NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	PULSING PUSH BUTTON (B1) - NO	RESPONSIBLE FOR CONNECTING THE CIRCUIT
	PULSING PUSH BUTTON (B0) - NC	RESPONSIBLE FOR DISCONNECTING THE CIRCUIT

4.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	SIGNAL MAN (H1)	RESPONSIBLE FOR INDICATING THE ENGINE OFF
	SIGNAL (H2)	RESPONSIBLE FOR INDICATING ENGINE OPERATION (ON)
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

5. DIRECT START WITH MOTOR CIRCUIT BREAKER AND SELECTOR SWITCH

5.1 WIRING DIAGRAM



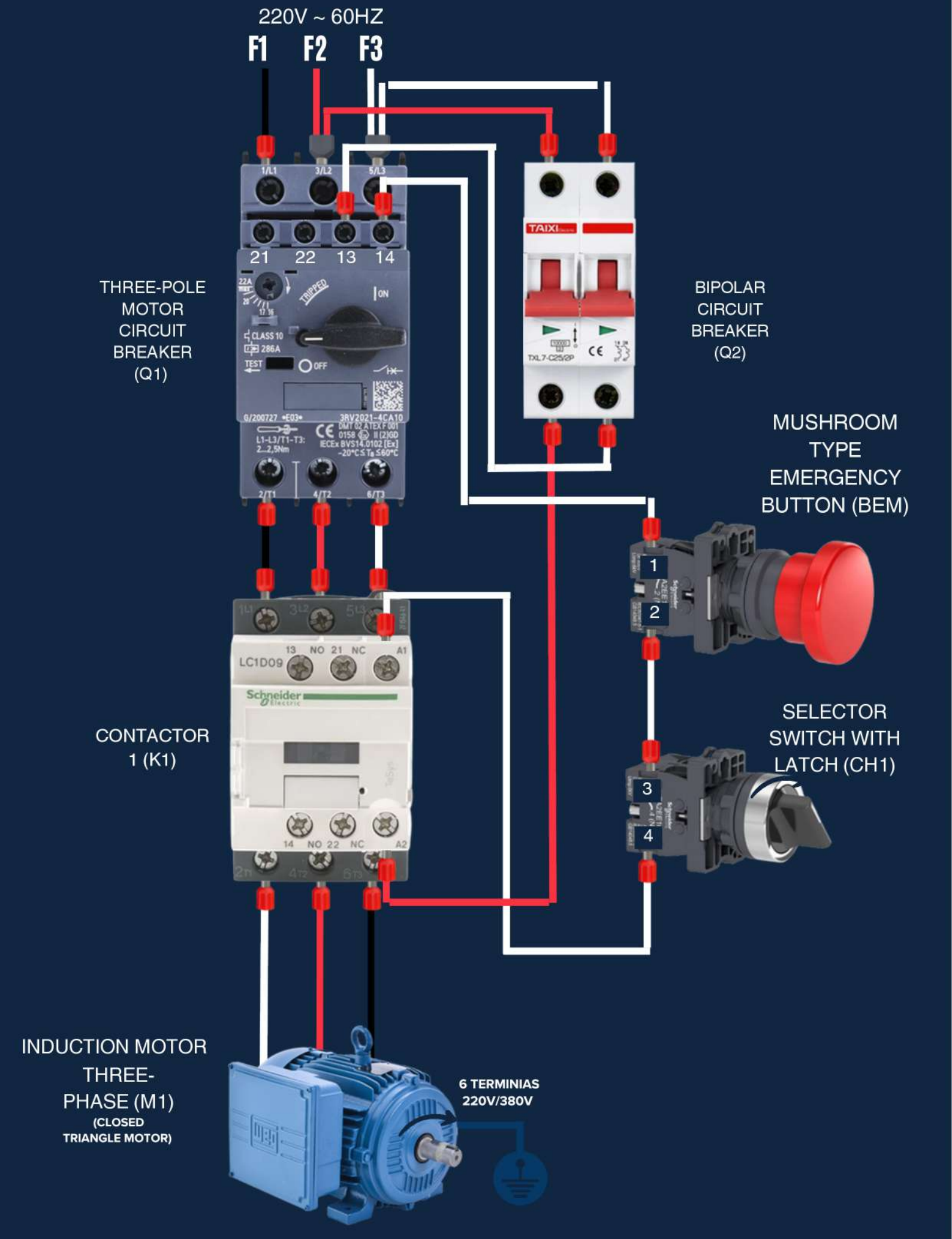
5.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN TURNING THE KEY (CH1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT OF THE MOTOR CIRCUIT BREAKER (Q1) IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT.

SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURN THE CIRCUIT OFF SELECTOR SWITCH (CH1): TURN THE CIRCUIT ON AND OFF NOTE: IN THIS CIRCUIT THE MOTOR CIRCUIT BREAKER IS USED INSTEAD OF A THERMAL RELAY

5.3 DIRECT START LAYOUT WITH MOTOR CIRCUIT BREAKER AND SELECTOR SWITCH

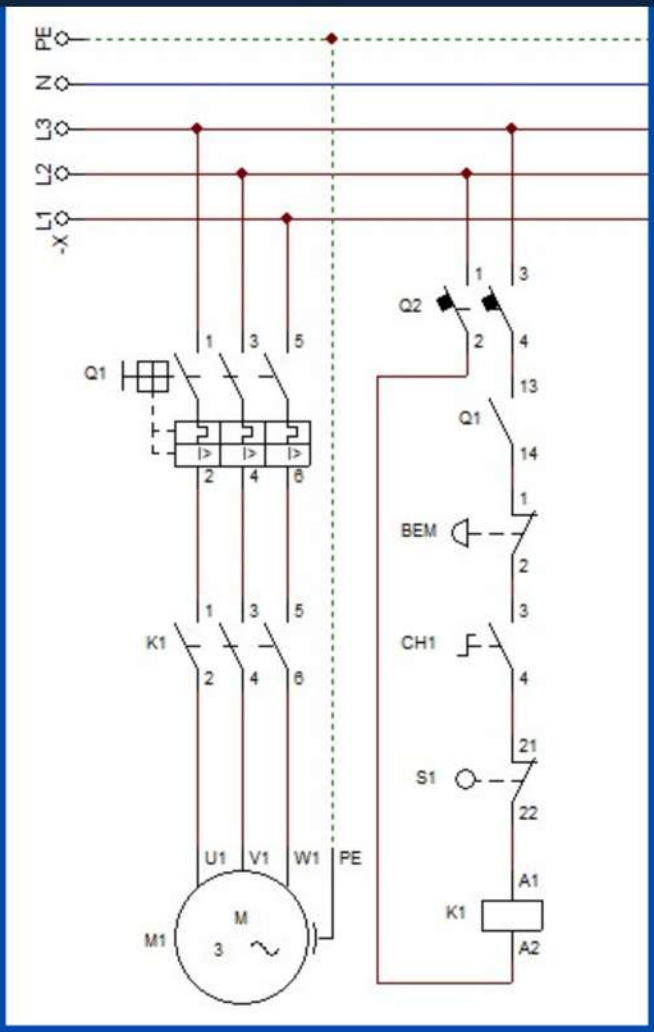


5.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	MOTOR CIRCUIT BREAKER (Q1) - NO	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH (CH1) - NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

6. DIRECT START WITH MOTOR CIRCUIT BREAKER, SELECTOR SWITCH AND LIMIT SWITCH

6.1 WIRING DIAGRAM

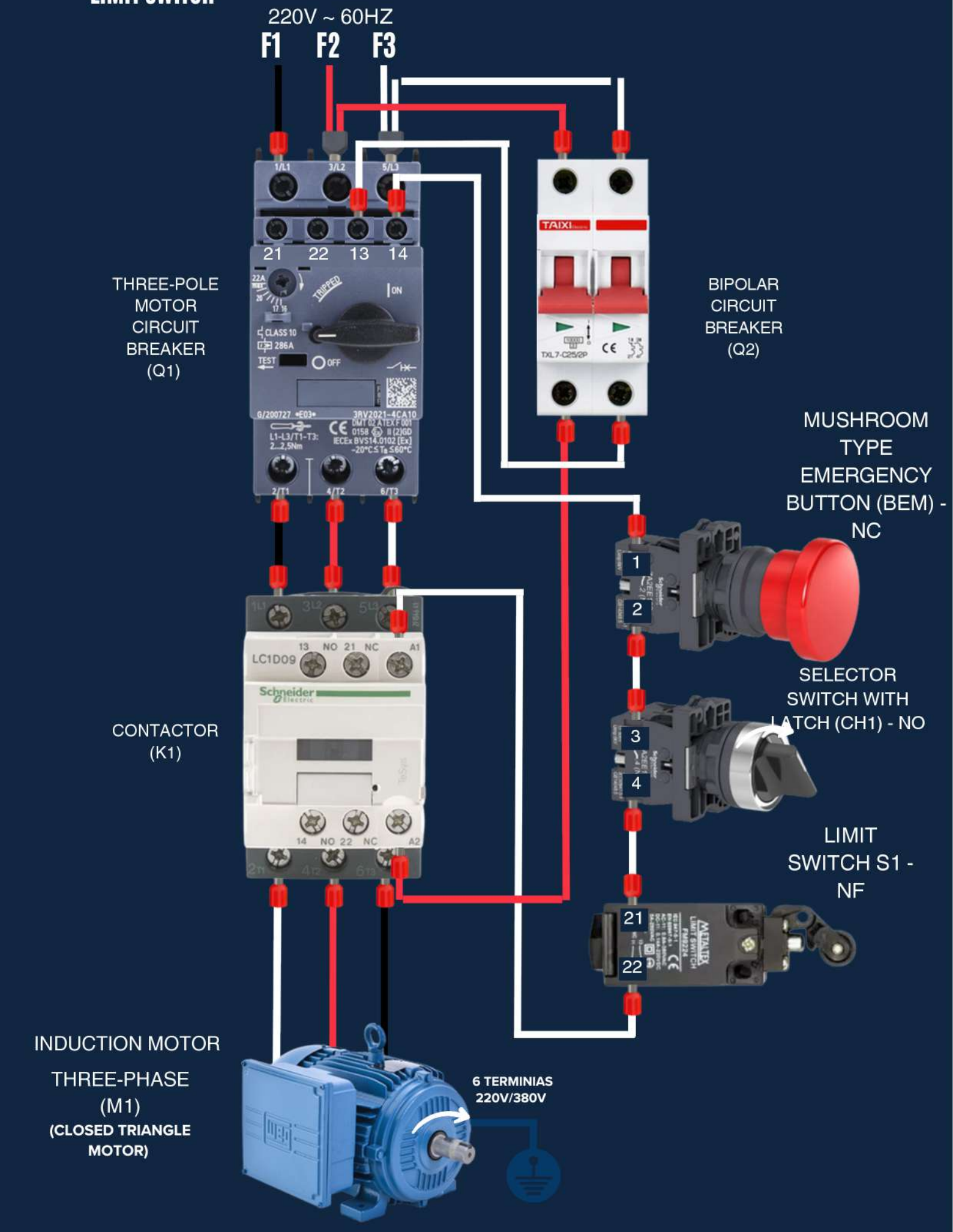


6.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN TURNING THE KEY (CH1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT OF THE MOTOR CIRCUIT BREAKER (Q1) IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT. THE LIMIT SWITCH (S1) INDICATES THE END OF A PROCESS, SWITCHING OFF THE CIRCUIT. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURN THE CIRCUIT OFF SELECTOR SWITCH (CH1): TURN THE CIRCUIT ON AND OFF LIMIT SWITCH (S1): TURN THE CIRCUIT OFF NOTE: IN THIS CIRCUIT THE MOTOR CIRCUIT BREAKER IS USED INSTEAD OF A THERMAL RELAY

6.3 DIRECT START LAYOUT WITH MOTOR CIRCUIT BREAKER, SELECTOR SWITCH AND LIMIT SWITCH

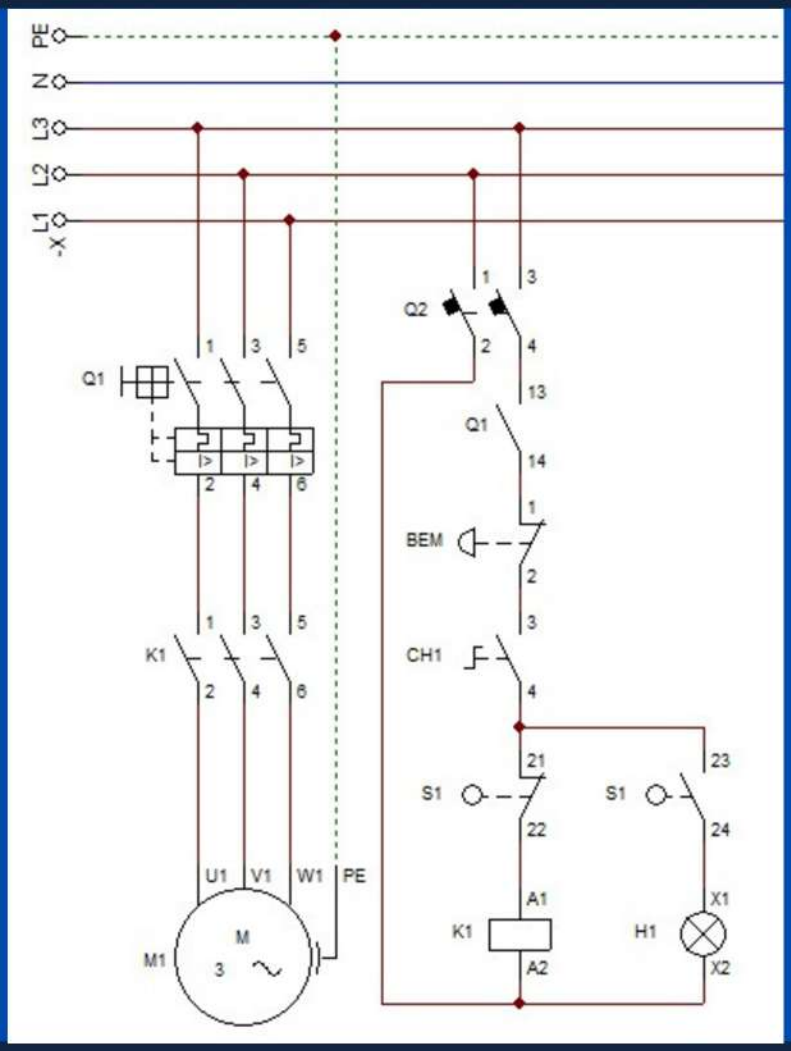


6.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	CIRCUIT BREAKER MOTOR (Q1) - NA	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	LIMIT SWITCH (S1) - NC	RESPONSIBLE FOR LIMITING, TURNING THE CIRCUIT ON OR OFF
	BUTTON OF EMERGENCY (WELL) - NF	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH - NO (CH1) - NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

7. DIRECT START WITH SELECTOR SWITCH

7.1 WIRING DIAGRAM

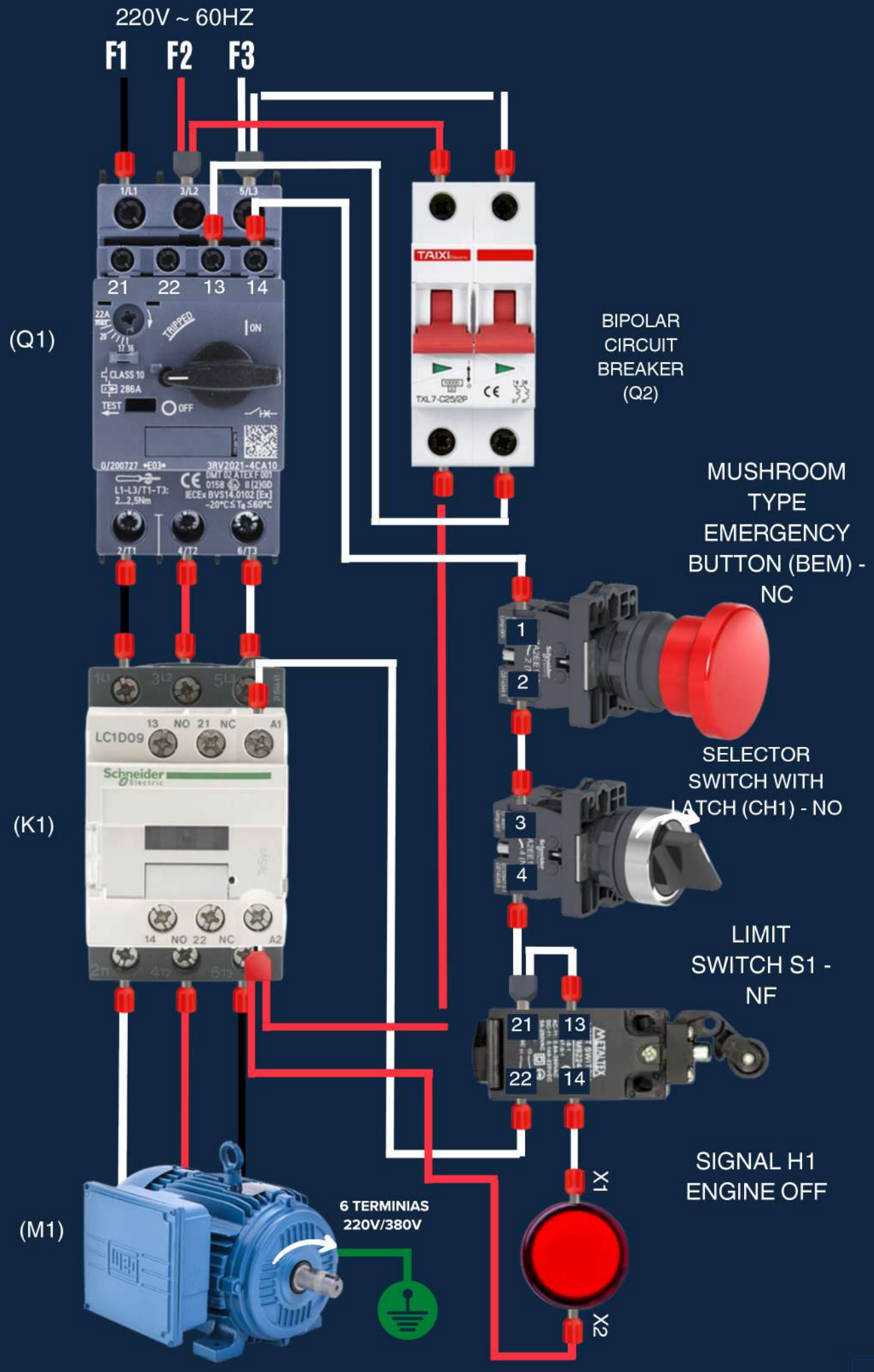


7.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN TURNING THE KEY (CH1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT OF THE MOTOR CIRCUIT BREAKER (Q1) IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT. THE LIMIT SWITCH (S1) INDICATES THE END OF A PROCESS, SWITCHING OFF THE CIRCUIT. THE SIGNAL LIGHT (H1) INDICATES THE CIRCUIT IS SWITCHED OFF. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURN THE CIRCUIT OFF SELECTOR SWITCH (CH1): TURN THE CIRCUIT ON AND OFF LIMIT SWITCH (S1): TURN THE CIRCUIT OFF AND SIGNAL THE SWITCH OFF SIGNAL LIGHT (H1): SIGNALS THAT THE MOTOR IS OFF NOTE: IN THIS CIRCUIT THE MOTOR CIRCUIT BREAKER IS USED INSTEAD OF A THERMAL RELAY

7.3 DIRECT START LAYOUT WITH MOTOR CIRCUIT BREAKER, SELECTOR SWITCH, LIMIT SWITCH AND SIGNALING



7.4 MATERIALS USED

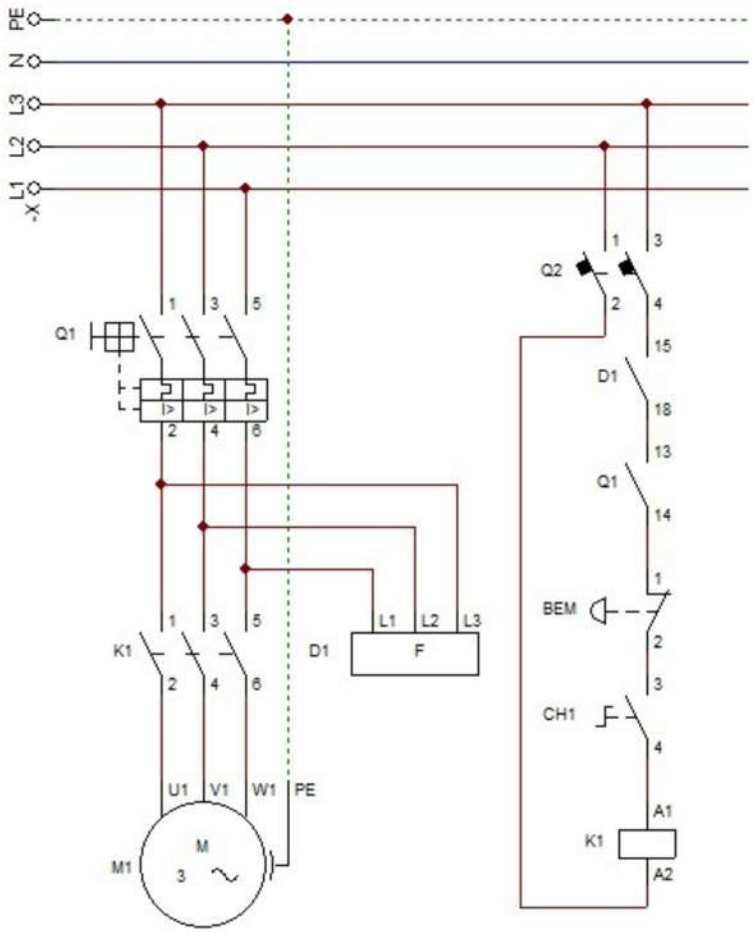
IMAGE	NOMENCLATURE	FUNCTION
	MOTOR CIRCUIT BREAKER (Q1) - NO	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	LIMIT SWITCH (S1) - NO AND NC	RESPONSIBLE FOR LIMITING, TURNING THE CIRCUIT ON OR OFF
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH (CH1) - NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING THE ENGINE IS OFF

7.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

8. DIRECT STARTER WITH MOTOR CIRCUIT BREAKER, SELECTOR SWITCH AND PHASE LACK RELAY

8.1 WIRING DIAGRAM

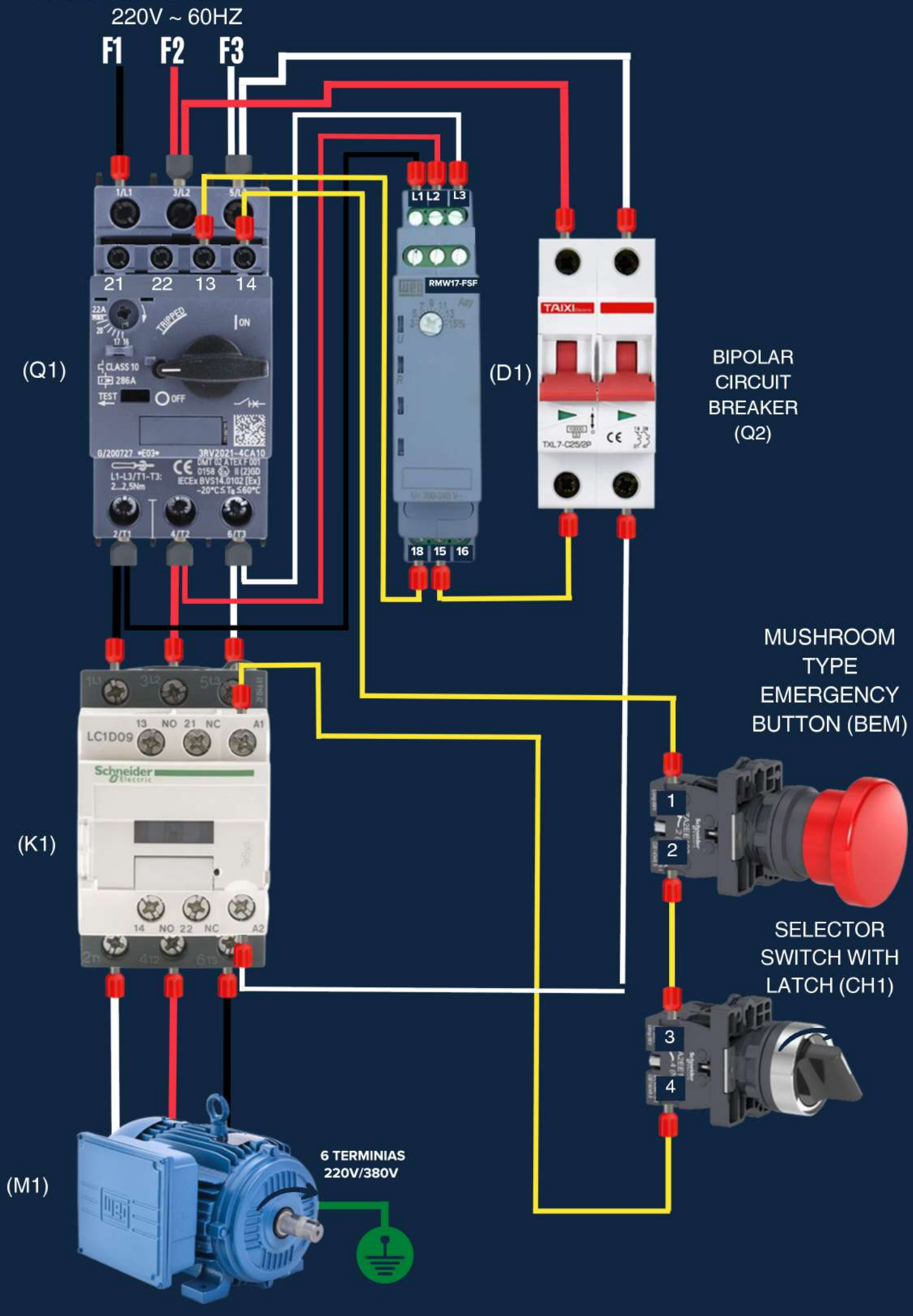


8.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN TURNING THE KEY (CH1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT OF THE MOTOR CIRCUIT BREAKER (Q1) IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT. THE PHASE SEQUENCE AND LACK RELAY (D1) MONITORS THE PHASES, IN THE EVENT OF FAILURE, IT DISCONNECTS THE CIRCUIT THROUGH ITS AUXILIARY CONTACT (NA) IN THE CONTROL CIRCUIT. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD
EMERGENCY BUTTON (BEM): TURN THE CIRCUIT OFF SELECTOR SWITCH (CH1): TURN THE CIRCUIT ON AND OFF SEQUENCE AND PHASE LOSS RELAY (D1): MONITORS THE THREE PHASES OF THE CIRCUIT, AND TURNS THE CIRCUIT OFF IN THE EVENT OF PHASE LOSS OR INVERTED SEQUENCE

8.3 DIRECT START LAYOUT WITH MOTOR CIRCUIT BREAKER, SELECTOR SWITCH AND PHASE LACK RELAY

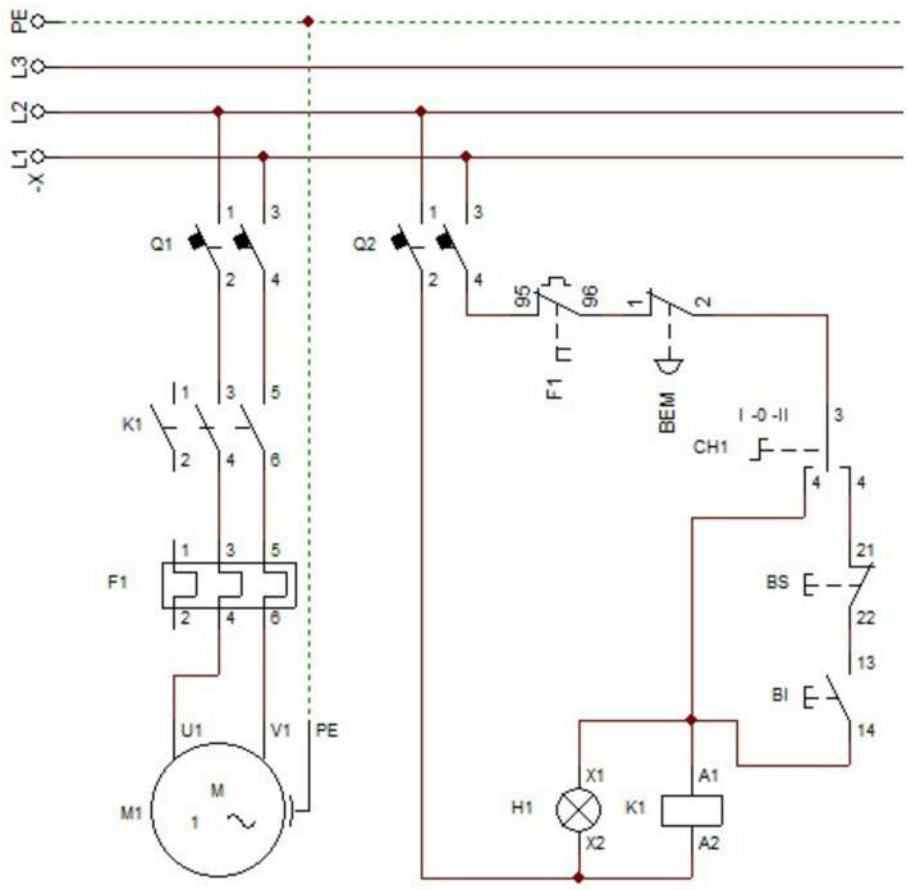


8.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	CIRCUIT BREAKER MOTOR (Q1) - NA	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	PHASE FAILURE RELAY (D1) - NO	RESPONSIBLE FOR MONITORING THE SEQUENCE AND LACK OF PHASE. IN CASE OF ABNORMALITY IT WILL DISCONNECT THE CIRCUIT.
	BUTTON OF EMERGENCY (WELL) - NF	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH (CH1) - NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

9. DIRECT START WITH MANUAL AND AUTOMATIC AND FLOAT SWITCHES

9.1 WIRING DIAGRAM

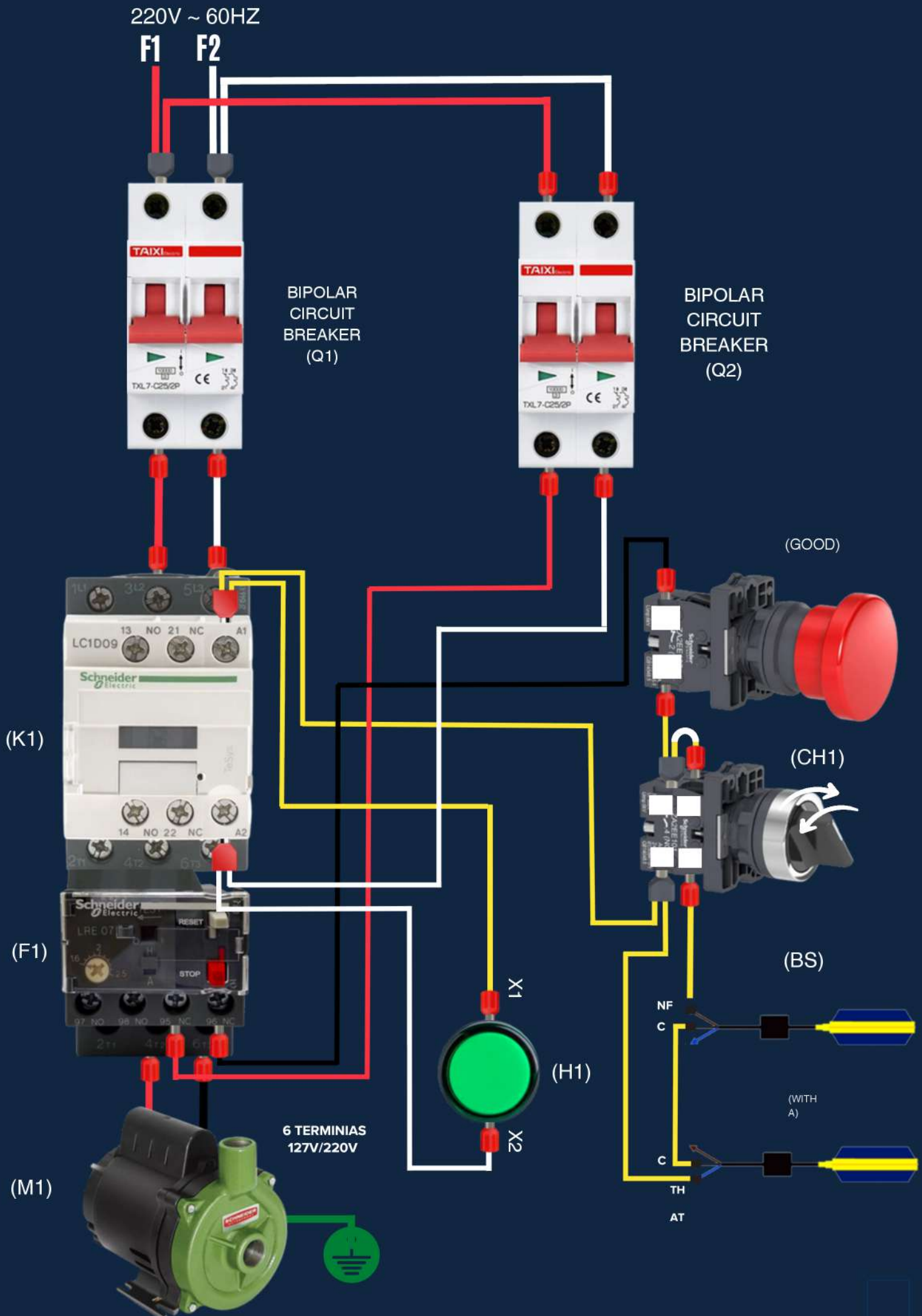


9.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO TURN ON CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN TURNING THE KEY (CH1) TO THE MANUAL SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. WHEN TURNING THE KEY (CH1) TO THE AUTOMATIC SIDE, THE MOTOR WILL BE CONTROLLED BY THE UPPER (BS) AND LOWER (BI) FLOAT. IN CASE OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT. THE SIGNAL LIGHT (H1) INDICATES CIRCUIT ON. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT SELECTOR SWITCH (CH1): SELECTS MANUAL OR AUTOMATIC UPPER FLOAT (BS): CONTROLS THE LEVEL OF THE UPPER RESERVOIR LOWER FLOAT (BI): CONTROLS LOWER TANK LEVEL SIGNAL (H1): SIGNALS THAT THE ENGINE IS ON

9.3 DIRECT START LAYOUT WITH MANUAL AND AUTOMATIC AND FLOAT SWITCHES



9.4 MATERIALS USED

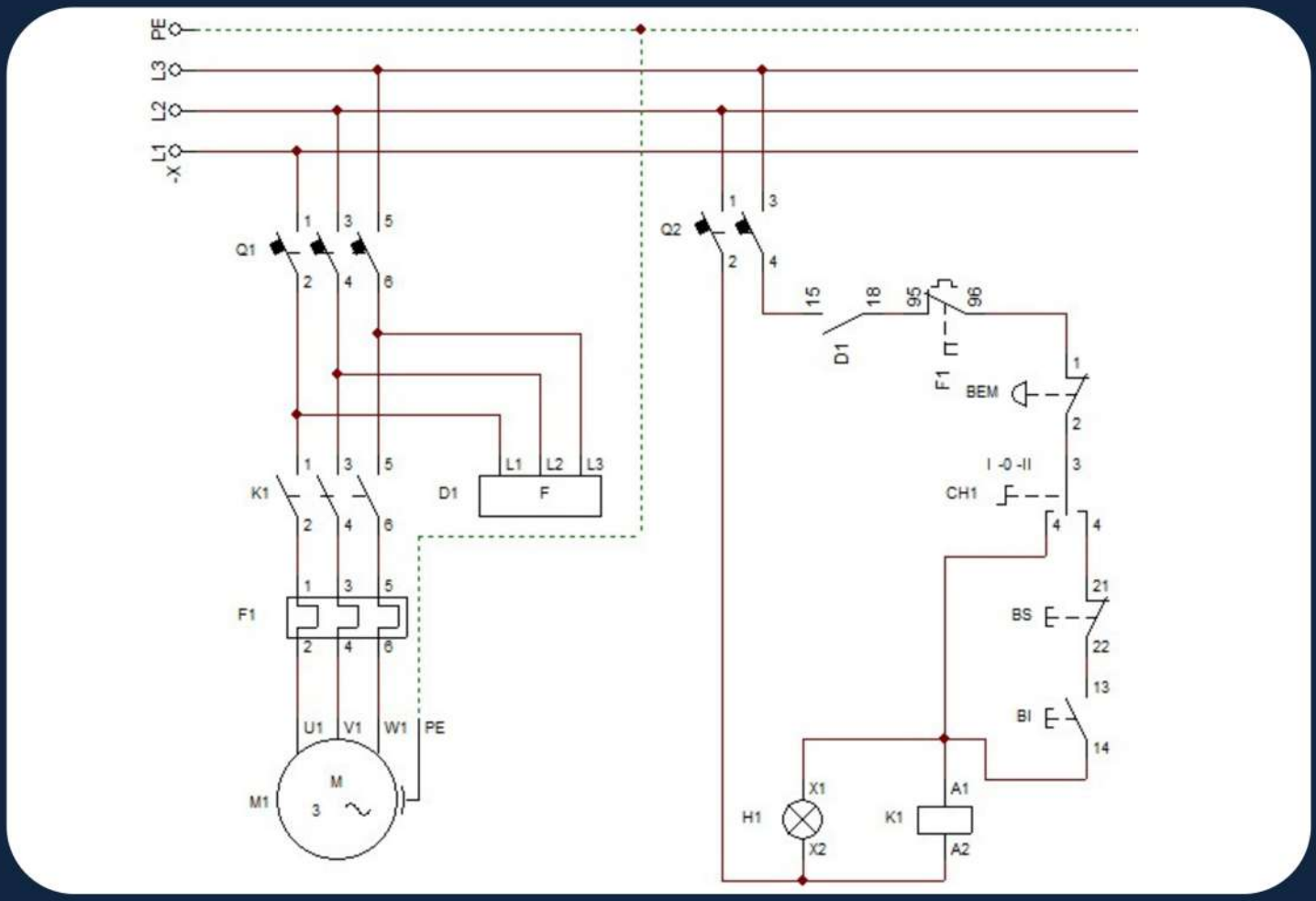
IMAGE	NOMENCLATURE	FUNCTION
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1) - NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH (CH1) - 2 X NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING ENGINE OPERATION (ON).

9.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	UPPER BUOY (BS) NF DOWN	RESPONSIBLE FOR TURNING ON AND OFF ACCORDING TO THE WATER LEVEL IN THE WATER TANK.
	UPPER BUOY (BI) NF UP	RESPONSIBLE FOR TURNING ON AND OFF ACCORDING TO THE WATER LEVEL IN THE CISTERN.
	SINGLE-PHASE ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

10. DIRECT STARTER WITH MANUAL AND AUTOMATIC, FLOAT SWITCHES AND PHASE LACK RELAY

10.1 WIRING DIAGRAM

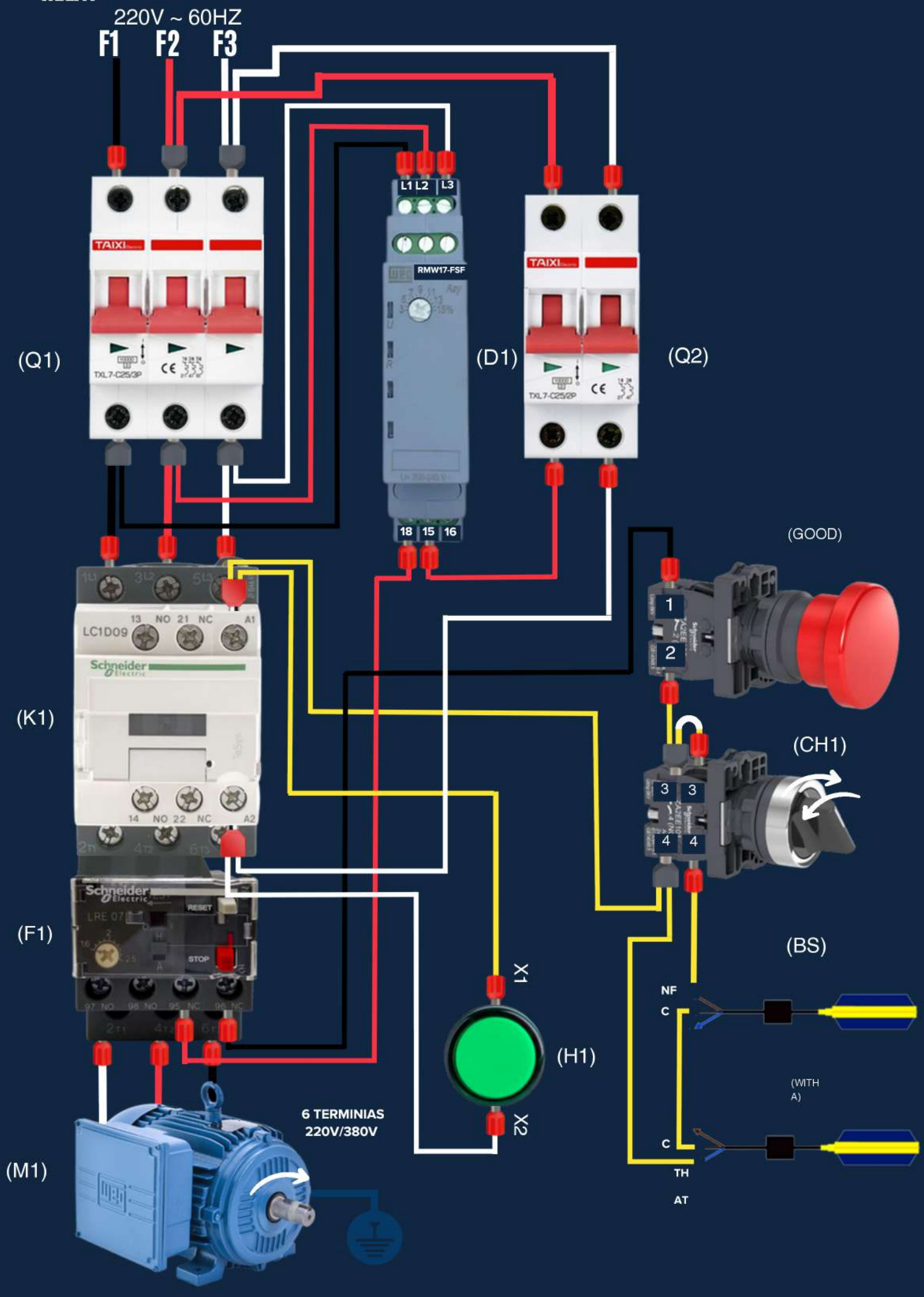


10.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO TURN ON CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN TURNING THE KEY (CH1) TO THE MANUAL SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. WHEN TURNING THE KEY (CH1) TO THE AUTOMATIC SIDE, THE MOTOR WILL BE CONTROLLED BY THE UPPER (BS) AND LOWER (BI) FLOATS. IN CASE OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT. THE SIGNAL LIGHT (H1) INDICATES THE CIRCUIT IS ON. THE SEQUENCE AND PHASE LOSS RELAY (D1) MONITORS THE PHASES, IN CASE OF FAILURE, IT SWITCHES OFF THE CIRCUIT THROUGH ITS AUXILIARY CONTACT (NA) IN THE CONTROL CIRCUIT. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT SELECTOR SWITCH (CH1): SELECTS MANUAL OR AUTOMATIC UPPER FLOAT (BS): CONTROLS THE LEVEL OF THE UPPER RESERVOIR LOWER FLOAT (BI): CONTROLS LOWER RESERVOIR LEVEL SIGNAL (H1): SIGNALS THAT THE MOTOR IS ON SEQUENCE AND PHASE LOSS RELAY (D1): MONITORS THE THREE PHASES OF THE CIRCUIT, AND SWITCHES OFF THE CIRCUIT IN THE EVENT OF PHASE LOSS OR INVERTED SEQUENCE

10.3 DIRECT START LAYOUT WITH MANUAL AND AUTOMATIC, FLOAT SWITCHES AND PHASE LACK RELAY



10.4 MATERIALS USED

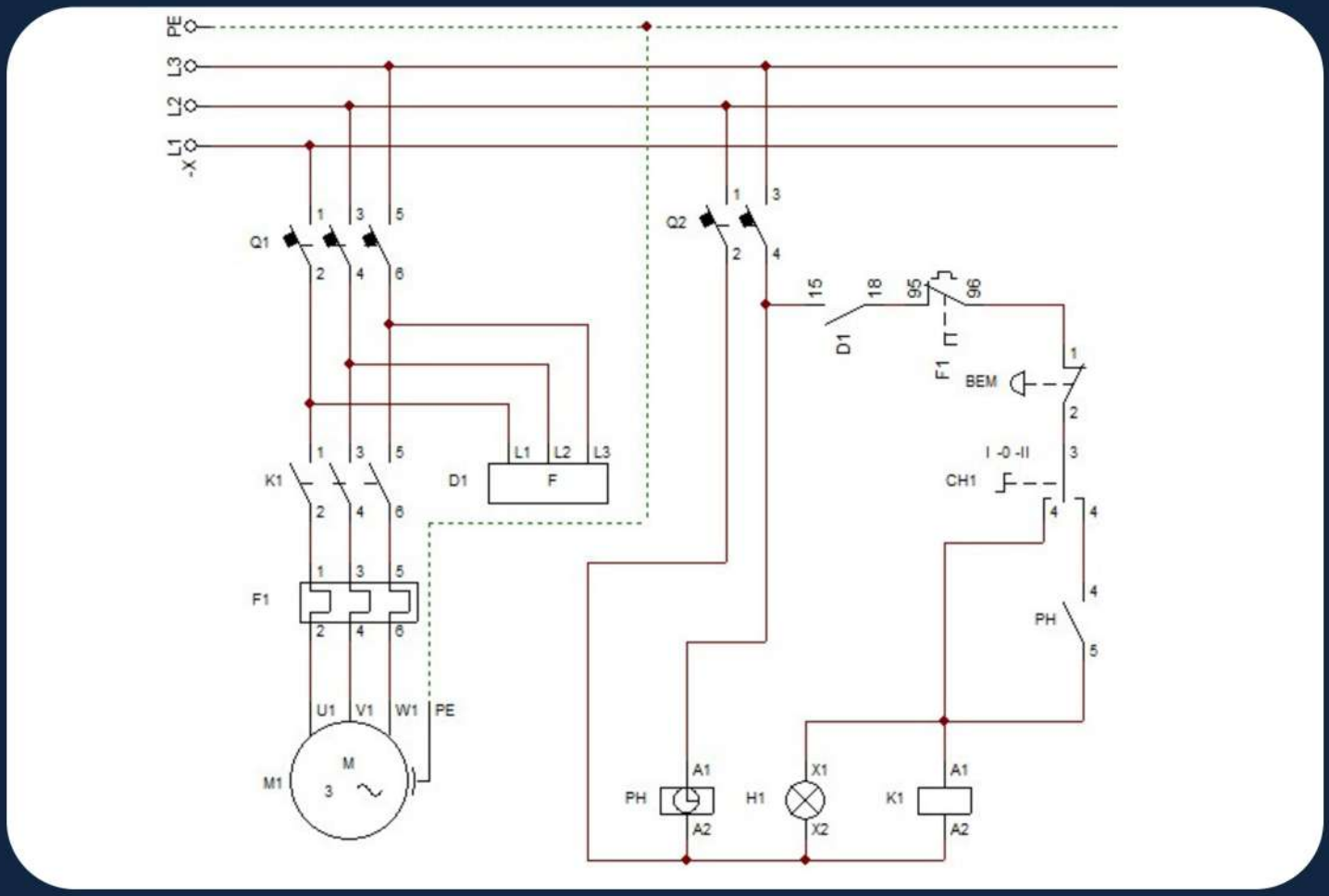
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1) - NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH (CH1) - 2 X NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING ENGINE OPERATION (ON)

10.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	UPPER BUOY (BS) NF DOWN	**RESPONSIBLE FOR TURNING ON AND OFF ACCORDING TO THE WATER LEVEL IN THE WATER TANK**
	UPPER BUOY (BI) NF UP	**RESPONSIBLE FOR TURNING ON AND OFF ACCORDING TO THE WATER LEVEL IN THE CISTERN**
	PHASE FAILURE RELAY (D1) - NO	**RESPONSIBLE FOR MONITORING THE SEQUENCE AND LACK OF PHASE. IN CASE OF ABNORMALITY IT WILL DISCONNECT THE CIRCUIT.**
	ELECTRIC MOTOR (M1)	**RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.**

11. DIRECT STARTER WITH MANUAL AND AUTOMATIC, TIME PROGRAMMER AND PHASE LACK RELAY

11.1 WIRING DIAGRAM

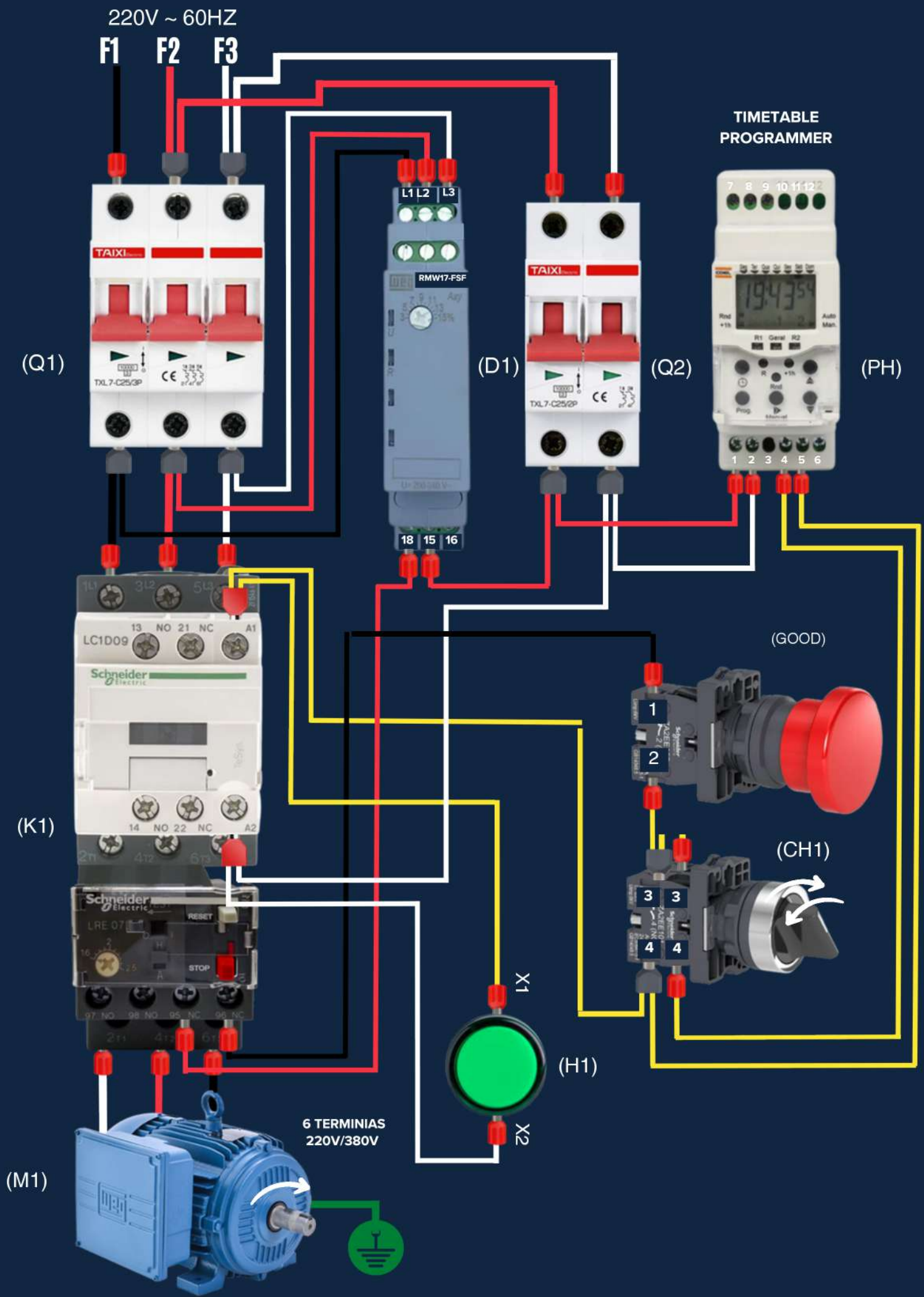


11.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO TURN ON CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN TURNING THE KEY (CH1) TO THE MANUAL SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START. WHEN TURNING THE KEY (CH1) TO THE AUTOMATIC SIDE, THE MOTOR WILL BE CONTROLLED BY THE TIME PROGRAMMER (PH). IN CASE OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT. THE SIGNAL LIGHT (H1) INDICATES THE CIRCUIT IS ON. THE SEQUENCE AND PHASE LOSS RELAY (D1) MONITORS THE PHASES, IN CASE OF FAILURE, IT SWITCHES OFF THE CIRCUIT THROUGH ITS AUXILIARY CONTACT (NA) IN THE CONTROL CIRCUIT. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT SELECTOR SWITCH (CH1): SELECTS MANUAL OR AUTOMATIC TIME PROGRAMMER (PH): WILL AUTOMATICALLY TURN THE MOTOR ON AND OFF THROUGH PRE-DEFINED PROGRAMMING SIGNAL (H1): SIGNALS THAT THE MOTOR IS ON SEQUENCE AND PHASE LOSS RELAY (D1): MONITORS THE THREE PHASES OF THE CIRCUIT, AND TURNS OFF THE CIRCUIT IN THE EVENT OF PHASE LOSS OR INVERTED SEQUENCE

11. 3 DIRECT START LAYOUT WITH MANUAL AND AUTOMATIC, TIME PROGRAMMER AND PHASE LACK RELAY



11.4 MATERIALS USED

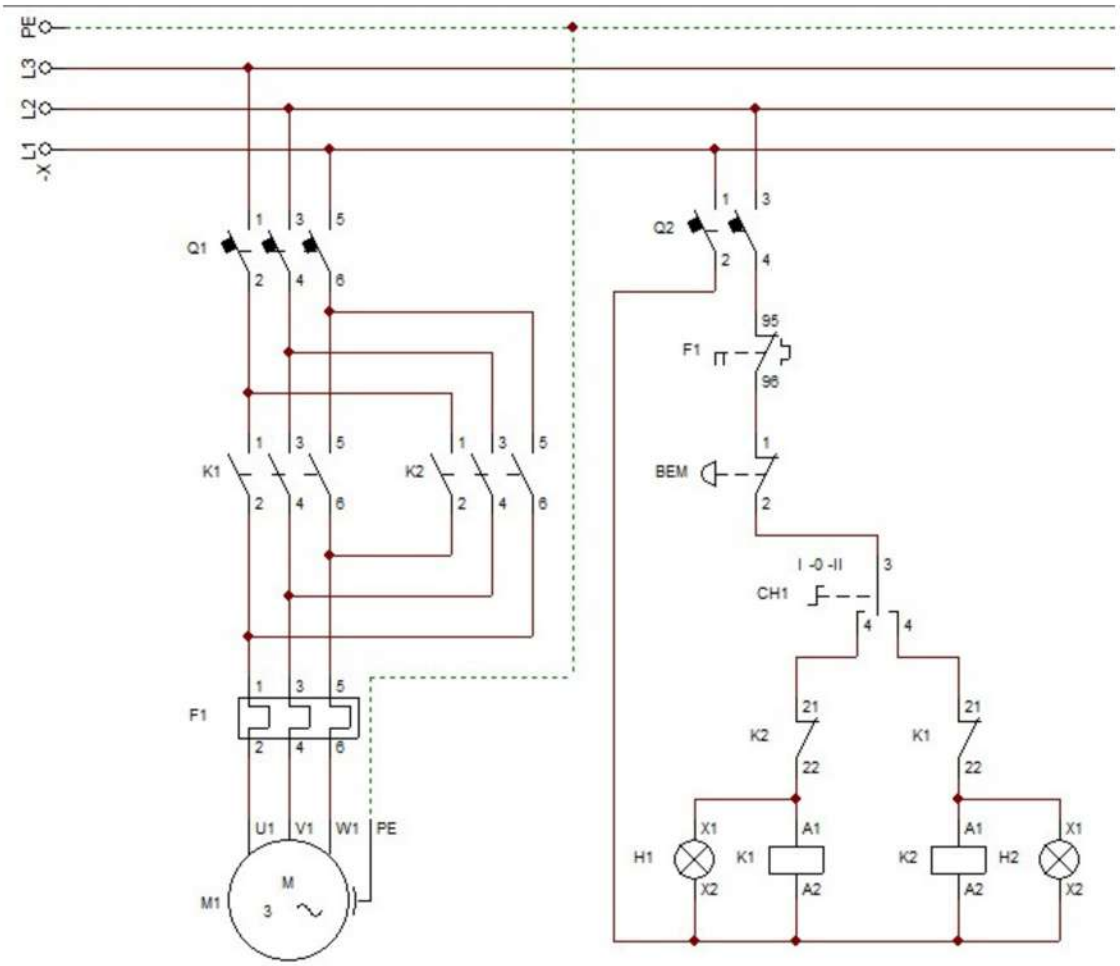
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1) - NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH (CH1) - 2 X NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING ENGINE OPERATION (ON)

11.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	PHASE FAILURE RELAY (D1) - NO	RESPONSIBLE FOR MONITORING THE SEQUENCE AND LACK OF PHASE. IN CASE OF ABNORMALITY IT WILL DISCONNECT THE CIRCUIT.
	TIME PROGRAMMER (PH) - NA	RESPONSIBLE FOR TURNING THE ENGINE ON AND OFF ON SCHEDULED DAYS AND TIMES.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

12. DIRECT START WITH REVERSE WITH SELECTOR SWITCH AND SIGNALING

12.1 WIRING DIAGRAM



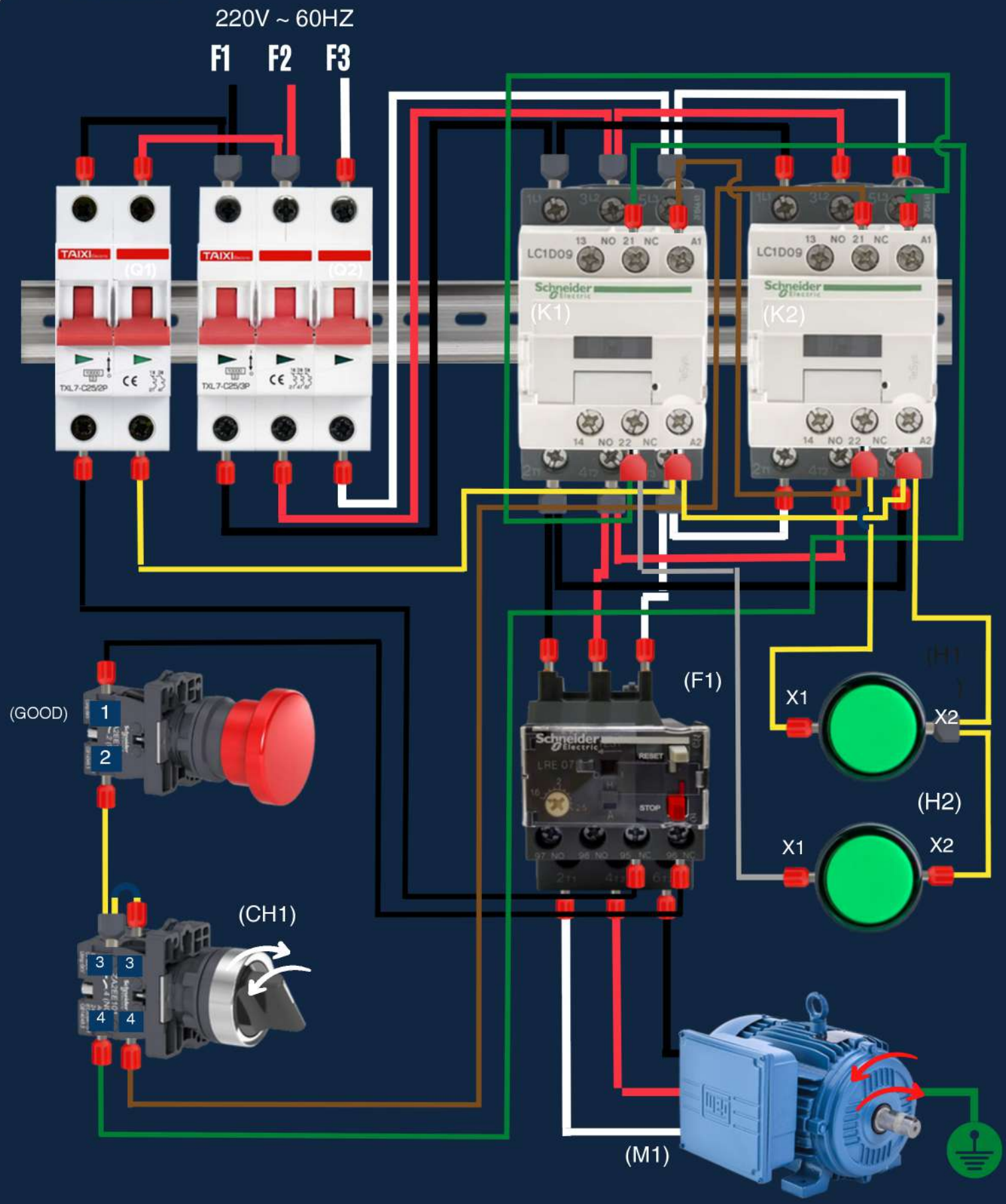
12.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO TURN ON CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE COILS OF K1 AND K2. WHEN TURNING THE KEY (CH1) TO THE LEFT SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE COIL OF K1 AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN A CLOCKWISE DIRECTION. WHEN TURNING THE KEY (CH1) TO THE RIGHT SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K2 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN AN COUNTERCLOCKWISE DIRECTION. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL TURN OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO TURNS OFF THE CIRCUIT. THE SIGNAL LIGHT (H1) INDICATES THE MOTOR STARTING IN THE CLOCKWISE DIRECTION. THE SIGNAL LIGHT (H2) INDICATES THE MOTOR STARTING IN THE COUNTERCLOCKWISE DIRECTION.

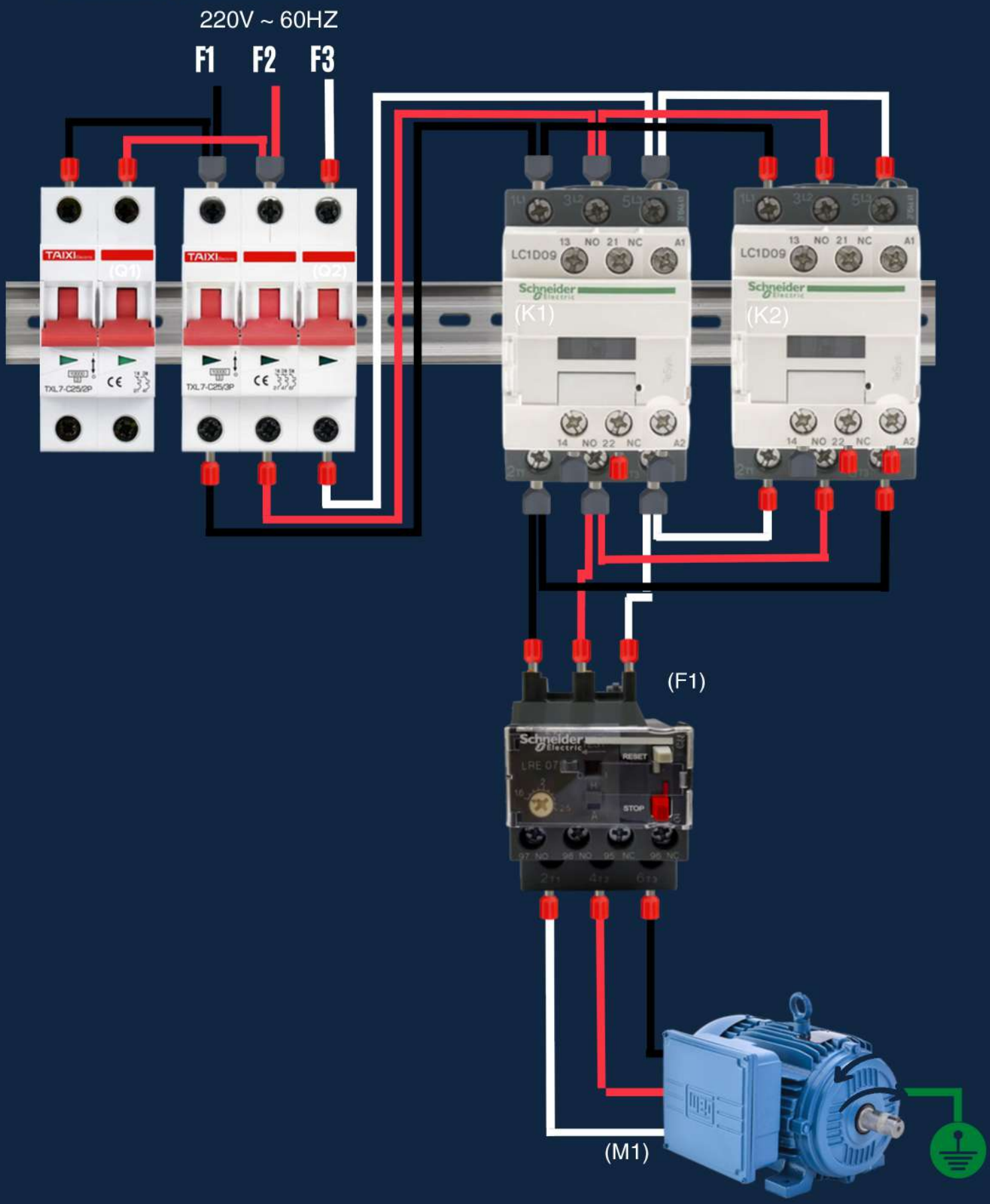
SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD
EMERGENCY BUTTON (BEM): TURN OFF THE CIRCUIT SELECTOR SWITCH (CH1): TURN THE ENGINE ON AND OFF IN A CLOCKWISE OR COUNTERCLOCKWISE DIRECTION
SIGNAL (H1): SIGNALS THAT THE ENGINE IS RUNNING IN A CLOCKWISE DIRECTION
SIGNAL (H2): SIGNALS THAT THE ENGINE IS RUNNING IN A COUNTERCLOCKWISE DIRECTION

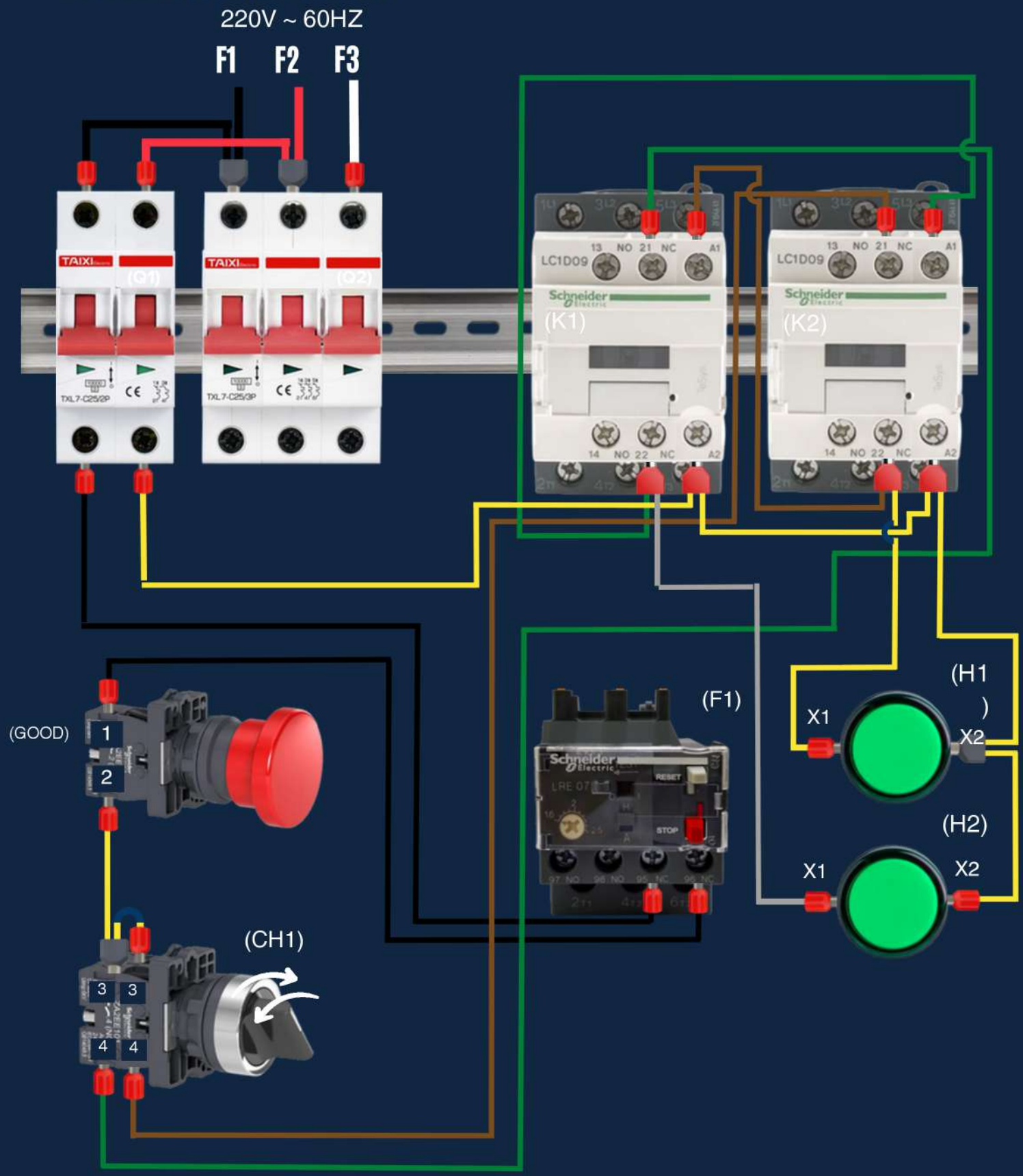
12.3 DIRECT START LAYOUT WITH REVERSING, SELECTOR SWITCH AND SIGNALING



12.3 DIRECT START LAYOUT WITH REVERSING, SELECTOR SWITCH AND SIGNALING (POWER CIRCUIT)



12.3 DIRECT START LAYOUT WITH REVERSING, SELECTOR SWITCH AND SIGNALING (CONTROL CIRCUIT)



12.4 MATERIALS USED

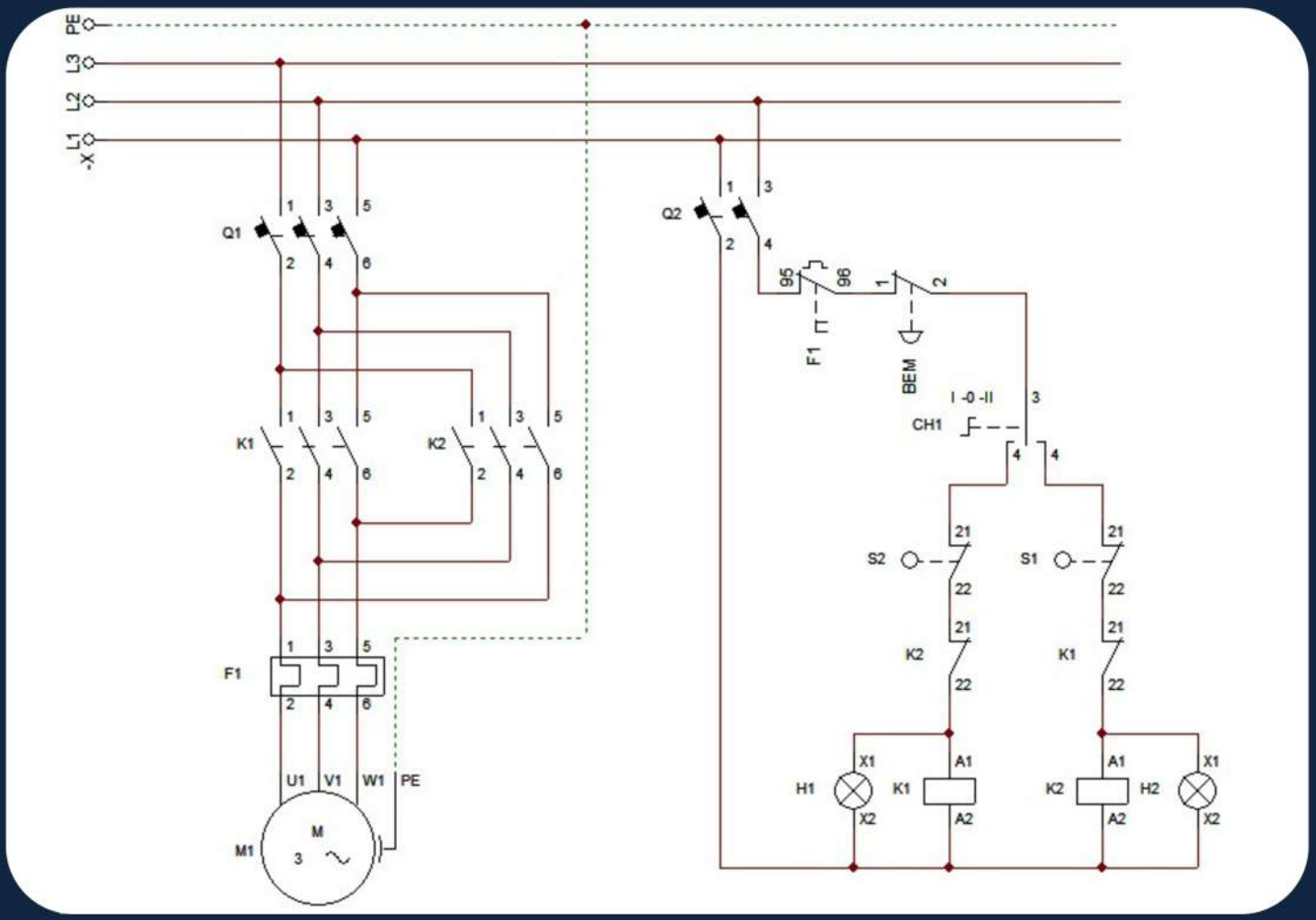
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE CIRCUIT OF STRENGTH AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT. CLOCKWISE.
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT. COUNTERCLOCKWISE.
	THERMAL RELAY (F1) - NF	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	BUTTON OF EMERGENCY (WELL) - NF	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH (CH1) - 2 X NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.

12.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING THE OPERATION OF THE MOTOR (ON). CLOCKWISE.
	SIGNAL (H2)	RESPONSIBLE FOR INDICATING THE OPERATION OF THE MOTOR (ON). COUNTERCLOCKWISE.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

13. DIRECT STARTER WITH REVERSE, SELECTOR SWITCH, LIMIT SWITCH AND SIGNALING

13.1 WIRING DIAGRAM

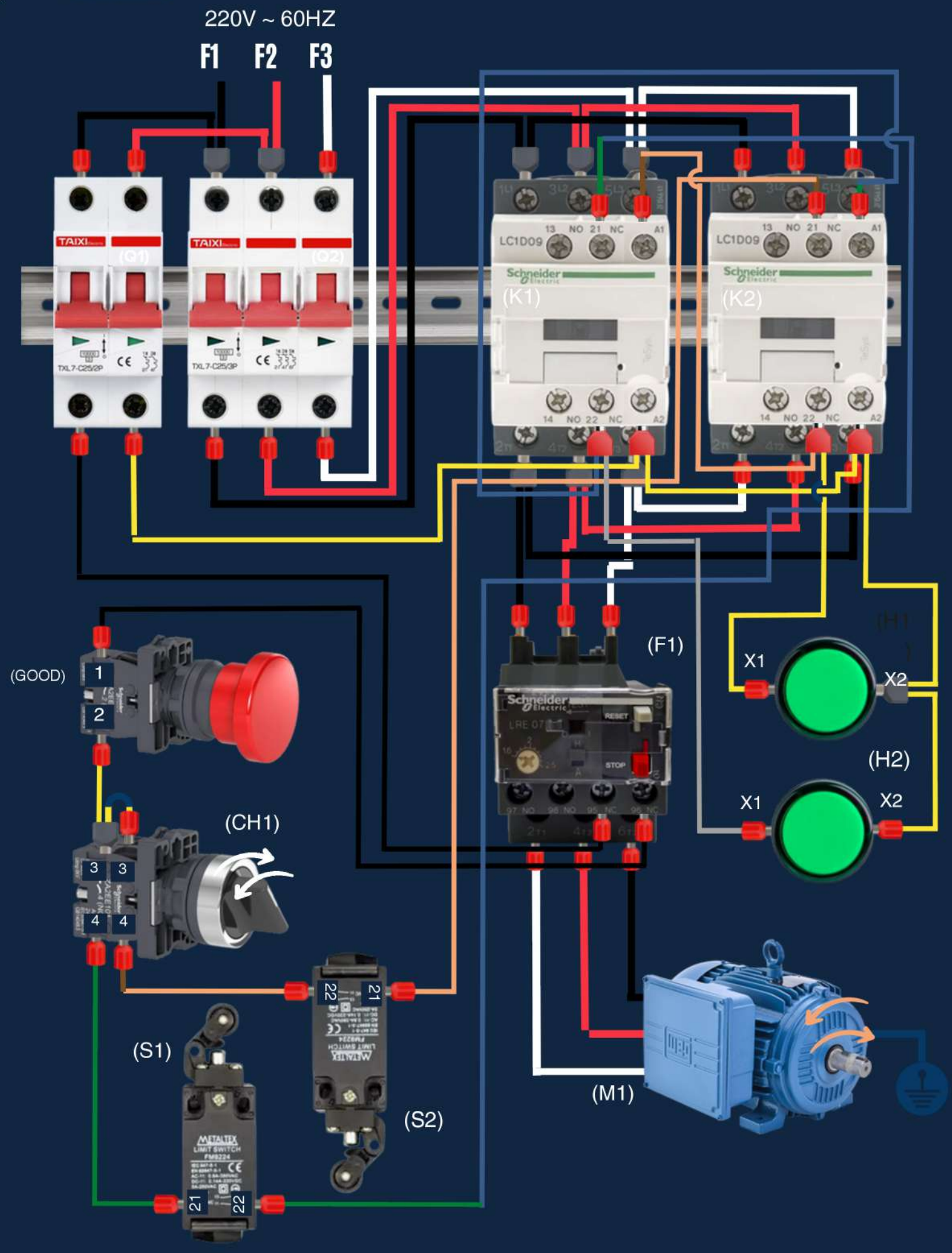


13.2 DESCRIPTION OF OPERATION

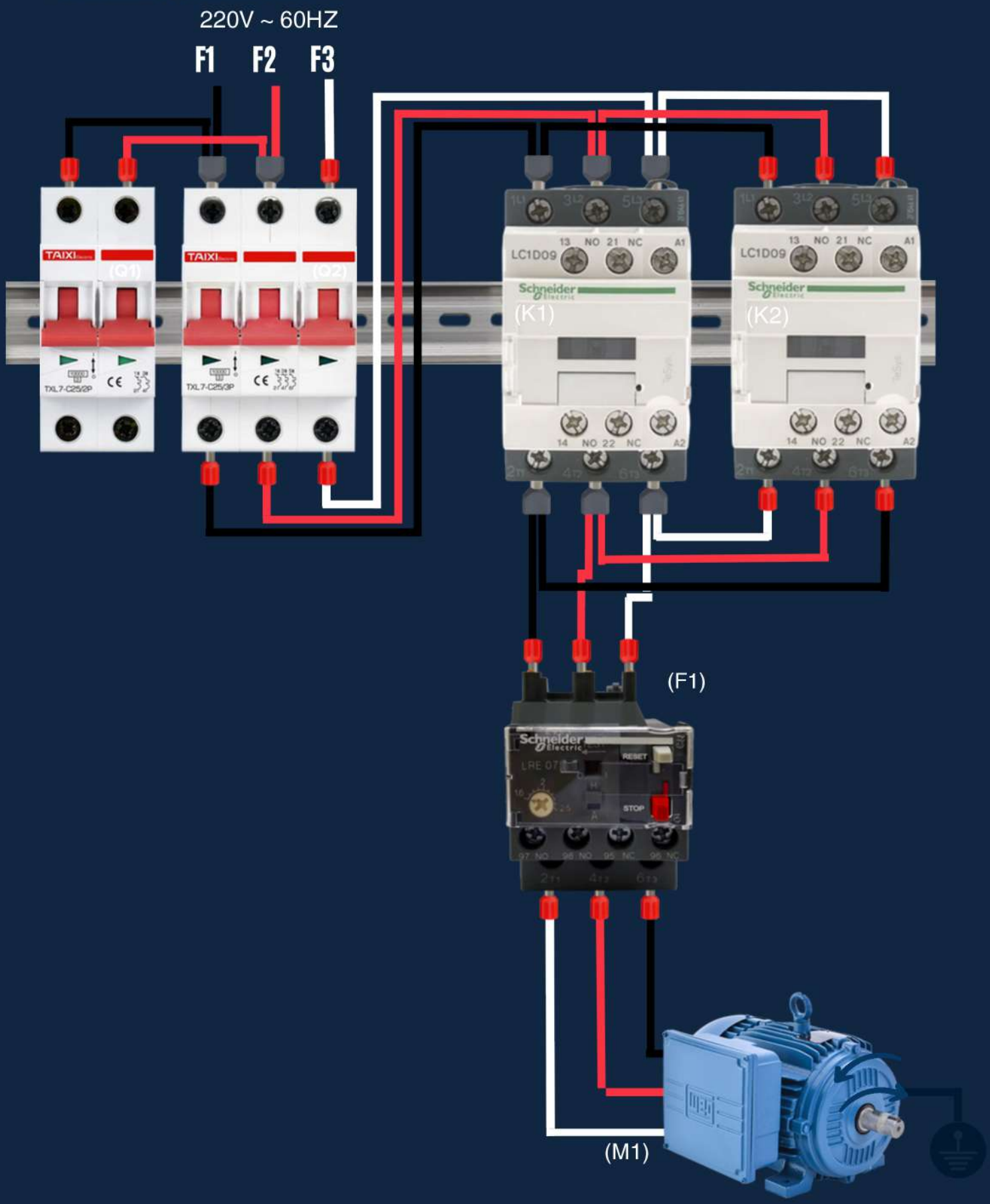
TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO TURN ON CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE COILS OF K1 AND K2. WHEN TURNING THE KEY (CH1) TO THE LEFT SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE COIL OF K1 AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN A CLOCKWISE DIRECTION. WHEN TURNING THE KEY (CH1) TO THE RIGHT SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K2 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN AN COUNTERCLOCKWISE DIRECTION. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL TURN OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO TURNS OFF THE CIRCUIT. THE SIGNAL LIGHT (H1) INDICATES THE MOTOR STARTING IN THE CLOCKWISE DIRECTION. THE SIGNAL LIGHT (H2) INDICATES THE MOTOR STARTING IN THE COUNTERCLOCKWISE DIRECTION. THE END OF COURSE SENSOR (S1) TURNS OFF THE MOTOR IN AN COUNTERCLOCKWISE DIRECTION, ENDING THE PROCESS. THE END OF COURSE SENSOR (S2) TURNS OFF THE MOTOR IN A CLOCKWISE DIRECTION, ENDING THE PROCESS. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURN OFF THE CIRCUIT SELECTOR SWITCH (CH1): TURN ON AND OFF THE MOTOR IN A CLOCKWISE OR COUNTERCLOCKWISE DIRECTION SIGNAL (H1): SIGNALS THAT THE MOTOR IS RUNNING IN A CLOCKWISE DIRECTION SIGNAL (H2): SIGNALS THAT THE MOTOR IS RUNNING IN A COUNTERCLOCKWISE DIRECTION END OF COURSE (S1): TURN OFF THE CIRCUIT IN A COUNTERCLOCKWISE DIRECTION END OF COURSE (S2): TURN OFF THE CIRCUIT IN A CLOCKWISE DIRECTION

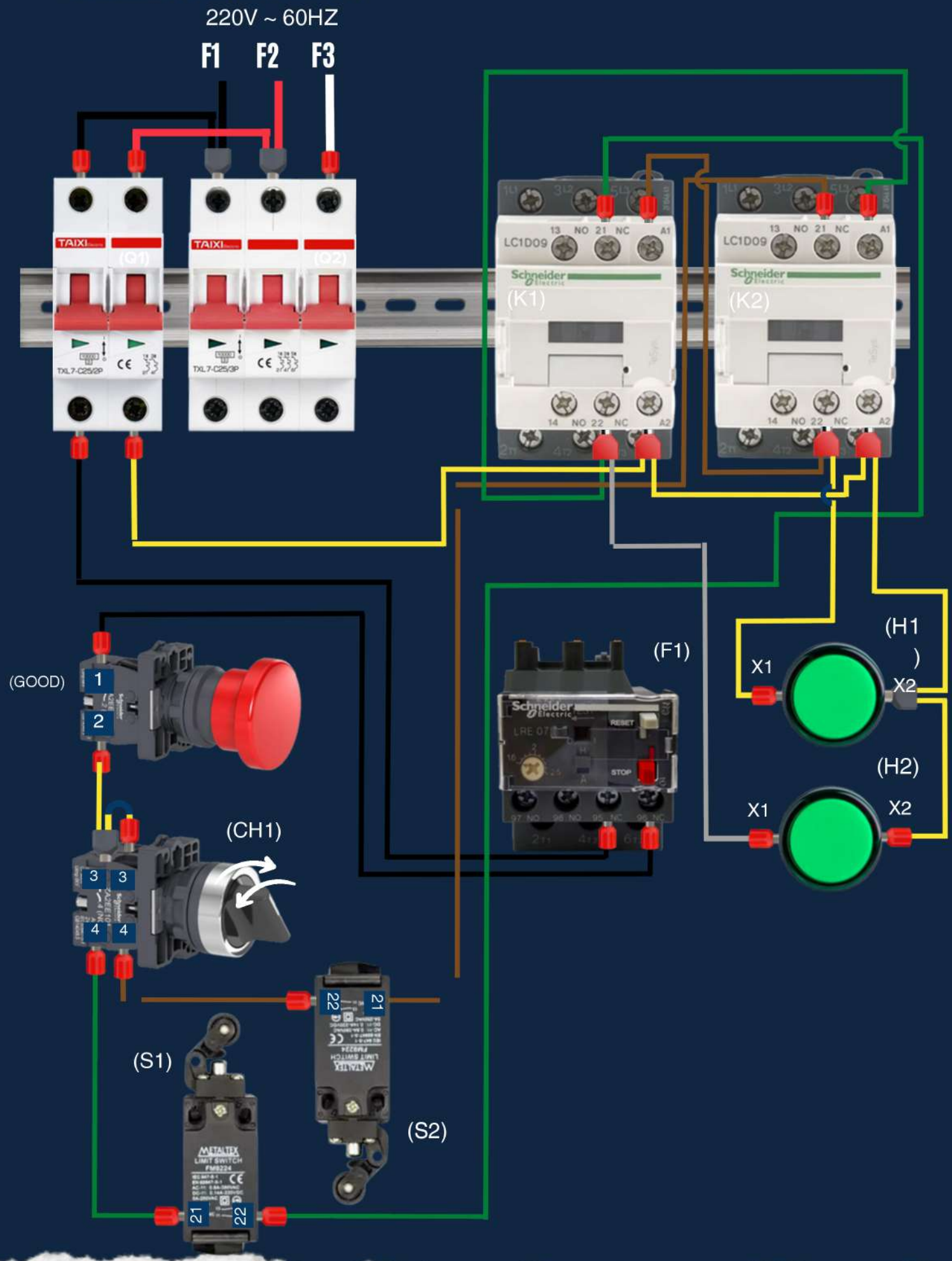
13.3 DIRECT START LAYOUT WITH REVERSAL, SELECTOR SWITCH, LIMIT SWITCH AND SIGNALING



13.3 DIRECT START LAYOUT WITH REVERSAL, SELECTOR SWITCH, LIMIT SWITCH AND SIGNALING (POWER CIRCUIT)



13.3 DIRECT START LAYOUT WITH REVERSAL, SELECTOR SWITCH, LIMIT SWITCH AND SIGNALING (CONTROL CIRCUIT)



13.4 MATERIALS USED

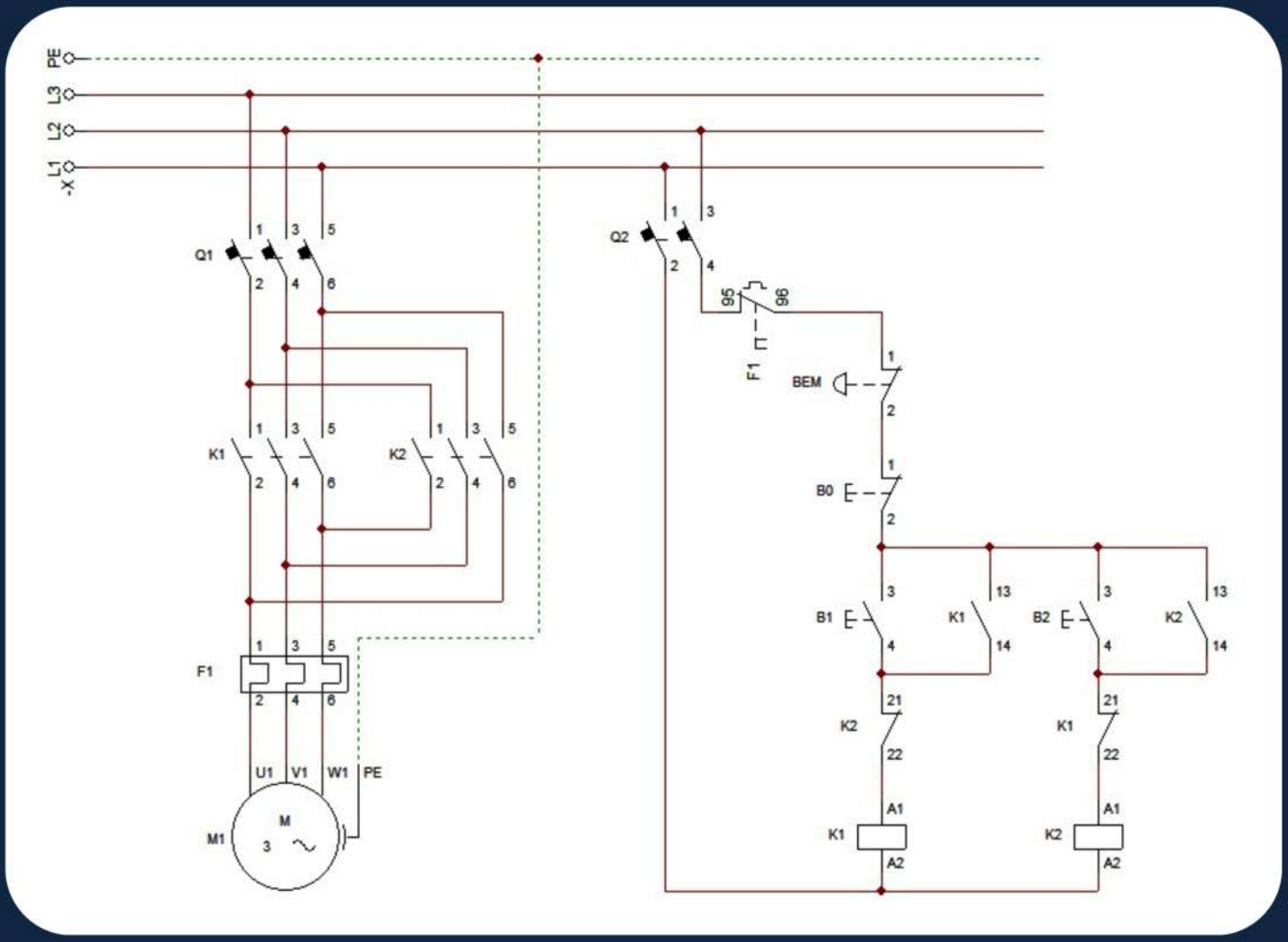
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT. COUNTERCLOCKWISE.
	THERMAL RELAY (F1) - NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	SELECTOR SWITCH (CH1) - NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.

13.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING THE OPERATION OF THE MOTOR (ON). CLOCKWISE.
	SIGNAL (H2)	RESPONSIBLE FOR INDICATING THE OPERATION OF THE MOTOR (ON). COUNTERCLOCKWISE.
	LIMIT SWITCH (S1) - NO AND NC	RESPONSIBLE FOR LIMITING, DISCONNECTING THE CIRCUIT IN A CLOCKWISE DIRECTION
	LIMIT SWITCH (S2) - NO AND NC	RESPONSIBLE FOR LIMITING, DISCONNECTING THE CIRCUIT IN AN COUNTERCLOCKWISE DIRECTION
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

14. DIRECT START WITH REVERSAL WITH PULSING PUSH BUTTON

14.1 WIRING DIAGRAM



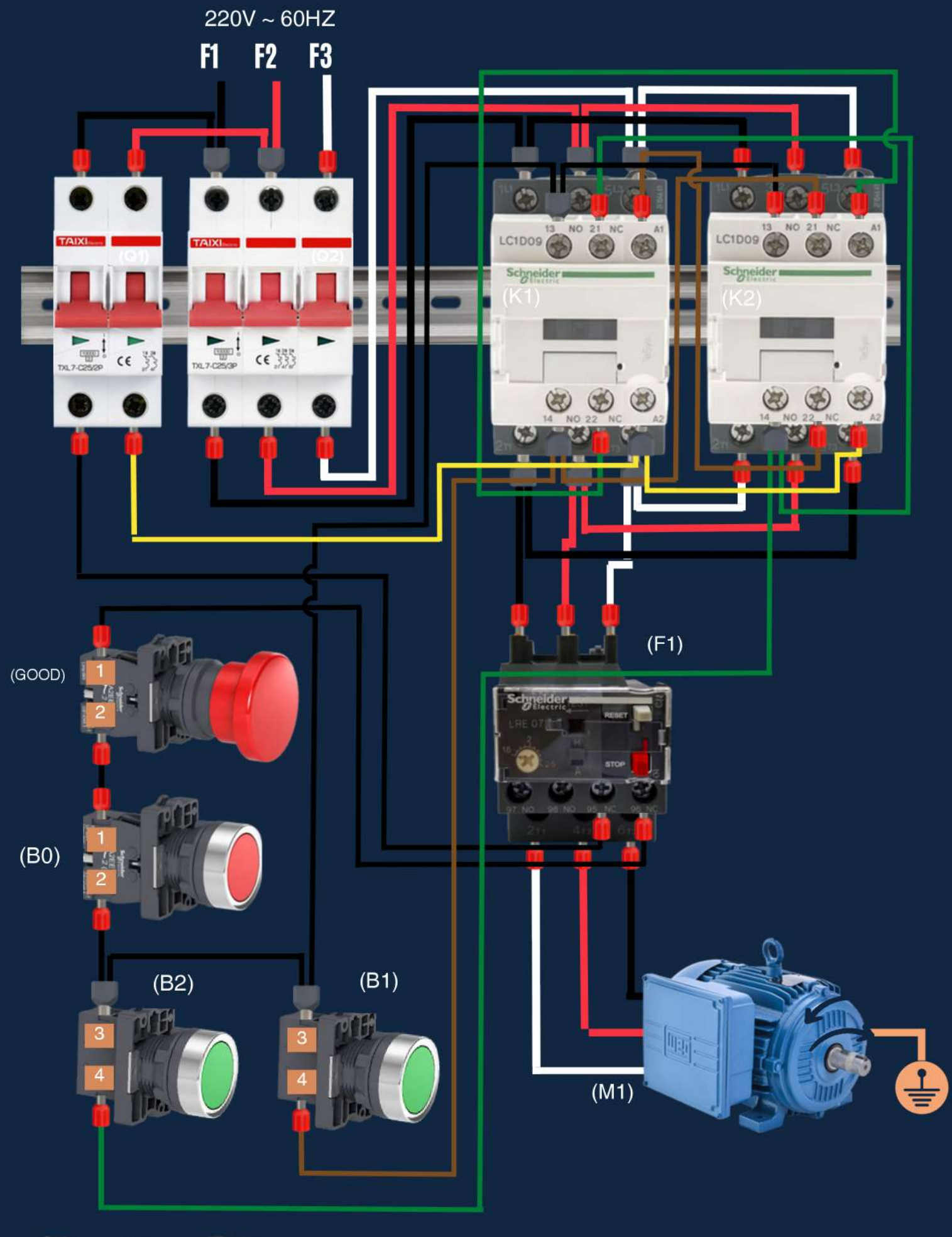
14.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE COILS OF K1 AND K2. WHEN PRESSING THE PUSH BUTTON (B1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE COIL OF K1 AND IT WILL BE ENERGIZED, AND WILL REMAIN CONNECTED THROUGH THE SEAL CONTACT, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN A CLOCKWISE DIRECTION. WHEN PRESSING THE PUSH BUTTON (B0), THE MOTOR WILL TURN OFF. WHEN PRESSING THE PUSH BUTTON (B2) THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K2 COIL AND IT WILL BECOME ENERGIZED, AND WILL REMAIN CONNECTED THROUGH THE SEAL CONTACT, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN AN COUNTERCLOCKWISE DIRECTION. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT.

SO WE HAVE:

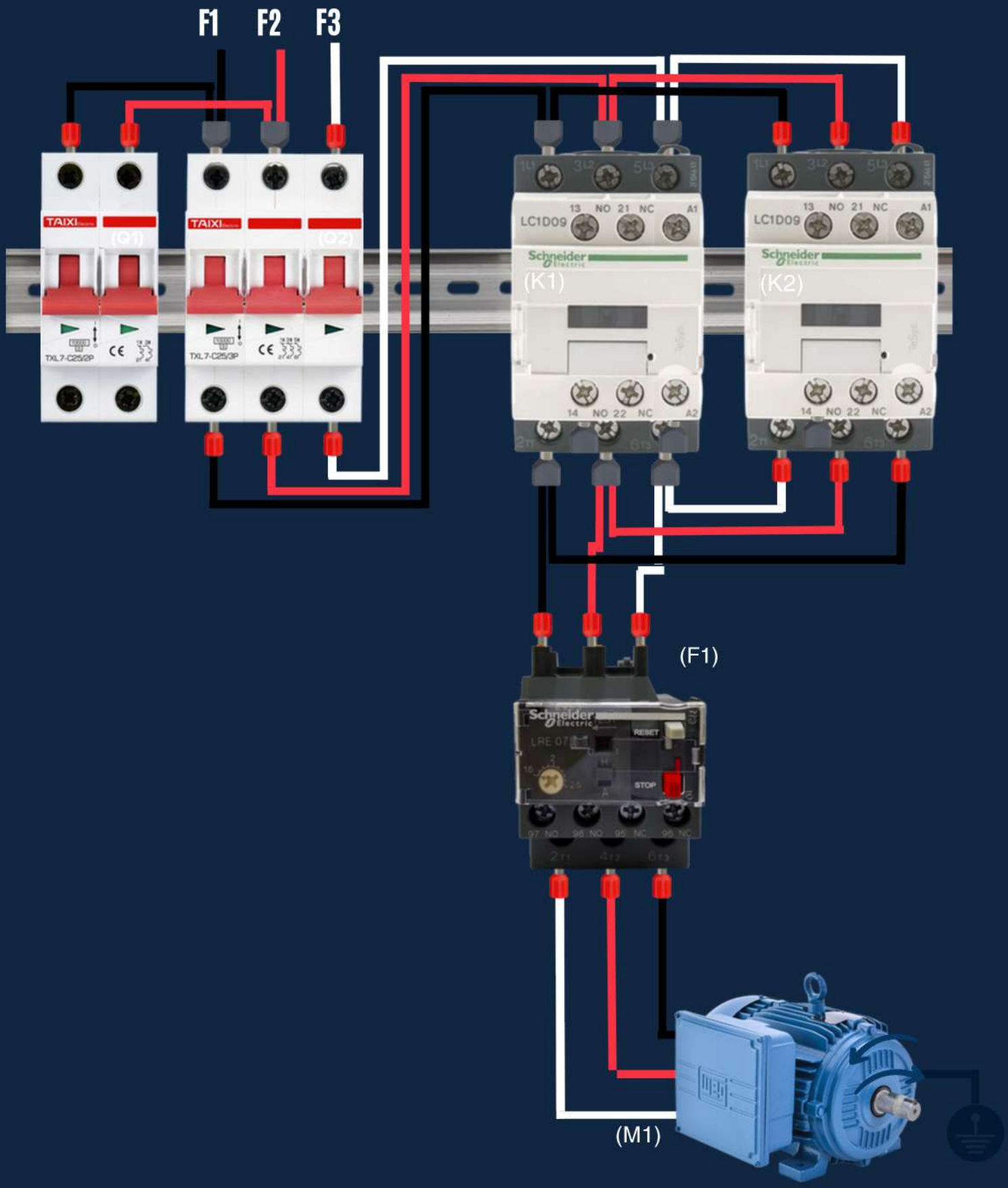
Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT PUSH BUTTON (B0): TURNS OFF THE CIRCUIT PUSH BUTTON (B1): TURNS ON THE MOTOR IN A CLOCKWISE DIRECTION PUSH BUTTON (B2): TURNS ON THE MOTOR IN A CLOCKWISE DIRECTION ANTI-CLOCKWISE

14.3 DIRECT START LAYOUT WITH REVERSAL WITH PULSING PUSH BUTTON

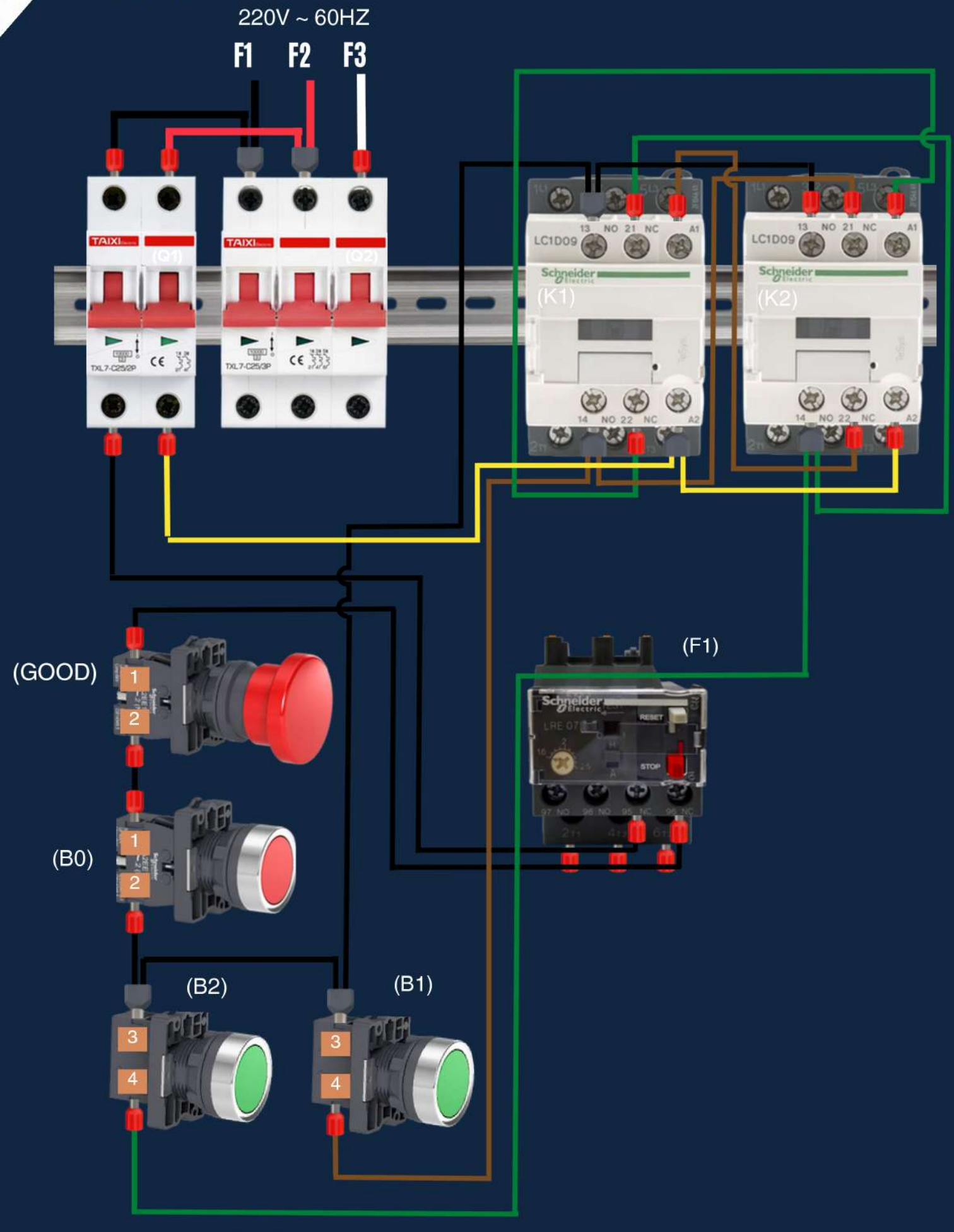


14.3 DIRECT START LAYOUT WITH REVERSAL WITH PULSED PUSH BUTTON (POWER CIRCUIT)

220V ~ 60HZ



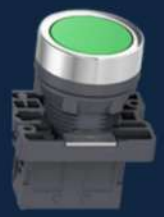
14.3 DIRECT START LAYOUT WITH REVERSAL WITH PULSING PUSH BUTTON (CONTROL CIRCUIT)



14.4 MATERIALS USED

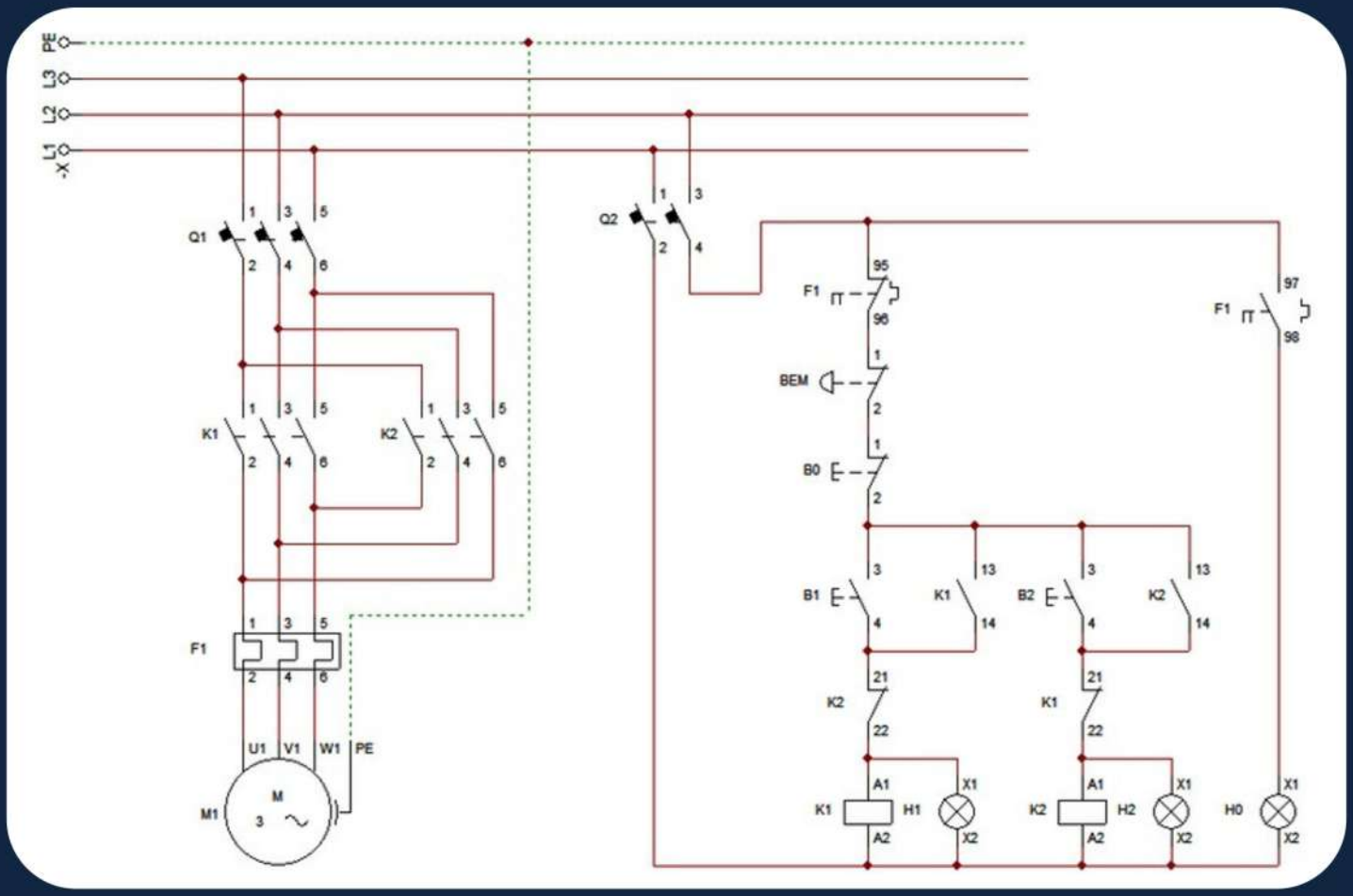
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT. CLOCKWISE
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT. COUNTERCLOCKWISE
	THERMAL RELAY (F1) - NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	PULSING PUSH BUTTON (B1) - NO	RESPONSIBLE FOR CONNECTING THE CIRCUIT IN THE DIRECTION

14.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	PULSING PUSH BUTTON (B2) - NO	RESPONSIBLE FOR CONNECTING THE CIRCUIT CLOCKWISE
	PULSING PUSH BUTTON (B0) - NC	RESPONSIBLE FOR DISCONNECTING THE CIRCUIT IN AN ANTICLOCHWISE DIRECTION
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

15. DIRECT START WITH REVERSAL WITH PULSING PUSH BUTTON AND OVERLOAD SIGNALING

15.1 WIRING DIAGRAM

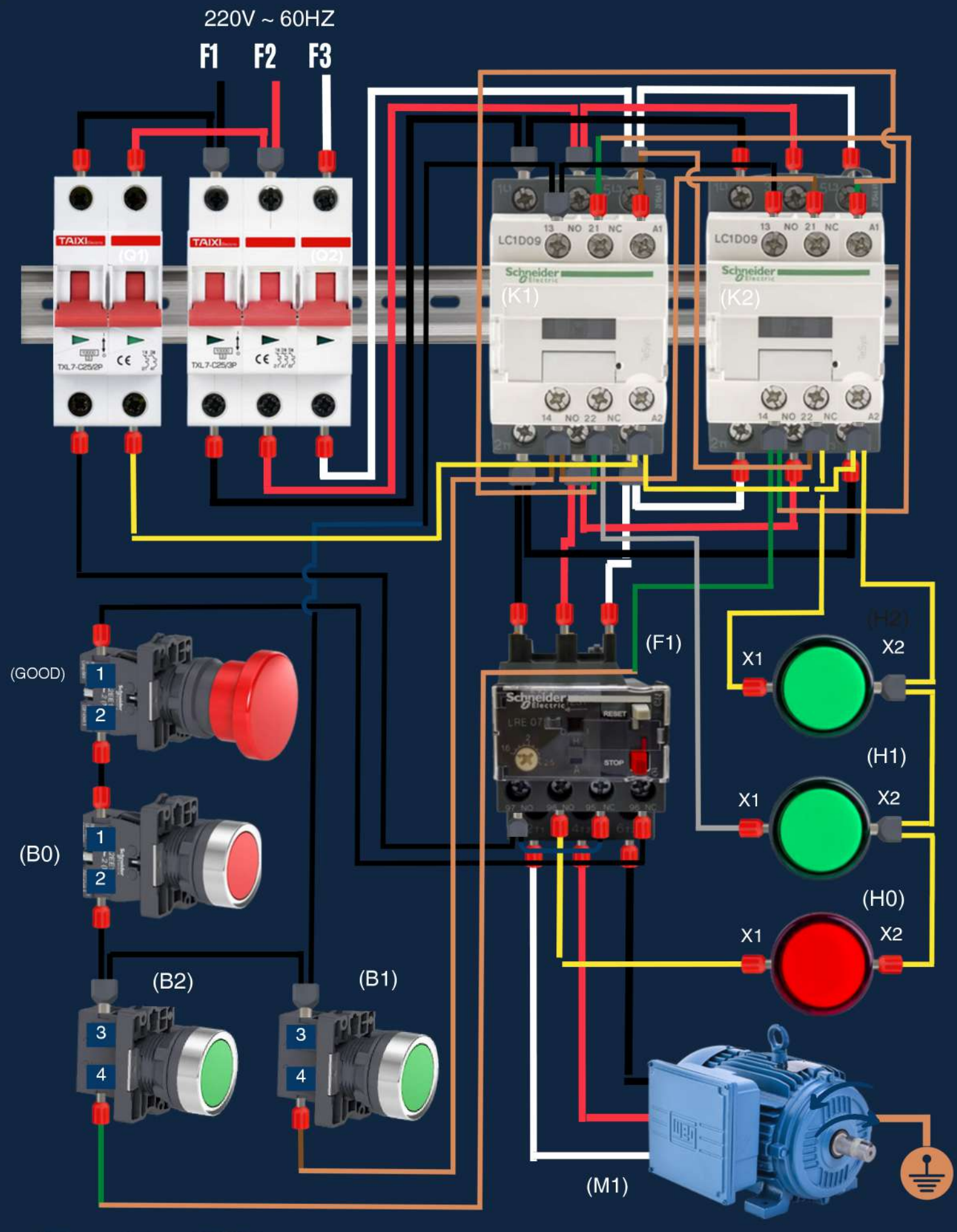


15.2 DESCRIPTION OF OPERATION

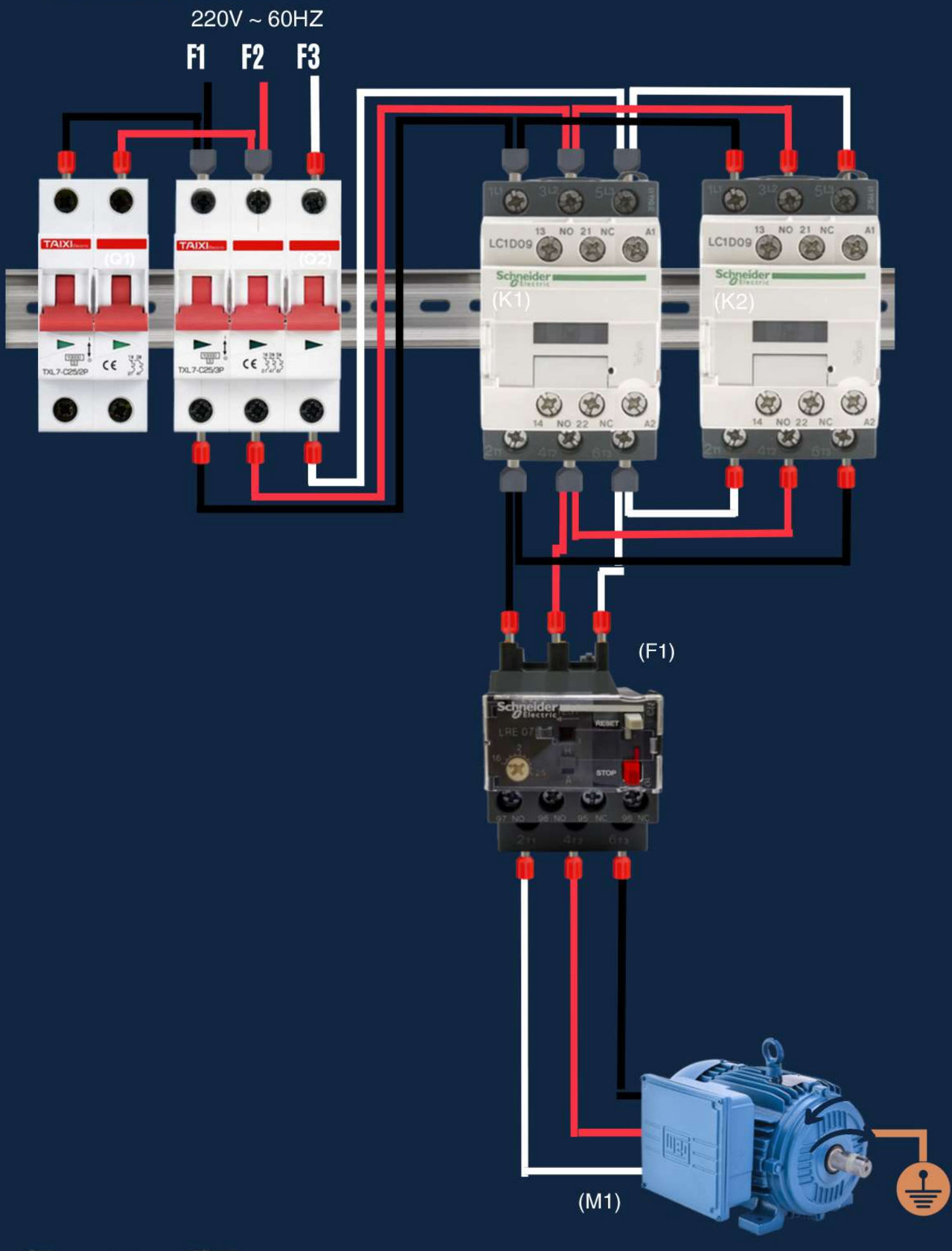
TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE COILS OF K1 AND K2. WHEN PRESSING THE PUSH BUTTON (B1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE COIL OF K1 AND IT WILL BE ENERGIZED, AND WILL REMAIN CONNECTED THROUGH THE SEAL CONTACT, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN A CLOCKWISE DIRECTION. WHEN PRESSING THE PUSH BUTTON (B0), THE MOTOR WILL TURN OFF. WHEN PRESSING THE PUSH BUTTON (B2) THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K2 COIL AND IT WILL BECOME ENERGIZED, AND WILL REMAIN CONNECTED THROUGH THE SEAL CONTACT, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN AN COUNTERCLOCKWISE DIRECTION. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL TURN OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO TURNS OFF THE CIRCUIT. THE SIGNAL LIGHT (H1) SIGNALS THAT THE MOTOR IS STARTED IN A CLOCKWISE DIRECTION. THE SIGNAL LIGHT (H2) SIGNALS THE MOTOR IS RUNNING IN AN ANTI-CLOCKWISE DIRECTION. THE SIGNAL LIGHT (H0) SIGNALS OVERLOAD. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT PUSHBUTTON (B0): TURNS OFF THE CIRCUIT PUSHBUTTON (B1): TURNS ON THE MOTOR IN A CLOCKWISE DIRECTION PUSHBUTTON (B2): TURNS ON THE MOTOR IN A COUNTERCLOCKWISE DIRECTION SIGNAL LIGHT (HO): SIGNALS OVERLOAD FAILURE SIGNAL LIGHT (H1): SIGNALS MOTOR TURNED IN A CLOCKWISE DIRECTION SIGNAL LIGHT (H2): SIGNALS MOTOR TURNED IN A COUNTERCLOCKWISE DIRECTION

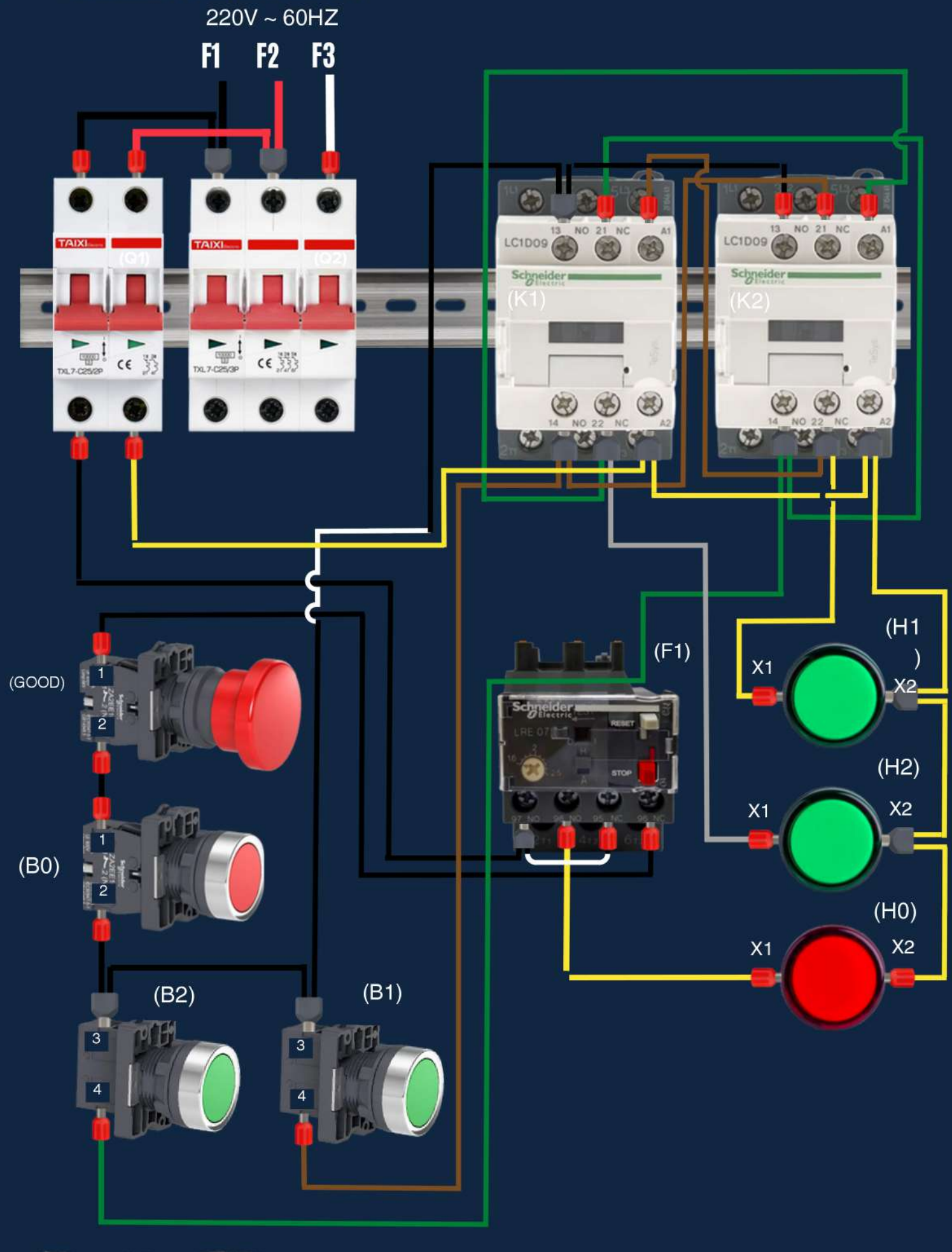
15.3 DIRECT START WITH REVERSAL WITH PULSING PUSH BUTTON AND OVERLOAD SIGNALING



15.3 DIRECT STARTER WITH REVERSAL WITH PULSING PUSH BUTTON AND OVERLOAD SIGNALING (POWER CIRCUIT)



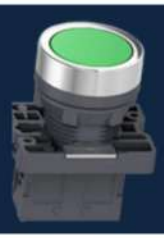
15.3 DIRECT STARTER WITH REVERSAL WITH PULSING PUSH BUTTON AND OVERLOAD SIGNALING (CONTROL CIRCUIT)



15.4 MATERIALS USED

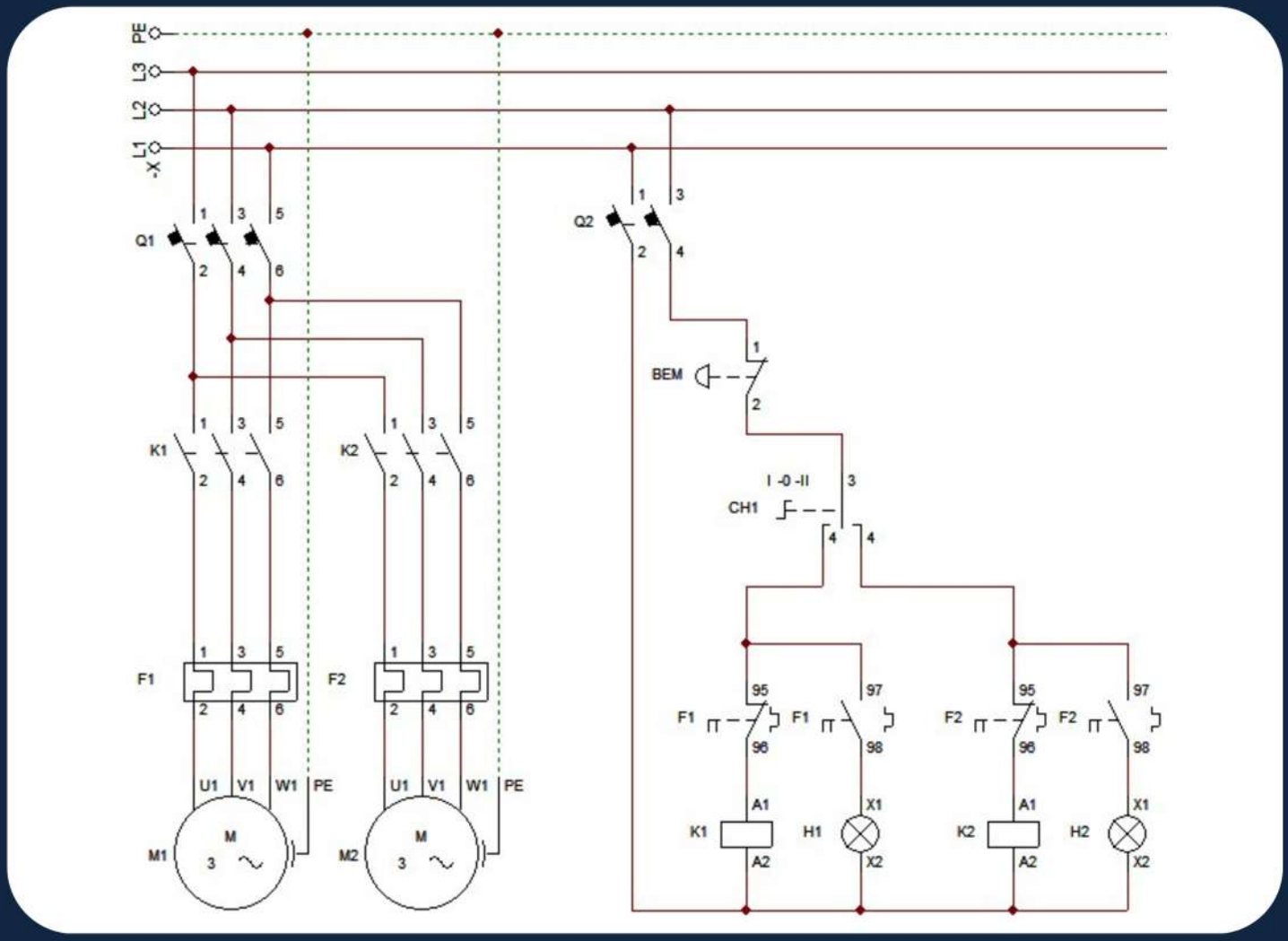
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT. CLOCKWISE
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT. COUNTERCLOCKWISE
	THERMAL RELAY (F1) - NO AND NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	PULSING PUSH BUTTON (B1) - NO	RESPONSIBLE FOR CONNECTING THE CIRCUIT IN THE DIRECTION

15.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	PULSING PUSH BUTTON (B2) - NO	RESPONSIBLE FOR CONNECTING THE CIRCUIT CLOCKWISE
	PULSING PUSH BUTTON (B0) - NC	RESPONSIBLE FOR DISCONNECTING THE CIRCUIT IN AN ANTICLOCUTORY DIRECTION
	SIGNAL (H0)	RESPONSIBLE FOR INDICATING THE ACTIVATION OF THE THERMAL RELAY IN THE EVENT OF OVERLOAD.
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING THE OPERATION OF THE MOTOR (ON). CLOCKWISE.
	SIGNAL (H2)	RESPONSIBLE FOR INDICATING THE OPERATION OF THE MOTOR (ON). COUNTERCLOCKWISE.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

16. DIRECT STARTER OF TWO MOTORS WITH SELECTOR SWITCH AND OVERLOAD SIGNALING

16.1 WIRING DIAGRAM



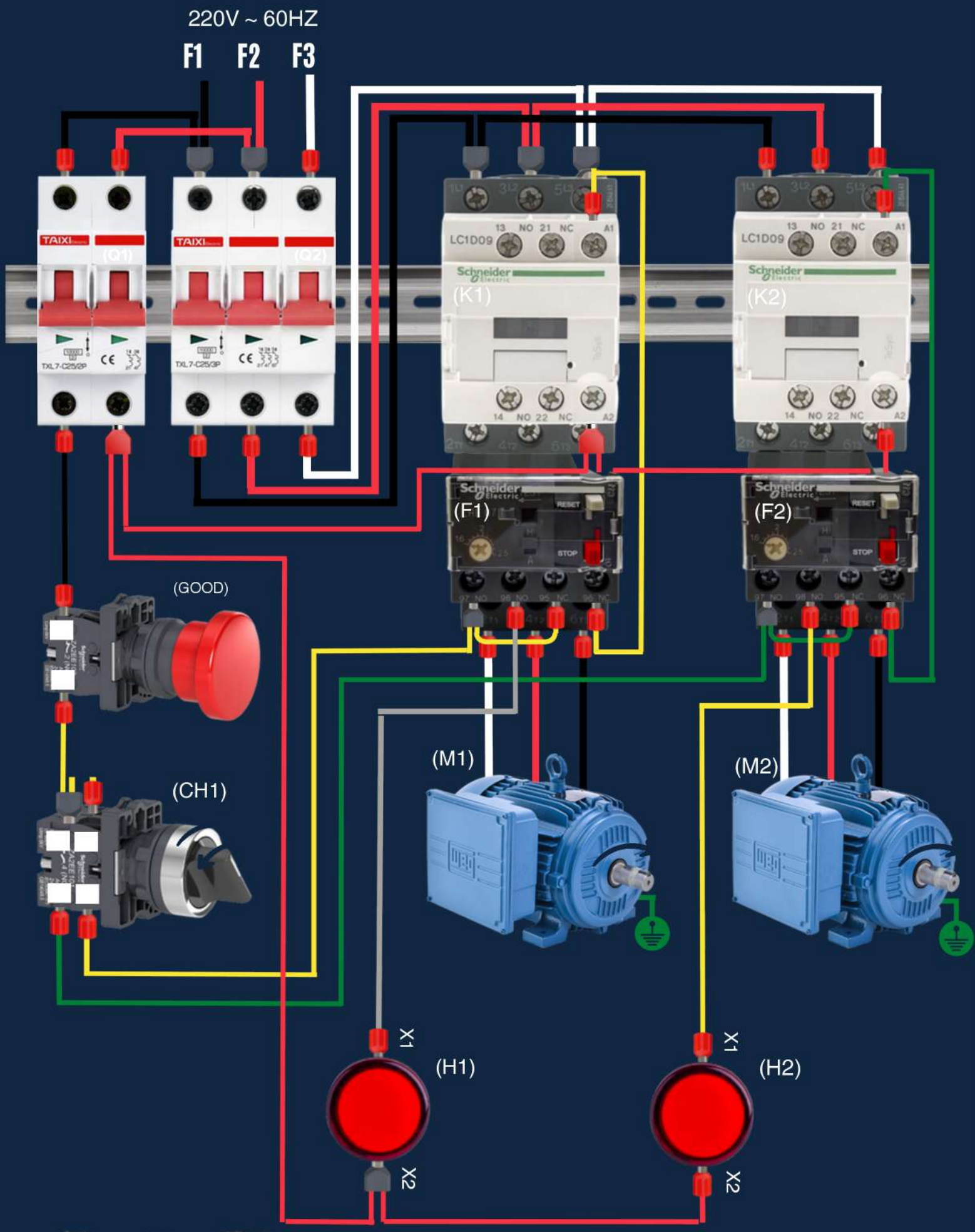
16.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO TURN ON CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE COILS OF K1 AND K2. WHEN TURNING THE KEY (CH1) TO THE LEFT SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE COIL OF K1 AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING MOTOR 1 TO START. WHEN TURNING THE KEY (CH1) TO THE RIGHT SIDE, THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K2 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING MOTOR 2 TO TURN ON. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL TURN OFF THROUGH THE CLOSED CONTACT (F1) OR (F2) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO TURNS OFF THE CIRCUIT. THE SIGNAL LIGHT (H1) INDICATES OVERLOAD IN MOTOR 1, AND TURNS IT OFF. THE SIGNAL LIGHT (H2) INDICATES OVERLOAD IN MOTOR 2, AND TURNS IT OFF.

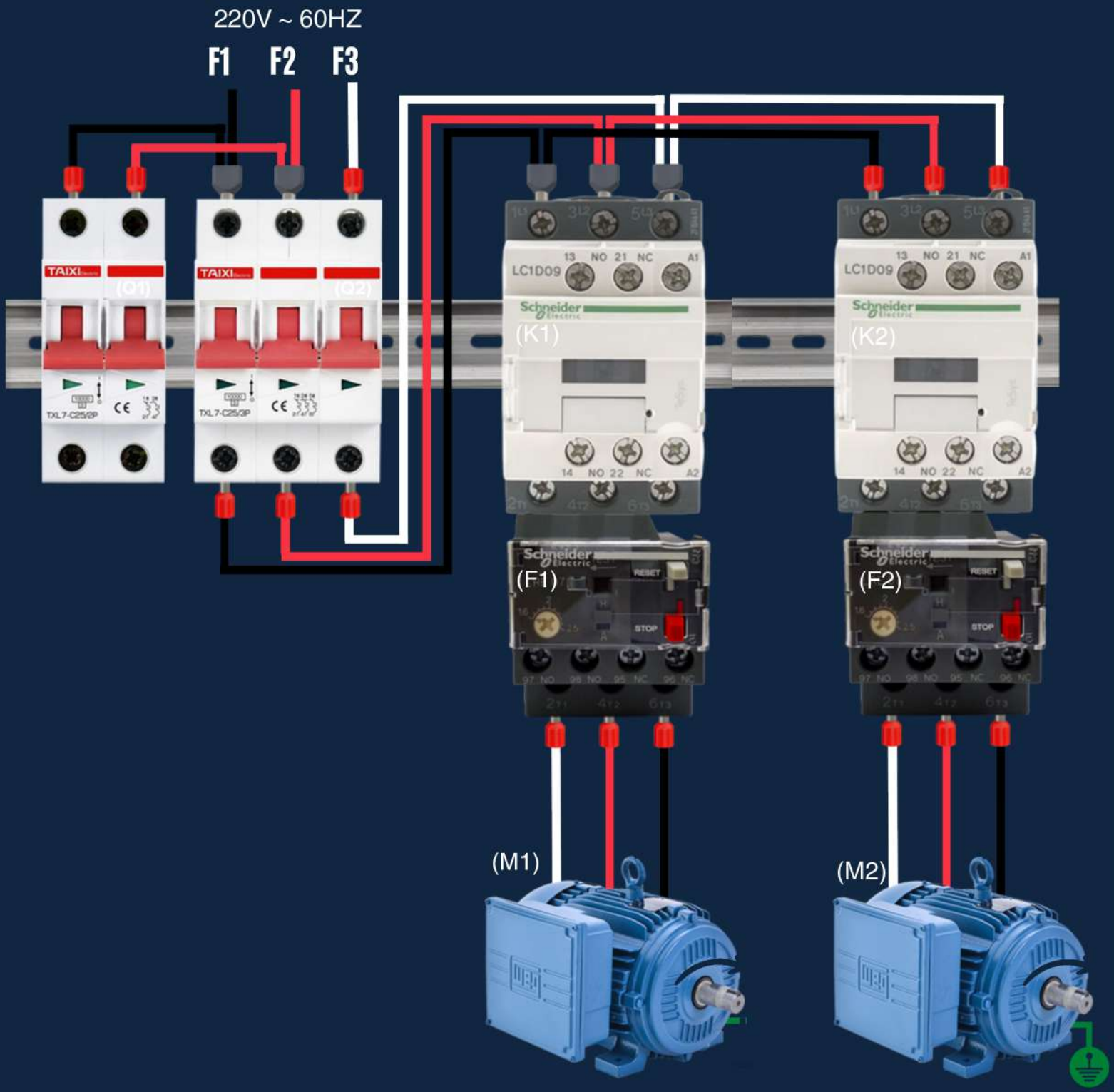
SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT SELECTOR SWITCH (CH1): SELECTS TO TURN ON OR OFF MOTOR 1 OR MOTOR 2 SIGNAL LIGHT (H1): SIGNALS OVERLOAD IN MOTOR 1 SIGNAL LIGHT (H2): SIGNALS OVERLOAD IN MOTOR 2

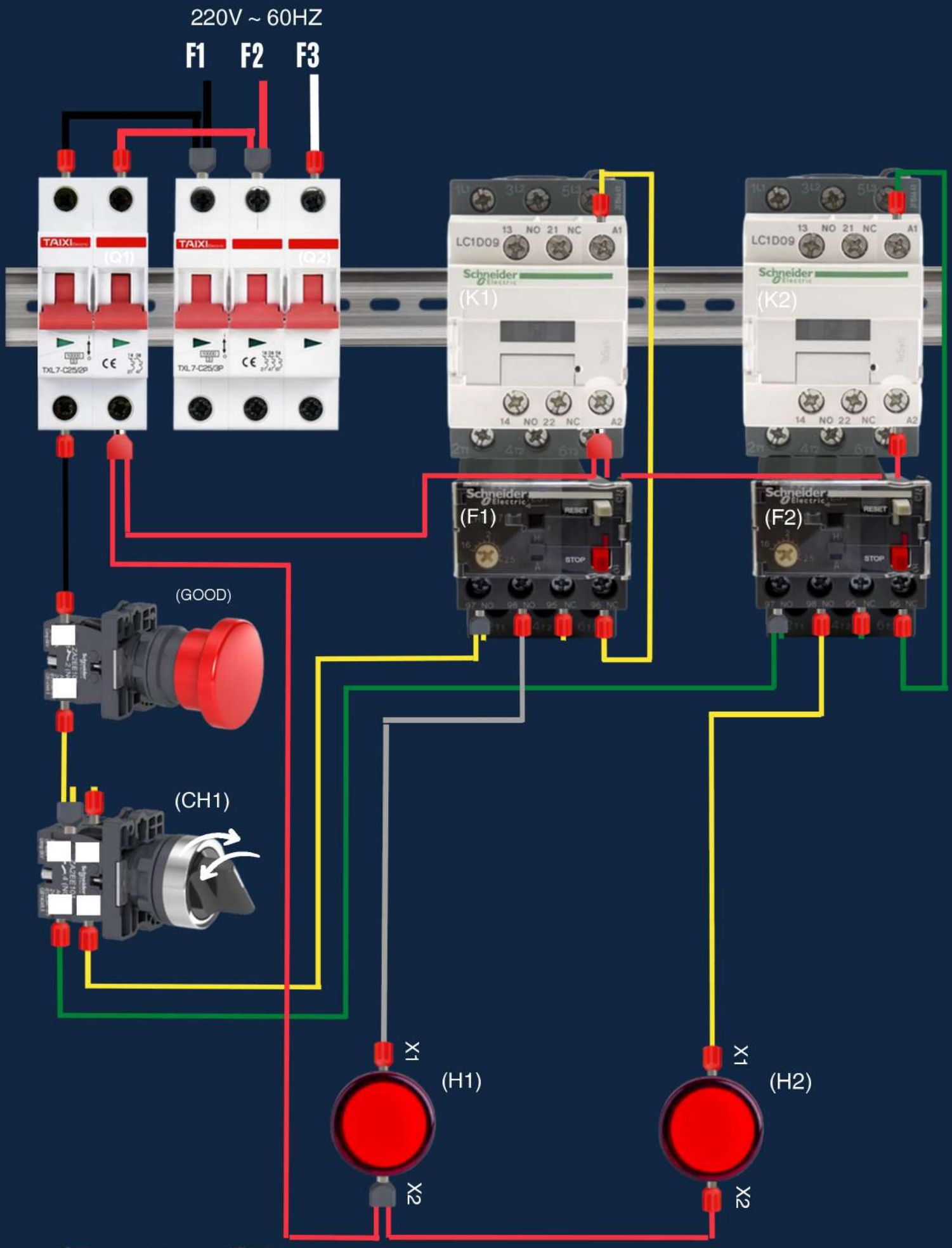
16.3 DIRECT START LAYOUT FOR TWO MOTORS WITH SELECTOR SWITCH AND OVERLOAD SIGNALING



16.3 DIRECT START LAYOUT FOR TWO MOTORS WITH SELECTOR SWITCH AND OVERLOAD SIGNALING (POWER CIRCUIT)



16.3 DIRECT START LAYOUT FOR TWO MOTORS WITH SELECTOR SWITCH AND OVERLOAD SIGNALING (CONTROL CIRCUIT)



16.4 MATERIALS USED

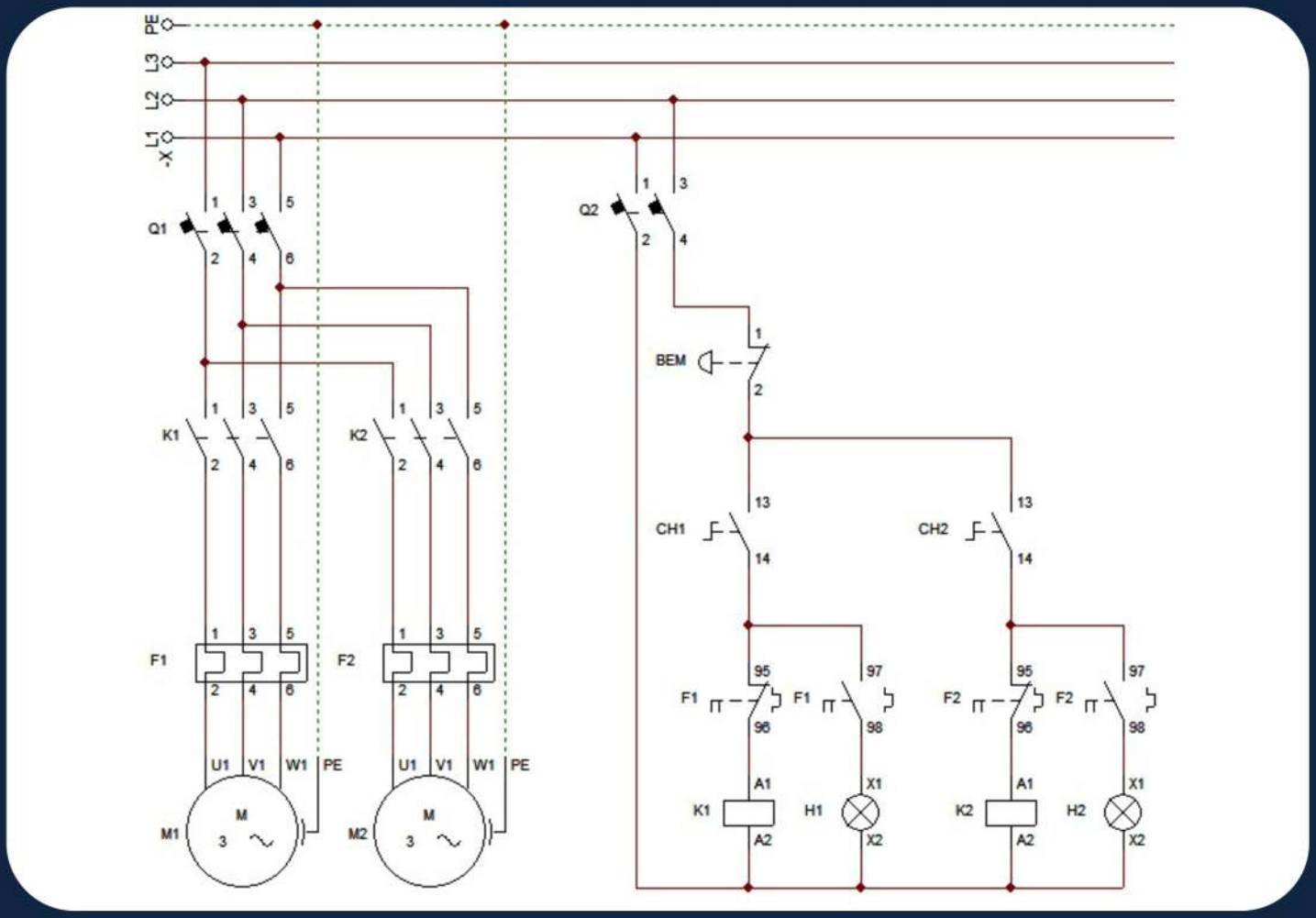
IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE CIRCUIT OF STRENGTH AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1) - NA AND NF	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	THERMAL RELAY (F2) - NO AND NC	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.

16.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	SELECTOR SWITCH (CH1) - NO	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING THE ACTIVATION OF THE THERMAL RELAY IN THE EVENT OF OVERLOAD IN MOTOR 1.
	SIGNAL (H2)	RESPONSIBLE FOR INDICATING THE ACTIVATION OF THE THERMAL RELAY IN THE EVENT OF OVERLOAD IN MOTOR 2.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.
	ELECTRIC MOTOR (M2)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

17. DIRECT STARTER OF TWO MOTORS WITH 2 SELECTOR SWITCHES AND OVERLOAD SIGNALING

1.1 WIRING DIAGRAM



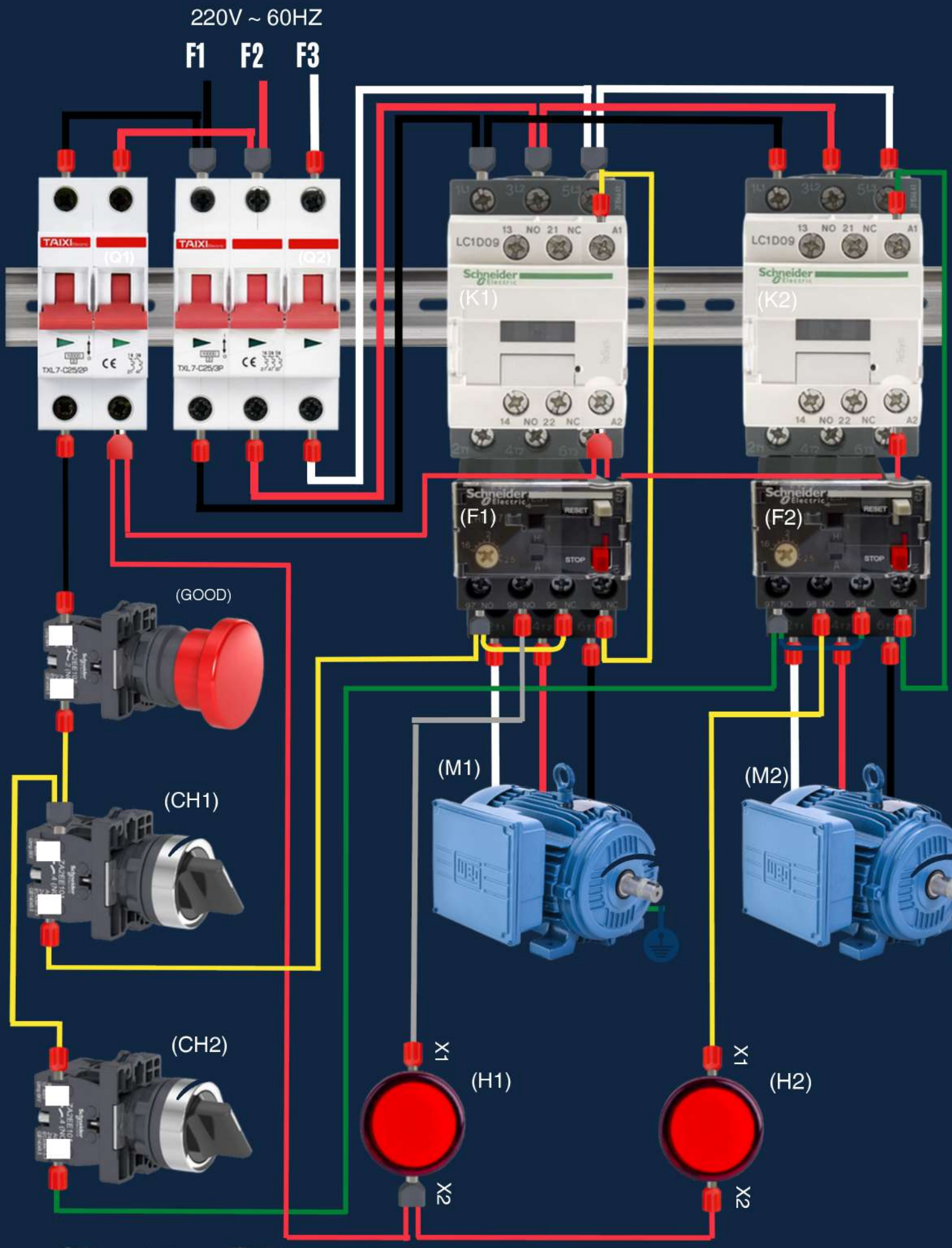
17.2 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO TURN ON CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE COILS OF K1 AND K2. WHEN TURNING THE KEY (CH1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING MOTOR 1 TO START. WHEN TURNING THE KEY (CH2), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K2 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING MOTOR 2 TO START. IN CASE OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OR (F2) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT. SIGNAL LIGHT (H1) INDICATES OVERLOAD IN MOTOR 1, AND SWITCHES IT OFF. SIGNAL LIGHT (H2) INDICATES OVERLOAD IN MOTOR 2, AND SWITCHES IT OFF.

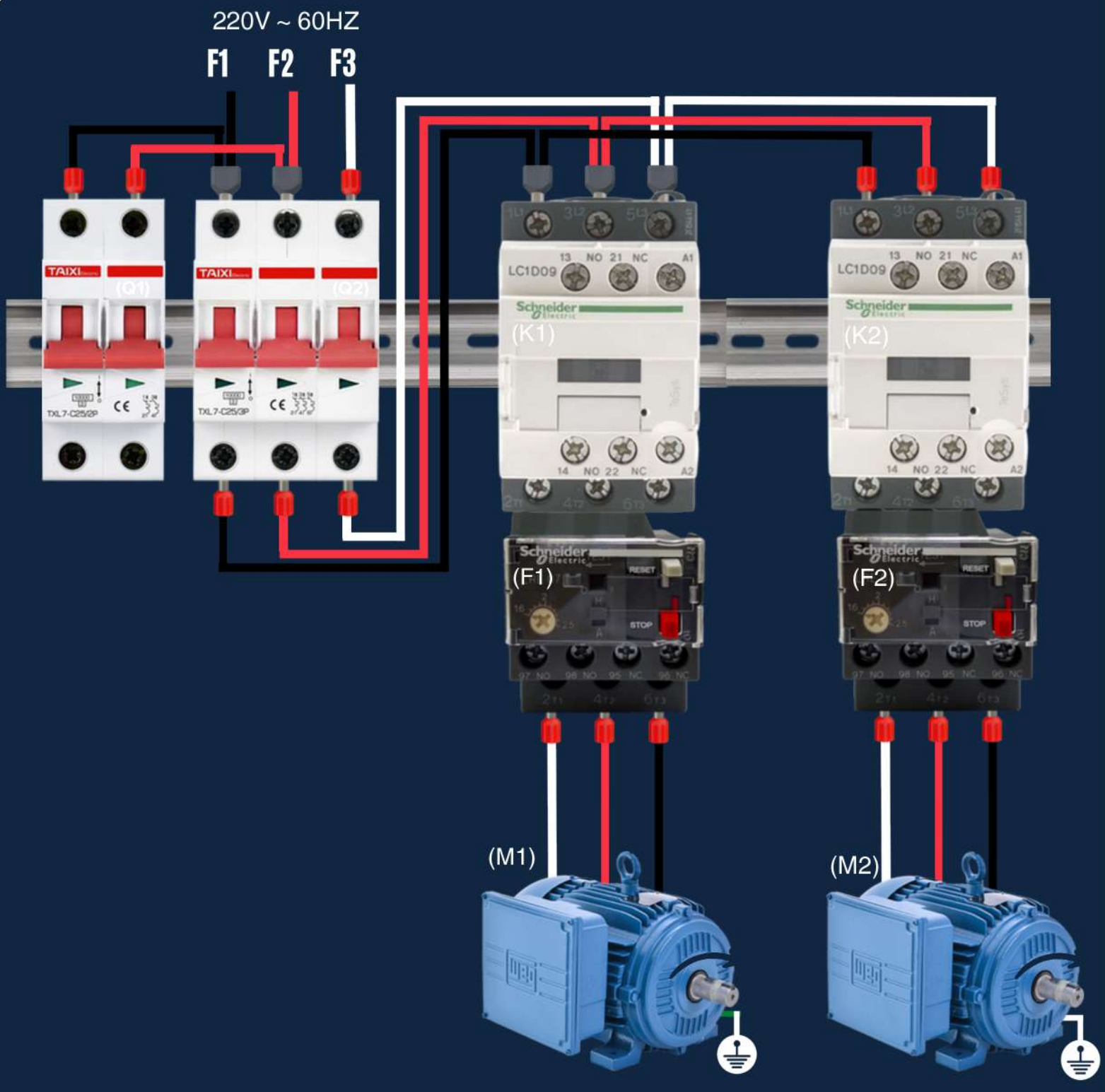
SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURN OFF THE CIRCUIT SELECTOR SWITCH (CH1): TURN MOTOR 1 ON AND OFF SELECTOR SWITCH (CH2): TURN MOTOR 2 ON AND OFF SIGNAL LIGHT (H1): SIGNALS OVERLOAD IN MOTOR 1 SIGNAL LIGHT (H2): SIGNALS OVERLOAD IN MOTOR 2

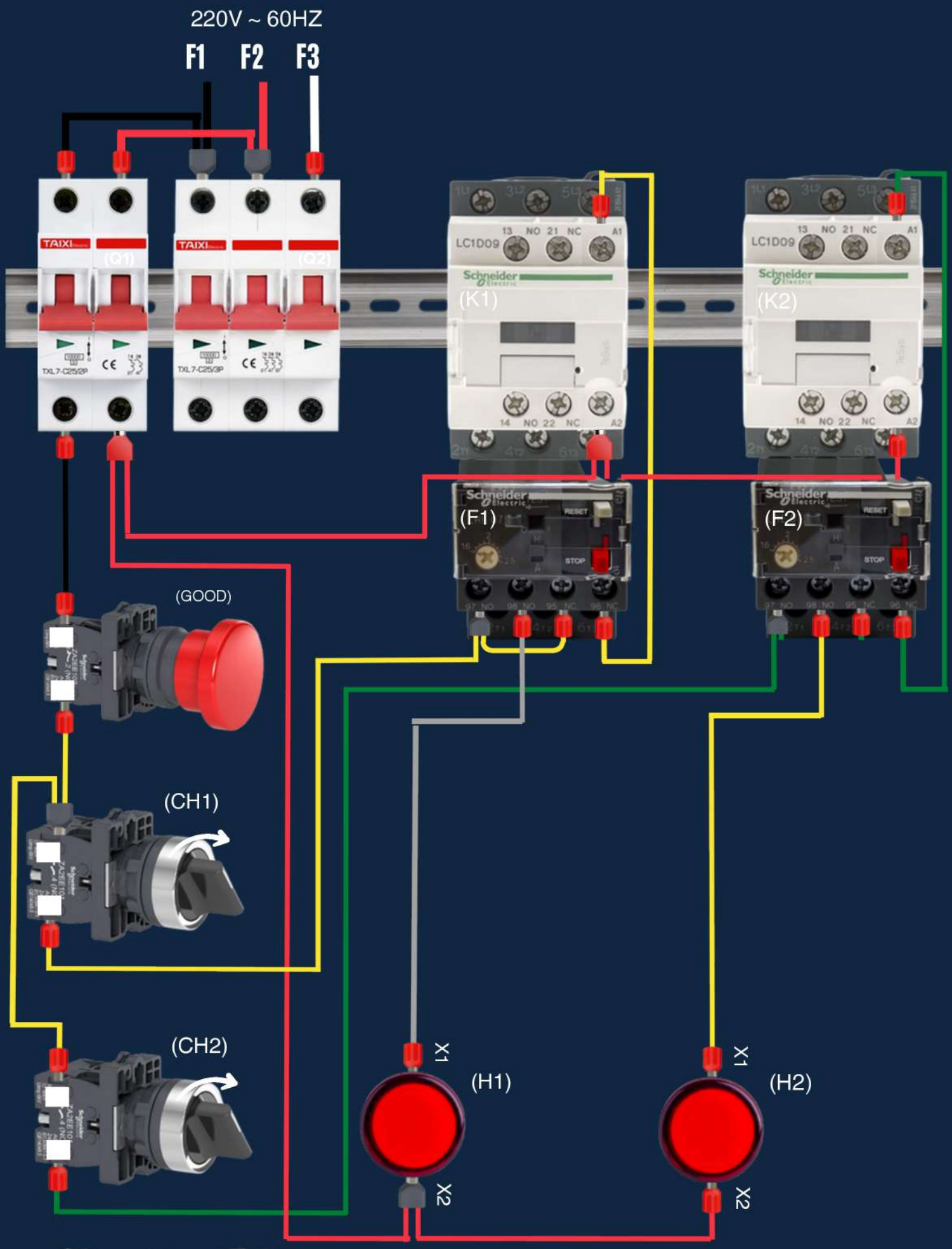
17.3 DIRECT START LAYOUT FOR TWO MOTORS WITH 2 SELECTOR SWITCHES AND OVERLOAD SIGNALING



17.3 DIRECT START LAYOUT FOR TWO MOTORS WITH 2 SELECTOR SWITCHES AND OVERLOAD SIGNALING (POWER CIRCUIT)



17.3 DIRECT START LAYOUT FOR TWO MOTORS WITH 2 SELECTOR SWITCHES AND OVERLOAD SIGNALING (CONTROL CIRCUIT)



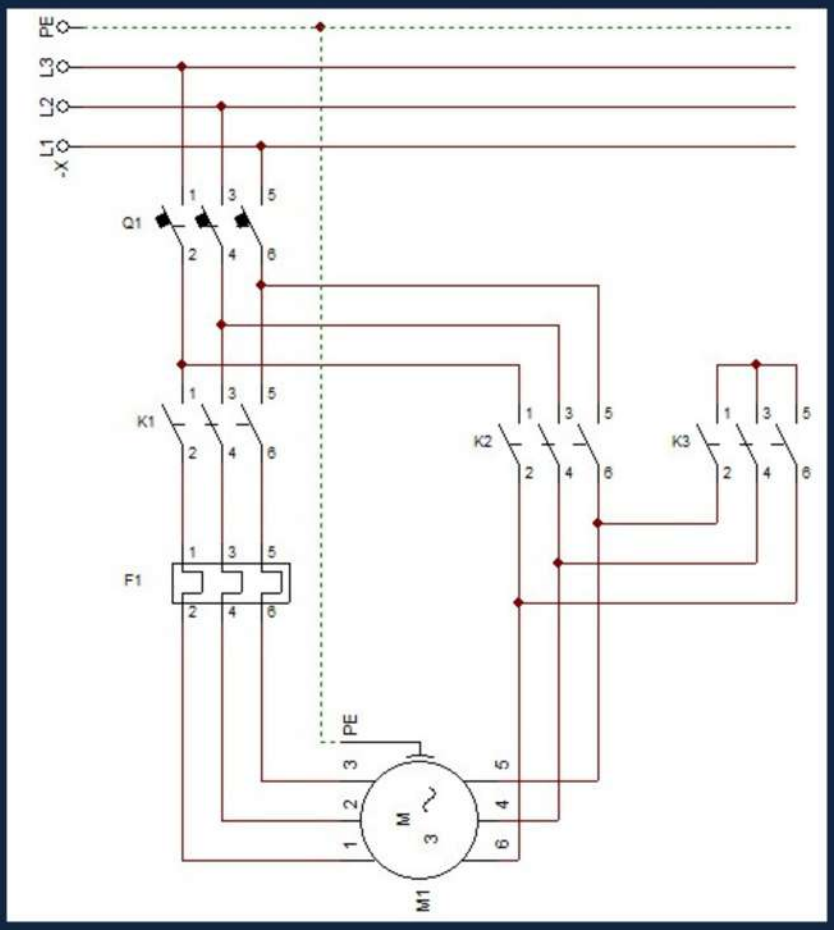
17.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE CIRCUIT OF STRENGTH AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1)	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	THERMAL RELAY (F2)	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.

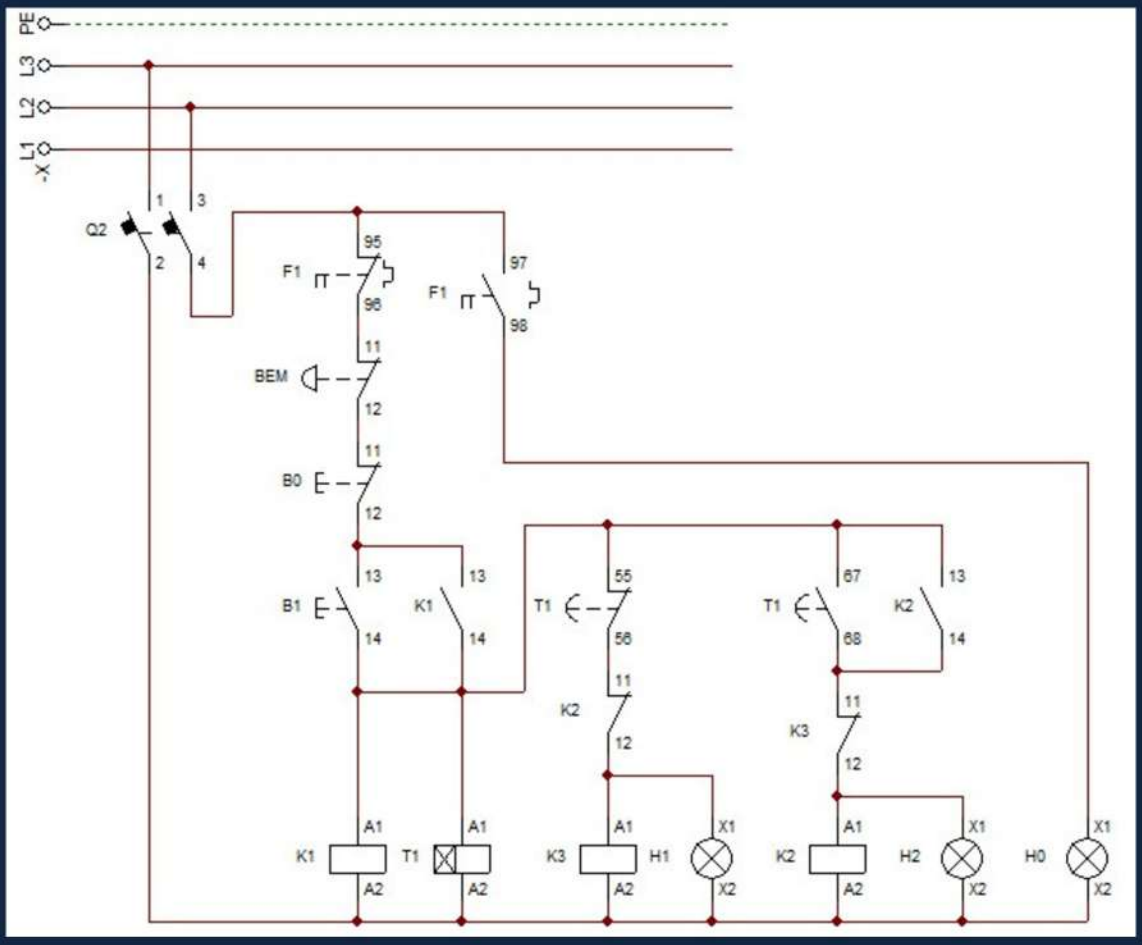
17.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	SELECTOR SWITCH - NO (CH1)	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	SELECTOR SWITCH - NO (CH2)	BY TURNING THE KNOB TO ONE SIDE, IT ALLOWS ELECTRIC CURRENT TO PASS. RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING THE ACTIVATION OF THE THERMAL RELAY IN THE EVENT OF OVERLOAD IN MOTOR 1.
	SIGNAL (H2)	RESPONSIBLE FOR INDICATING THE ACTIVATION OF THE THERMAL RELAY IN THE EVENT OF OVERLOAD IN MOTOR 2.
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.
	ELECTRIC MOTOR (M2)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

18. INDIRECT STARTER STARTER STARTER 18.1
WIRING DIAGRAM - POWER CIRCUIT



18.1 WIRING DIAGRAM - CONTROL CIRCUIT

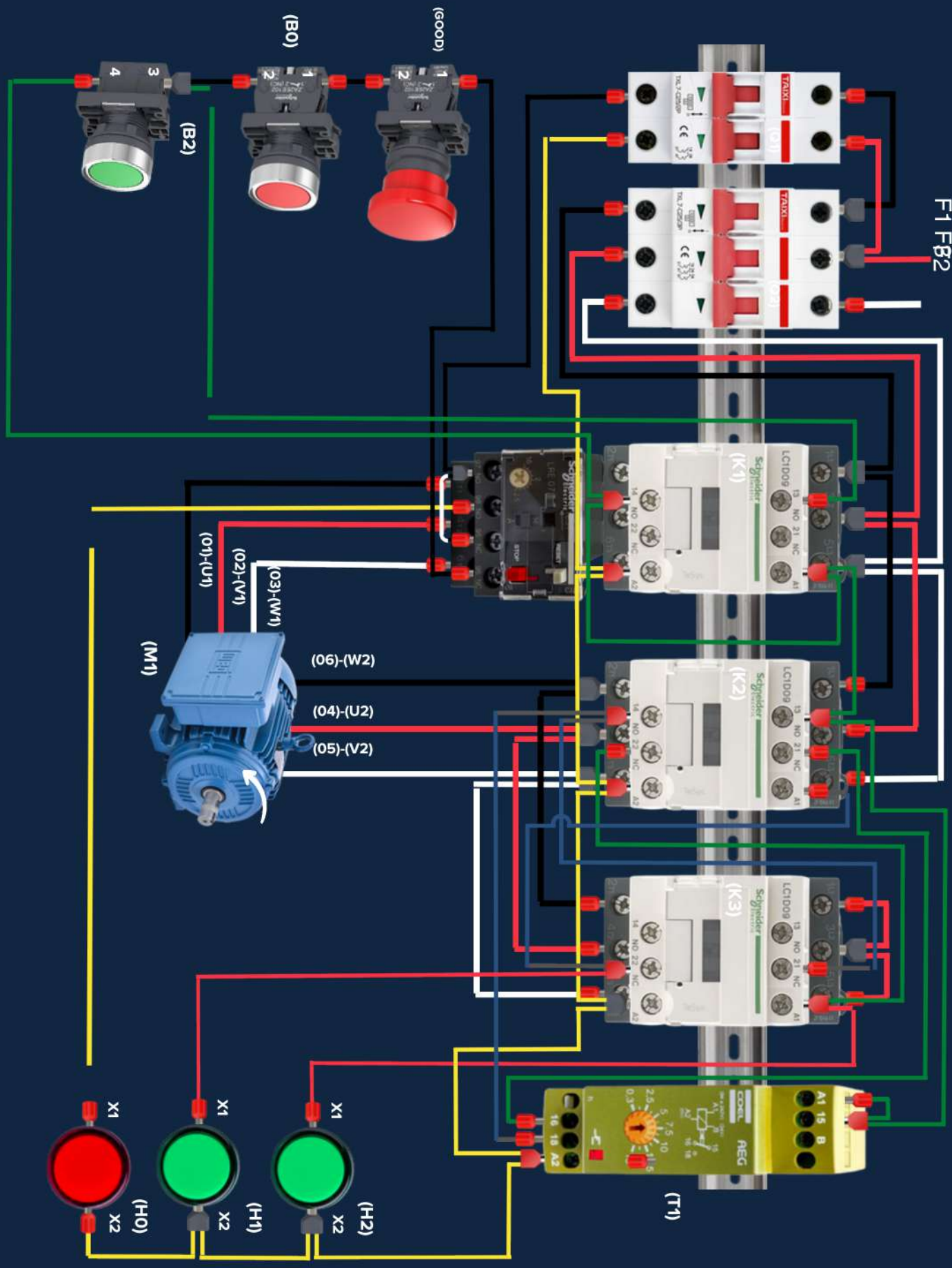


18. INDIRECT STARTER STARTER 18.2 FUNCTIONAL DESCRIPTION

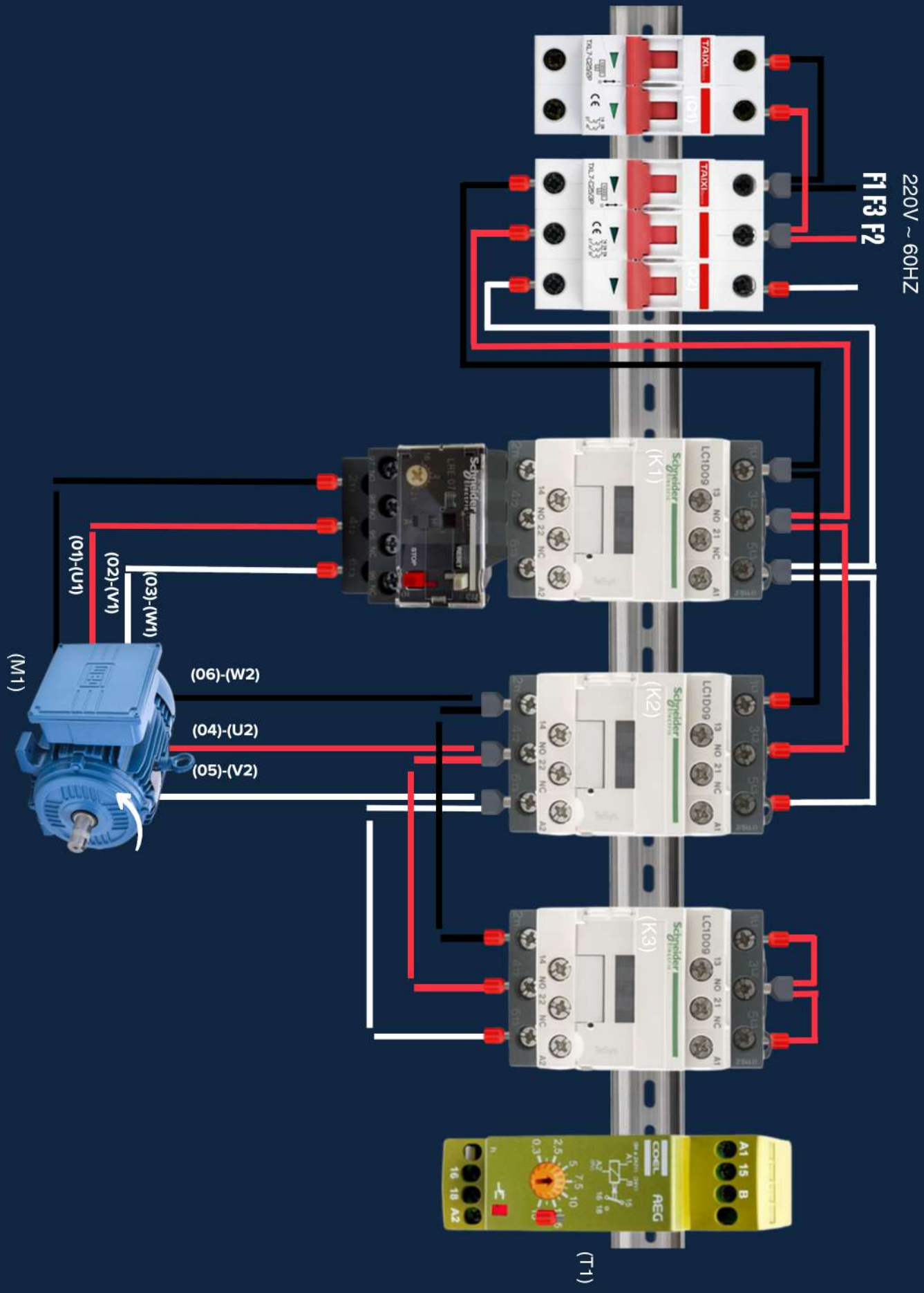
TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE COILS OF K1, K2, K3 AND T1. WHEN PRESSING THE PUSH BUTTON (B1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE COIL OF K1 AND K3 (STAR). THEY WILL BECOME ENERGIZED, INVERTING THEIR MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN STAR CONDITION. AFTER A PRE-DETERMINED TIME IN THE TIMER (T1), POWER CONTACTOR K3 IS TURNED OFF AND POWER CONTACTOR K2 IS TURNED ON, STAYING TURNED ON, THEREFORE, K1 AND K2, INVERTING THEIR MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING THE MOTOR TO START IN A TRIANGLE. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL TURN OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON ALSO TURNS OFF THE CIRCUIT. SIGNAL LIGHT (H1) INDICATES MOTOR TURNED ON IN A STAR. SIGNAL LIGHT (H2) INDICATES MOTOR TURNED ON IN A TRIANGLE. THE SIGNAL LIGHT (H0) INDICATES ENGINE OVERLOAD. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT PUSHBUTTON (B0): TURNS OFF THE MOTOR PUSHBUTTON (B1): TURNS ON THE MOTOR SIGNAL LIGHT (H0): SIGNALS MOTOR OVERLOAD SIGNAL LIGHT (H1): SIGNALS MOTOR CONNECTED IN STAR SIGNAL LIGHT (H2): SIGNALS MOTOR CONNECTED IN TRIANGLE TIMER (T1): CHANGE FROM STAR TO TRIANGLE AFTER A PRE-PROGRAMMED TIME

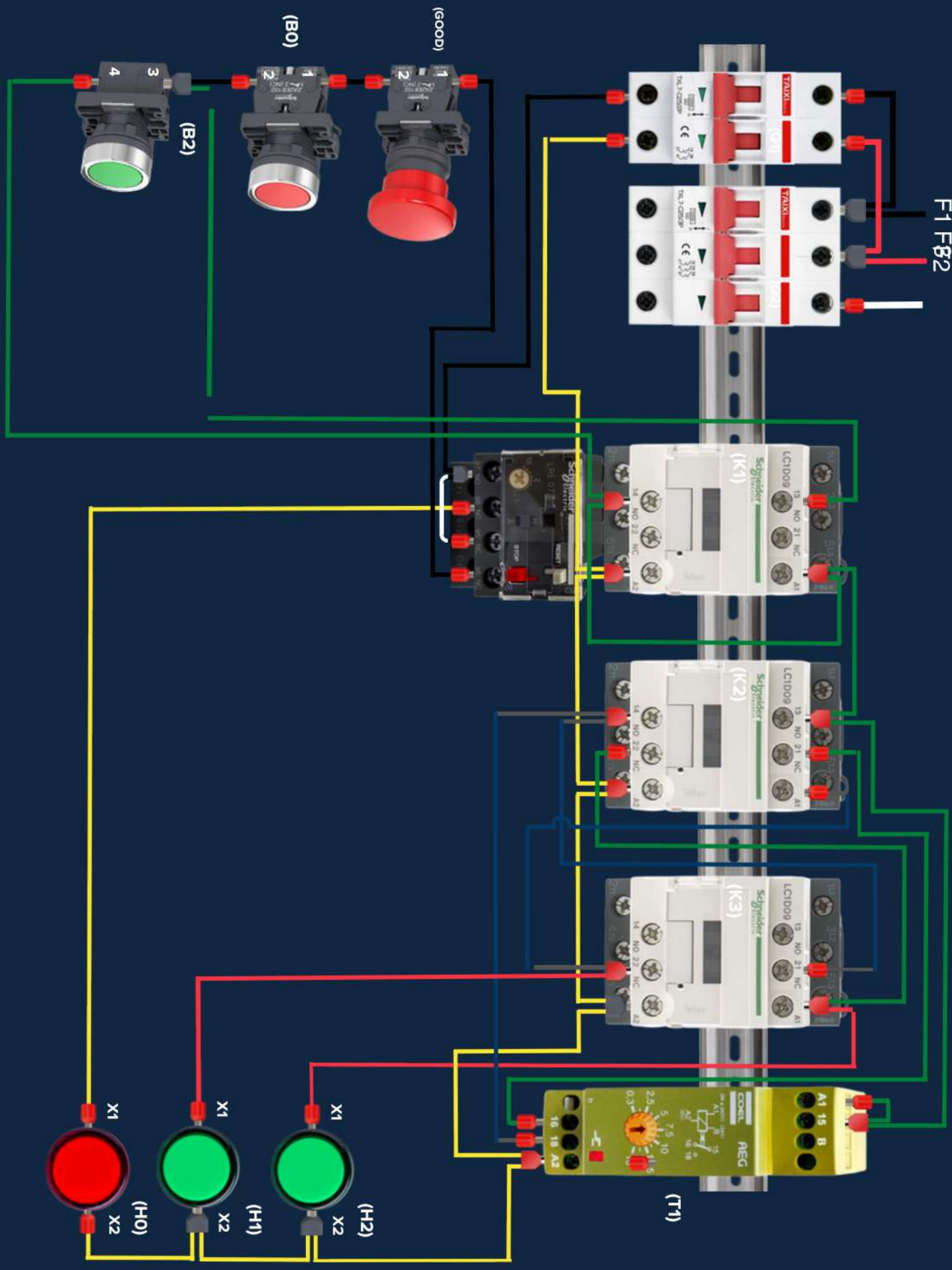
18.3 INDIRECT STARTING LAYOUT STARTER STARTER (START)



18.3 INDIRECT STARTER LAYOUT STARTER STARTER (POWER CIRCUIT)



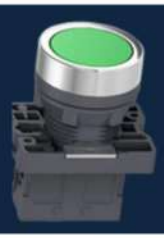
18.3 INDIRECT STARTER LAYOUT STARTER (CONTROL CIRCUIT)



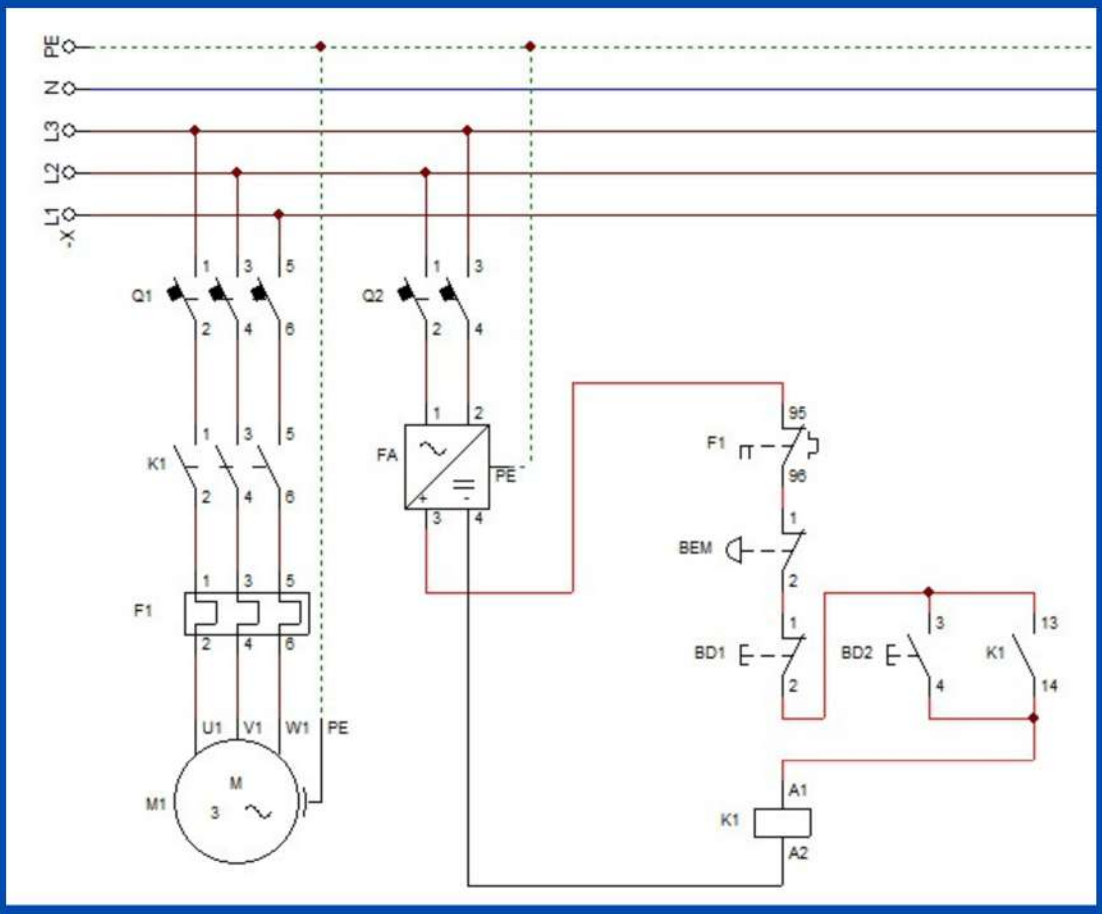
18.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	POWER CONTACTOR (K3)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1)	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.

18.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	PULSING PUSH BUTTON (B1) - NO	RESPONSIBLE FOR CONNECTING THE CIRCUIT
	PULSING PUSH BUTTON (B0) - NC	RESPONSIBLE FOR DISCONNECTING THE CIRCUIT
	SIGNAL (H0)	RESPONSIBLE FOR INDICATING THE ACTIVATION OF THE THERMAL RELAY IN THE EVENT OF OVERLOAD.
	TRAFFIC LIGHT (H1)	RESPONSIBLE FOR INDICATING THE OPERATION OF THE ENGINE IN TRIANGLE
	SIGNAL (H2)	RESPONSIBLE FOR INDICATING THE ENGINE OPERATION IN STAR.
	TIMER RELAY (T1) ON DELAY - NO AND NC	RESPONSIBLE FOR CONNECTING THE CIRCUIT IN STAR AND AFTER A PRE-DETERMINED TIME CONNECTING THE MOTOR IN DRIANGLE
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

19. DIRECT START WITH DOUBLE PUSH BUTTON 19.1 WIRING DIAGRAM

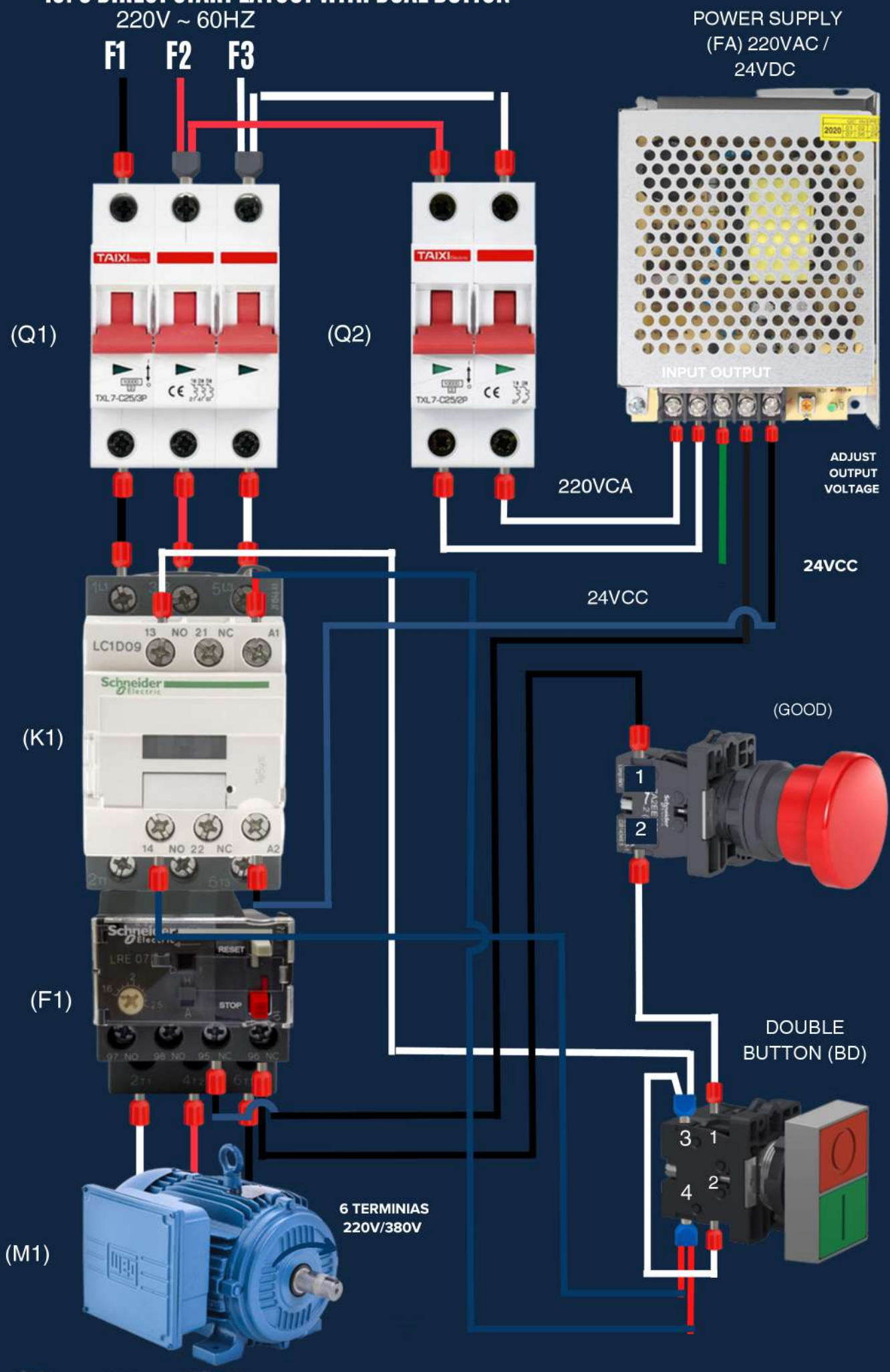


19.1 DESCRIPTION OF OPERATION

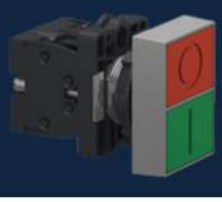
TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE K1 COIL. WHEN PRESSING THE BUTTON (BD1) - GREEN - THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE K1 COIL AND IT WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, THE COIL WILL REMAIN ENERGIZED EVEN IF THE BUTTON (BD1) RETURNS TO ITS INITIAL STATE, THROUGH THE SEAL CONTACT (13 AND 14). IN CASE OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE BUTTON (BD1) - RED - SWITCHES OFF THE CIRCUIT AND THE EMERGENCY BUTTON ALSO SWITCHES OFF THE CIRCUIT IN CASE OF EMERGENCY. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT THERMAL RELAY (F1): TURNS OFF THE CIRCUIT IN CASE OF OVERLOAD PUSHBUTTON (BD1) - GREEN: TURNS ON THE CIRCUIT PUSHBUTTON (BD1) - RED: TURNS OFF THE CIRCUIT POWER SUPPLY (FA): TRANSFORMS ALTERNATING CURRENT INTO DIRECT CURRENT, LEAVING THE CONTROL CIRCUIT AT A SAFE ELECTRICAL VOLTAGE

19. 3 DIRECT START LAYOUT WITH DUAL BUTTON



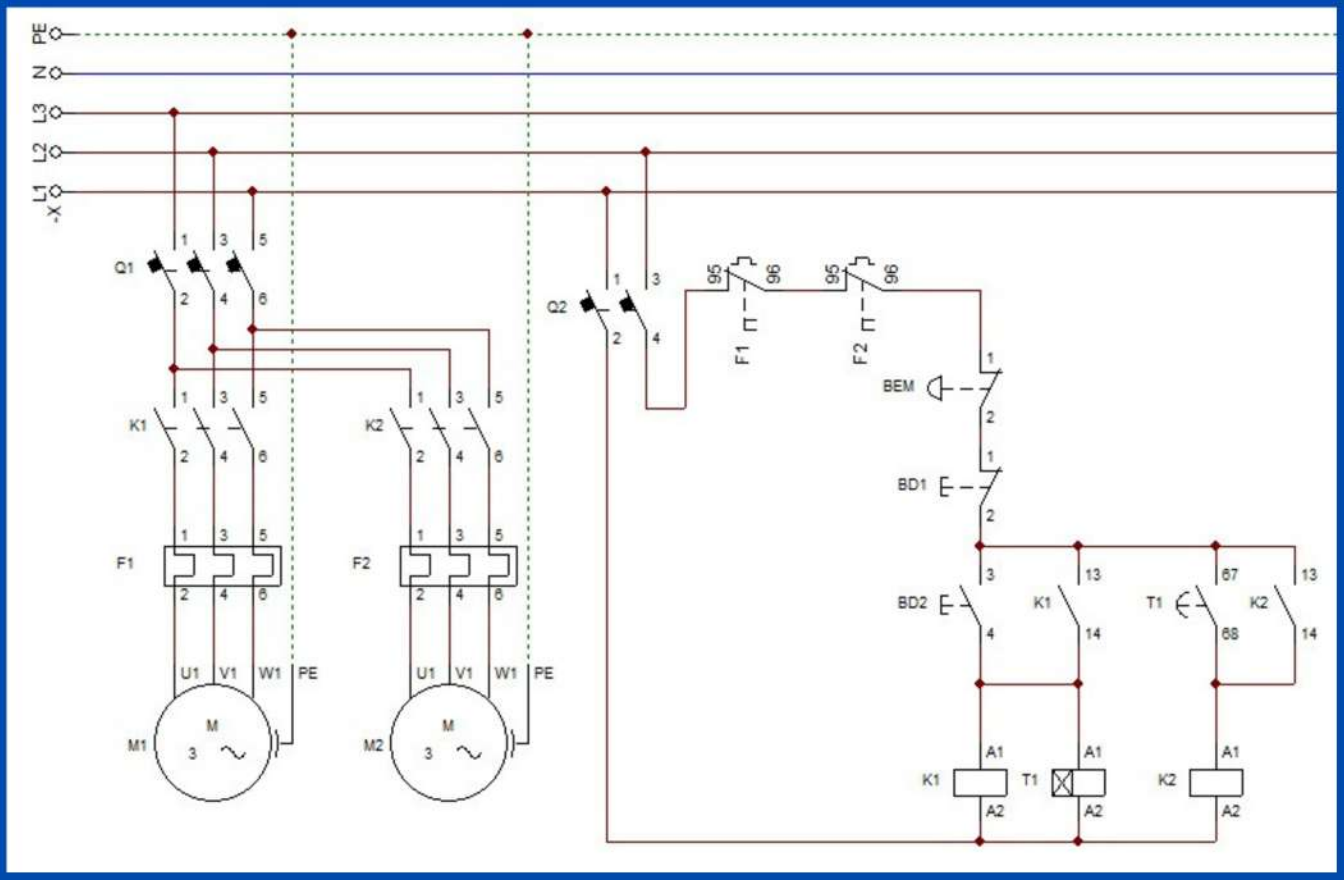
19.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1)	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.
	DOUBLE BUTTON (BD)	RESPONSIBLE FOR TURNING THE CIRCUIT ON AND OFF.

18.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	POWER SUPPLY (PSU)	RESPONSIBLE FOR TRANSFORMING FROM ALTERNATING CURRENT TO DIRECT CURRENT
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

20. CONSECUTIVE STARTING OF TWO MOTORS WITH TIMER 20.1 WIRING DIAGRAM

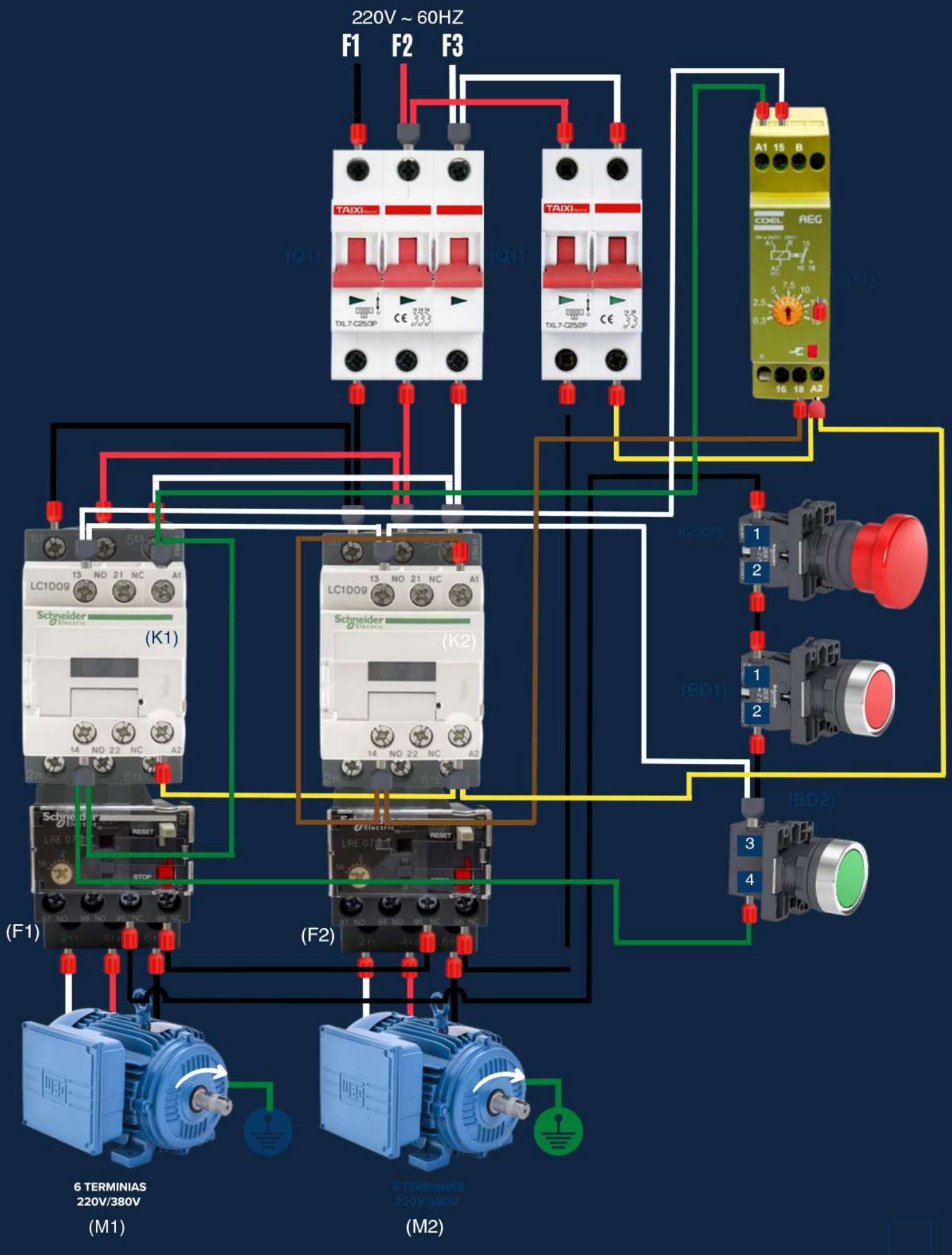


20.1 DESCRIPTION OF OPERATION

TO CONNECT THE CIRCUIT, THE FIRST STEP IS TO CONNECT CIRCUIT BREAKERS Q1 AND Q2. IN THE CONTROL CIRCUIT, ONE OF THE PHASES IS CONNECTED DIRECTLY TO A2 IN THE COILS OF K1, K2 AND T1. WHEN PRESSING THE PUSH BUTTON (BD1), THE ELECTRIC CURRENT WILL FLOW TO A1 OF THE COIL OF K1, WHICH WILL BECOME ENERGIZED, INVERTING ITS MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING MOTOR 1 TO START. AFTER A PRE-DETERMINED TIME IN THE TIMER (T1), THE POWER CONTACTOR K2 IS SWITCHED ON, STAYING SWITCHED ON, THEREFORE, K1 AND K2, INVERTING THEIR MAIN CONTACTS IN THE POWER CIRCUIT, CAUSING MOTOR 2 TO ALSO SWITCH ON. IN THE EVENT OF OVERLOAD, THE CIRCUIT WILL SWITCH OFF THROUGH THE CLOSED CONTACT (F1) OR (F2) OF THE THERMAL RELAY IN THE CONTROL CIRCUIT. THE EMERGENCY BUTTON AND THE PUSH BUTTON PANEL (BD2) ALSO SWITCH OFF THE CIRCUIT. SO WE HAVE:

Q1 AND Q2: PROTECT THE CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD
EMERGENCY BUTTON (BEM): TURNS OFF THE CIRCUIT PUSHBUTTON (BD1): TURNS OFF THE MOTOR PUSHBUTTON (BD2): TURNS ON THE MOTOR TIMER (T1): TURNS ON MOTOR 2 AFTER A PRE-PROGRAMMED TIME

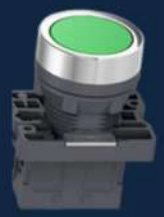
20. 3 LAYOUT FOR CONSECUTIVE STARTING OF TWO MOTORS WITH TIMER



20.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	THREE-POLAR THERMOMAGNETIC CIRCUIT BREAKER (Q1)	RESPONSIBLE FOR PROTECTING THE POWER CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	BIPOLAR THERMOMAGNETIC CIRCUIT BREAKER (Q2)	RESPONSIBLE FOR PROTECTING THE CONTROL CIRCUIT AGAINST SHORT CIRCUIT AND OVERLOAD.
	POWER CONTACTOR (K1)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	POWER CONTACTOR (K2)	RESPONSIBLE FOR TURNING THE LOAD ON AND OFF, THROUGH A CONTROL CIRCUIT.
	THERMAL RELAY (F1)	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	THERMAL RELAY (F2)	RESPONSIBLE FOR PROTECTING THE CIRCUIT AGAINST OVERLOAD, DISCONNECTING THE CIRCUIT IN THE EVENT OF AN ABNORMALITY.
	EMERGENCY BUTTON (BEM) - NC	WHEN YOU PRESS THE BUTTON, IT PREVENTS THE PASSAGE OF ELECTRIC CURRENT. WHEN YOU TURN OR PULL THE BUTTON, IT RETURNS TO ITS ORIGINAL POSITION.

18.4 MATERIALS USED

IMAGE	NOMENCLATURE	FUNCTION
	PULSED PUSH BUTTON (BD2) - NO	RESPONSIBLE FOR CONNECTING THE CIRCUIT
	PULSED PUSH BUTTON (BD1) - NC	RESPONSIBLE FOR DISCONNECTING THE CIRCUIT
	TIMER RELAY (T1) ON DELAY - NO AND NC	RESPONSIBLE FOR STARTING THE M2 ENGINE AFTER A PRE-DETERMINED TIME
	ELECTRIC MOTOR (M1)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.
	ELECTRIC MOTOR (M2)	RESPONSIBLE FOR TRANSFORMING ELECTRICAL ENERGY INTO MECHANICAL ENERGY.

TEST YOUR KNOWLEDGE

AFTER READING ALL THE CONTENT, TAKE THE FOLLOWING TEST. REMEMBER THAT THE ANSWER KEY IS AT THE END:

1) WHICH OF THE FOLLOWING ELECTRICAL QUANTITIES IS MEASURED IN VOLTS (V)?

A) CURRENT B) RESISTANCE C) VOLTAGE D) POWER

2) WHICH OF THE FOLLOWING ELECTRICAL QUANTITIES IS MEASURED IN AMPERES

(A)? A) VOLTAGE B) RESISTANCE C) POWER D) CURRENT

3) WHAT IS THE UNIT OF MEASUREMENT FOR ELECTRICAL RESISTANCE? A) VOLTS

(V) B) OHMS (Ω) C) WATTS (W) D) AMPERES (A)

4) THE LIGHTING LIGHTS IN A HOME RECEIVE THE SAME ELECTRICAL VOLTAGE,

HOW SHOULD THEY BE CONNECTED? MARK THE CORRECT ALTERNATIVE.

(A) SERIES (B) PARALLEL (C) SERIES AND PARALLEL (D) NONE OF THE ABOVE

5) WHAT LETTER AND UNIT OF MEASUREMENT REPRESENTS ACTIVE POWER IN ALTERNATING CURRENT?
(A) LETTER S AND UNIT OF MEASUREMENT IN VOLT AMPERE (VA) (B) LETTER P AND UNIT OF MEASUREMENT IN WATTS (W) (C) LETTER Q AND UNIT OF MEASUREMENT IN VOLT AMPERE REACTIVE (VAR) (D) LETTER F AND UNIT OF MEASUREMENT IN HERTZ (HZ)

6) WHAT LETTER AND UNIT OF MEASUREMENT REPRESENTS REACTIVE POWER IN ALTERNATING CURRENT? (A) LETTER S AND UNIT OF MEASUREMENT IN VOLT AMPERE (VA) (B) LETTER P AND UNIT OF MEASUREMENT IN WATTS (W) (C) LETTER Q AND UNIT OF MEASUREMENT IN REACTIVE VOLT AMPERE (VAR) (D) LETTER F AND UNIT OF MEASUREMENT IN HERTZ (HZ)

7) WHAT LETTER AND UNIT OF MEASUREMENT REPRESENTS THE APPARENT POWER IN ALTERNATING CURRENT? (A) LETTER S AND UNIT OF MEASUREMENT IN VOLT AMPERE (VA) (B) LETTER P AND UNIT OF MEASUREMENT IN WATTS (W) (C) LETTER Q AND UNIT OF MEASUREMENT IN VOLT AMPERE REACTIVE (VAR) (D) LETTER F AND UNIT OF MEASUREMENT IN HERTZ (HZ) 8) WHAT IS THE MAIN FUNCTION OF A THERMOMAGNETIC CIRCUIT BREAKER? (A) IT IS A PROTECTION DEVICE CAPABLE OF DETECTING TRANSIENT CURRENTS IN ELECTRIC GROUNDING CABLES, AUTOMATICALLY DISCONNECTING THE CIRCUIT. (B) IT IS AN AUTOMATIC DEVICE THAT DISCONNECTS THE ELECTRICAL CIRCUIT IN THE EVENT OF A CURRENT LEAKAGE THAT PUT THE LIVES OF PEOPLE AND DOMESTIC ANIMALS AND THE ELECTRICAL INSTALLATION AT RISK. (C) IT IS A MANEUVERING DEVICE CAPABLE OF INTERRUPTING THE ELECTRIC CURRENT WHEN, IN THE CIRCUIT, ABNORMAL WORKING CONDITIONS ARISE THAT RESULT IN AN OVERCURRENT CAUSED BY AN OVERLOAD IN THAT ELECTRICAL CIRCUIT OR BY THE OCCURRENCE OF A SHORT CIRCUIT. (D) IT IS A PROTECTION DEVICE WITH THE PURPOSE OF LIMITING OVERVOLTAGES AND DISCHARGING TO THE GROUND CURRENT SURROUNDS ORIGINATING FROM DISCHARGES. ATMOSPHERIC IN POWER GRIDS, THUS PROTECTING EQUIPMENT. 9) IN WHICH CIRCUITS ARE CURVE B THERMO-MAGNETIC CIRCUIT BREAKERS USED?

(A) INDUCTIVE CIRCUITS (B) RESISTIVE CIRCUITS (C) CAPACITIVE CIRCUITS (D) PARALLEL CIRCUITS

10) IN WHICH CIRCUITS ARE CURVE C THERMAL MAGNETIC CIRCUIT BREAKERS USED? (A) INDUCTIVE CIRCUITS (B) RESISTIVE CIRCUITS (C) CAPACITIVE CIRCUITS (D) PARALLEL CIRCUITS 11) AGAINST WHICH ADVERSE SITUATIONS DOES THE THERMAL MAGNETIC CIRCUIT BREAKER TRIP? (A) EARTH LEAKAGE (B) ATMOSPHERIC SURPASSES (C) OVERLOAD AND SHORT CIRCUIT (D) VOLTAGE DROP 12) WHAT IS A THERMAL RELAY? A) A DEVICE USED TO CONTROL TEMPERATURE IN REFRIGERATION SYSTEMS. B) A DEVICE USED TO PROTECT ELECTRIC MOTORS AGAINST THERMAL OVERLOAD. C) A COMPONENT USED TO REGULATE VOLTAGE IN ELECTRONIC CIRCUITS. D) A DEVICE USED TO MEASURE ELECTRICAL RESISTANCE IN A CIRCUIT. 13) HOW DOES A THERMAL RELAY WORK? A) IT DETECTS ELECTRIC CURRENT AND DISCONNECTS THE CIRCUIT IN CASE OF OVERLOAD. B) IT MONITORS THE TEMPERATURE AND INTERRUPTS THE POWER SUPPLY IN CASE OF OVERHEATING. C) IT CONTROLS THE VOLTAGE IN A CIRCUIT, ADJUSTING IT AS NECESSARY. D) IT MEASURES ELECTRICAL RESISTANCE AND ACTS AS A SWITCH IN CASE OF ANOMALIES.

14) WHAT IS A MOTOR CIRCUIT BREAKER?

A) A DEVICE THAT PROTECTS ELECTRIC MOTORS AGAINST OVERCURRENT AND SHORT-CIRCUIT.

CIRCUIT.

B) A COMPONENT THAT REGULATES VOLTAGE IN POWER CIRCUITS.

C) A DEVICE USED TO MEASURE ELECTRICAL RESISTANCE IN ELECTRIC MOTORS.

D) A SWITCH USED TO CONTROL THE STARTING AND STOPPING OF ELECTRIC MOTORS.

15) WHAT IS THE FUNCTION OF THE MOTOR CIRCUIT BREAKER IN AN ELECTRICAL SYSTEM? A) TO SUPPLY ENERGY TO THE ELECTRIC MOTOR DURING ITS OPERATION.

B) REGULATE THE ROTATION SPEED OF THE ELECTRIC MOTOR.

C) PROTECT THE MOTOR AGAINST ELECTRICAL OVERLOAD AND SHORT CIRCUITS.

D) CONTROL THE TEMPERATURE OF THE ELECTRIC MOTOR DURING ITS OPERATION.

16) WHAT IS THE FUNCTION OF A POWER CONTACTOR IN A MOTOR STARTER? A) TO CONTROL THE ROTATION SPEED OF ELECTRIC MOTORS.

B) REGULATE VOLTAGE IN LOW POWER CIRCUITS.

C) OPENING AND CLOSING POWER CIRCUITS, TURNING THE MOTOR ON AND OFF.

D) MEASURING ELECTRICAL RESISTANCE IN A POWER CIRCUIT.

17) WHAT IS THE PURPOSE OF AN AUXILIARY CONTACTOR IN AN ELECTRICAL SYSTEM?

A) TO MEASURE THE ELECTRIC CURRENT CONSUMED BY AUXILIARY DEVICES.

B) REGULATE THE SPEED OF AUXILIARY MOTORS.

C) CONTROL TEMPERATURE IN LOW POWER ELECTRICAL SYSTEMS.

D) PROVIDE COMMAND SIGNALS TO OPERATE OTHER COMPONENTS OF THE ELECTRICAL SYSTEM. 18) WHAT DIFFERENTIATES AN AUXILIARY CONTACTOR FROM A POWER CONTACTOR? A) THE ABILITY TO INTERRUPT THE FLOW OF ELECTRIC CURRENT.

B) THE MAXIMUM POWER THEY CAN SUPPORT.

C) THE PRESENCE OF ELECTROMAGNETIC COILS.

D) THE TYPE OF ELECTRIC LOAD THEY CAN CONTROL.

19) WHAT IS THE MAIN FUNCTION OF A MOTOR CIRCUIT BREAKER IN AN ELECTRIC MOTOR STARTER?

A) PROTECT THE MOTOR AGAINST ELECTRICAL OVERLOAD AND SHORT CIRCUITS.
B) CONTROL THE ROTATION SPEED OF THE ELECTRIC MOTOR.
C) ADJUST THE VOLTAGE SUPPLIED TO THE MOTOR DURING ITS OPERATION.
D) MEASURE THE ELECTRIC POWER CONSUMED BY THE MOTOR.

20) WHAT HAPPENS WHEN A MOTOR CIRCUIT BREAKER IS ACTIVATED, BUT THERE IS AN ELECTRICAL OVERLOAD?

A) THE MOTOR CIRCUIT BREAKER AUTOMATICALLY SWITCHES OFF, INTERRUPTING THE ELECTRICITY CURRENT TO PROTECT THE MOTOR.

B) THE ENGINE ROTATION SPEED IS REDUCED TO AVOID DAMAGE.
C) THE VOLTAGE SUPPLIED TO THE MOTOR IS INCREASED TO COMPENSATE FOR THE OVERLOAD.
D) THE MOTOR CIRCUIT BREAKER EMITS AN AUDIBLE ALARM TO WARN OF OVERLOAD.

21) WHAT IS THE PURPOSE OF ADJUSTING THE CURRENT OF A MOTOR CIRCUIT BREAKER? A) TO AVOID EXCESSIVE WEAR ON THE ELECTRIC MOTOR.
B) ADAPT THE CIRCUIT BREAKER TO DIFFERENT MOTOR LOADS.
C) CONTROL THE ROTATION SPEED OF THE ELECTRIC MOTOR.
D) REDUCE THE VOLTAGE SUPPLIED TO THE MOTOR DURING ITS OPERATION.

22) WHAT DOES THE TERM "ON DELAY" MEAN IN A TIMER? A) REFERS TO THE DELAY IN DE-ENERGIZING THE DEVICE.
B) INDICATES THAT THE TIMER IS ACTIVATED IMMEDIATELY AFTER BEING ENERGIZED.
C) MEANS THAT THE TIMER DELAYS ACTIVATION AFTER BEING ENERGIZED.
D) REPRESENTS THE TIMER'S ABILITY TO COUNT THE ELAPSED TIME.

23) WHAT IS THE ADVANTAGE OF USING AN ON DELAY TIMER IN AN AUTOMATED SYSTEM?

A) ALLOWS PRECISE CONTROL OF THE OPERATING TIME OF DEVICES AFTER THEIR ENERGIZING.

B) HELPS REDUCE ELECTRICITY CONSUMPTION IN DEVICES.
C) PREVENTS ELECTRICAL OVERLOAD IN THE SYSTEM CIRCUITS.
D) GUARANTEES A CONSTANT ROTATION SPEED IN ELECTRIC MOTORS.

24) WHAT IS A PHASE FAILURE RELAY? A) A DEVICE THAT PROTECTS AGAINST OVERCURRENT IN AN ELECTRICAL CIRCUIT. B) A COMPONENT USED TO MEASURE THE ELECTRICAL POWER CONSUMED BY A DEVICE. C) A DEVICE USED TO DETECT THE ABSENCE OF ONE OR MORE PHASES IN A THREE-PHASE ELECTRICAL SYSTEM. D) A RELAY THAT CONTROLS THE ROTATION SPEED OF ELECTRIC MOTORS. 25) WHAT IS THE IMPORTANCE OF A PHASE SEQUENCE RELAY IN A MOTOR STARTER? A) TO PREVENT OVERHEATING OF ELECTRICAL DEVICES. B) TO PROTECT MOTORS AGAINST ELECTRICAL OVERLOAD. C) ENSURE THAT THE PHASES ARE CORRECTLY CONNECTED IN THE THREE-PHASE SYSTEM. D) CONTROL THE POWER SUPPLIED TO THE DEVICES OF THE ELECTRICAL SYSTEM. 26) WHAT IS THE MAIN FUNCTION OF A SIGNAL LIGHT IN AN ELECTRICAL SYSTEM? A) CONTROL THE ROTATION SPEED OF ELECTRIC MOTORS. B) VISUALLY SIGNAL THE STATUS OR CONDITION OF A PROCESS OR EQUIPMENT. C) MEASURE THE ELECTRICAL POWER CONSUMED BY SPECIFIC DEVICES. D) PROTECT THE SYSTEM AGAINST ELECTRICAL OVERLOADS. 27) WHAT ARE THE TYPICAL COLORS USED IN SIGNALS TO INDICATE DIFFERENT STATES OR CONDITIONS? A) RED, YELLOW AND GREEN. B) BLUE, ORANGE AND PINK. C) BLACK, BROWN AND WHITE. D) GRAY, PURPLE AND GOLD.

28) WHAT ARE THE MAIN TYPES OF SIGNALS FOUND IN ELECTRICAL SYSTEMS? A) LIGHT SIGNALS AND SOUND SIGNALS. B) HIGH POWER SIGNALS AND LOW POWER SIGNALS. C) ANALOG SIGNALS AND DIGITAL SIGNALS. D) INDUSTRIAL SIGNALS AND RESIDENTIAL SIGNALS. 29) IN WHAT TYPE OF SITUATION ARE PUSHBUTTONS COMMONLY USED? A) TO CONTROL TEMPERATURE IN REFRIGERATION SYSTEMS. B) TO REGULATE THE VOLTAGE SUPPLIED TO ELECTRONIC DEVICES. C) TO START AND TURN OFF ELECTRIC MOTORS. D) TO MEASURE THE ELECTRIC CURRENT CONSUMED BY AUXILIARY DEVICES. 30) WHAT IS THE MAIN FUNCTION OF A LIMIT SWITCH IN AN INDUSTRIAL SYSTEM? A) TO CONTROL THE TEMPERATURE IN A WORK ENVIRONMENT. B) TO REGULATE THE VOLTAGE SUPPLIED TO ELECTRIC MOTORS. C) TO PROTECT THE SYSTEM AGAINST ELECTRICAL OVERLOADS. D) TO DETECT AND SIGNAL THE FINAL POSITION OF MECHANICAL COMPONENTS. 31) WHAT IS THE DIFFERENCE BETWEEN A NO (NORMALLY OPEN) CONTACT AND A NC (NORMALLY CLOSED) CONTACT IN AN ELECTRICAL DEVICE? A) A NO CONTACT IS ALWAYS OPEN WHEN THE DEVICE IS AT REST, WHILE AN NC CONTACT IS ALWAYS CLOSED. B) A NO CONTACT IS ALWAYS CLOSED WHEN THE DEVICE IS AT REST, WHILE AN NC CONTACT IS ALWAYS OPEN. C) A NO CONTACT IS ACTIVATED AND CLOSES THE CIRCUIT WHEN THE DEVICE IS ACTIVATED, WHILE AN NC CONTACT IS ACTIVATED AND OPENS THE CIRCUIT WHEN THE DEVICE IS ACTIVATED. D) A NO CONTACT IS ACTIVATED AND OPENS THE CIRCUIT WHEN THE DEVICE IS ACTIVATED, WHILE AN NC CONTACT IS ACTIVATED AND CLOSES THE CIRCUIT WHEN THE DEVICE IS ACTIVATED.

32) WHAT IS THE WORKING PRINCIPLE OF AN ELECTRIC FLOAT? A) THE FLOAT FLOATS IN THE LIQUID AND, WHEN IT REACHES A CERTAIN LEVEL, IT ACTIVATES AN ELECTRIC SWITCH. B) THE FLOAT SINKS IN THE LIQUID AND, WHEN IT REACHES A CERTAIN LEVEL, IT RELEASES AN ELECTRIC CURRENT. C) THE FLOAT CHANGES THE TEMPERATURE OF THE LIQUID, THUS INDICATING THE LEVEL. D) THE FLOAT REGULATES THE PRESSURE OF THE LIQUID TO MAINTAIN THE DESIRED LEVEL. 33) IN ADDITION TO ACTIVATING AN ELECTRIC SWITCH, WHAT IS THE MAIN PURPOSE OF AN ELECTRIC FLOAT IN A LEVEL CONTROL SYSTEM? A) PREVENT EXCESSIVE EVAPORATION OF THE LIQUID. B) PREVENT OVERFLOWING OF THE RESERVOIR. C) REGULATE THE VISCOSITY OF THE LIQUID. D) MEASURE THE DENSITY OF THE LIQUID. 34) WHAT IS THE MAIN PURPOSE OF A TIME PROGRAMMER IN AN ELECTRICAL SYSTEM? A) CONTROL THE POWER SUPPLIED TO ELECTRICAL DEVICES. B) MEASURE THE ELECTRIC CURRENT CONSUMED BY SPECIFIC EQUIPMENT. C) PROTECT THE SYSTEM AGAINST ELECTRICAL OVERLOADS. D) AUTOMATE THE SWITCHING ON AND OFF OF EQUIPMENT ACCORDING TO PRE-PROGRAMMED TIMES. 35) IMAGINE A STREET LIGHTING SYSTEM IN A CITY. HOW CAN A TIME PROGRAMMER BE USED IN THIS CONTEXT? A) TO MEASURE THE AMBIENT TEMPERATURE AND ADJUST THE INTENSITY OF THE LIGHTING. B) TO CONTROL THE VOLTAGE SUPPLIED TO THE LIGHTING POSTS. C) TO AUTOMATE THE SWITCHING ON AND OFF OF THE LIGHTS ACCORDING TO PRE-DETERMINED TIMES. D) TO REGULATE THE FLASHING FREQUENCY OF THE SIGNALING LIGHTS.

36) WHAT ARE THE MAIN COMPONENTS OF A THREE-PHASE INDUCTION MOTOR? A) STATOR, ROTOR AND COMMUTATOR. B) COILS, MAGNETS AND CARBON BRUSHES. C) ROTOR, STATOR AND LAMINATED IRON CORE. D) GEARS, SHAFT AND FRAMES. 37) WHAT ARE THE ADVANTAGES OF A THREE-PHASE INDUCTION MOTOR COMPARED TO A SINGLE-PHASE MOTOR? A) HIGHER ENERGY EFFICIENCY AND HIGHER STARTING TORQUE. B) LOWER ACQUISITION COST AND SMALLER PHYSICAL SIZE. C) LONGER DURABILITY AND LESS MAINTENANCE NEEDS. D) CONSTANT ROTATION SPEED AND LOWER ENERGY CONSUMPTION. 38) IN A THREE-PHASE INDUCTION MOTOR, WHAT IS THE FUNCTION OF THE STATOR AND ROTOR? A) THE STATOR IS RESPONSIBLE FOR CONVERTING MECHANICAL ENERGY INTO ELECTRICAL ENERGY, WHILE THE ROTOR GENERATES THE MAGNETIC FIELD. B) THE STATOR PRODUCES THE ROTATING MAGNETIC FIELD, WHILE THE ROTOR IS RESPONSIBLE FOR RECEIVING THE THREE-PHASE ELECTRIC CURRENT AND ROTATING ACCORDING TO THE MAGNETIC FIELD. C) THE STATOR IS RESPONSIBLE FOR CONTROLLING THE ROTATION SPEED, WHILE THE ROTOR PROVIDES MECHANICAL POWER TO THE SYSTEM. D) THE STATOR GENERATES THE THREE-PHASE ELECTRIC CURRENT, WHILE THE ROTOR IS RESPONSIBLE FOR CONVERTING THE ELECTRIC ENERGY INTO MECHANICAL ENERGY. 39) WHAT ARE THE COMMON TYPES OF CLOSING USED IN THREE-PHASE INDUCTION MOTORS? A) STAR CLOSING AND DRIANGLE CLOSING. B) SEQUENTIAL CLOSING AND PARALLEL CLOSING. C) SERIES CLOSING AND PARALLEL CLOSING. D) DELTA CLOSING AND RECTANGULAR CLOSING.

40) WHAT ARE THE TYPICAL APPLICATIONS OF A SINGLE-PHASE INDUCTION MOTOR? A) FANS, WATER PUMPS AND HOUSEHOLD APPLIANCES. B) LARGE INDUSTRIAL MACHINERY AND AIR CONDITIONING SYSTEMS. C) ELEVATORS, AIR COMPRESSORS AND ELECTRIC GENERATORS. D) AUTOMOTIVE ENGINES AND MARINE PROPULSION SYSTEMS. 41) WHAT ARE THE MAIN CHARACTERISTICS OF A SINGLE-PHASE INDUCTION MOTOR IN RELATION TO TORQUE AND SPEED? A) LOW STARTING TORQUE AND CONSTANT ROTATION SPEED. B) HIGH STARTING TORQUE AND VARIABLE ROTATION SPEED. C) CONSTANT TORQUE AND ROTATION SPEED. D) VARIABLE TORQUE AND ROTATION SPEED ACCORDING TO THE LOAD. 42) WHAT IS THE MAIN METHOD USED TO START A SINGLE-PHASE INDUCTION MOTOR? A) REVERSAL OF POLARITY OF THE STATOR COILS. B) USE OF A STARTING CAPACITOR. C) APPLICATION OF AN EXTERNAL MAGNETIC FIELD. D) GRADUAL INCREASE IN THE SUPPLY VOLTAGE. 43) WHAT ARE THE MAIN CHARACTERISTICS OF A SINGLE-PHASE INDUCTION MOTOR IN RELATION TO TORQUE AND SPEED? A) LOW STARTING TORQUE AND CONSTANT ROTATION SPEED. B) HIGH STARTING TORQUE AND VARIABLE ROTATION SPEED. C) CONSTANT TORQUE AND ROTATION SPEED. D) VARIABLE TORQUE AND ROTATION SPEED ACCORDING TO THE LOAD. 44) HOW IS THE ROTATION REVERSAL OF A THREE-PHASE MOTOR PERFORMED? A) BY CHANGING THE PHASE SEQUENCE OF THE MOTOR SUPPLY. B) ADJUSTING THE ROTATION SPEED USING A FREQUENCY VARIATOR. C) REPLACING THE MOTOR COMPONENTS FOR THE OPPOSITE DIRECTION OF ROTATION. D) CHANGING THE POLARITY OF THE MOTOR ROTOR.

45) WHAT ARE THE CONSEQUENCES OF AN INCORRECT REVERSAL OF ROTATION IN A THREE-PHASE MOTOR? A) REDUCED STARTING TORQUE AND INCREASED MOTOR VIBRATION. B) INCREASED ROTATION SPEED AND DECREASED MOTOR POWER. C) MOTOR OVERLOAD AND RISK OF DAMAGE TO CONNECTED EQUIPMENT. D) LOSS OF SYNCHRONISM BETWEEN MOTOR PHASES AND INCREASED ENERGY CONSUMPTION. 46) WHAT ARE THE MAIN ADVANTAGES OF USING A THREE-PHASE NETWORK COMPARED TO A SINGLE-PHASE NETWORK? A) LOWER INSTALLATION COST AND GREATER ENERGY EFFICIENCY. B) MORE STABLE ENERGY SUPPLY AND GREATER LOAD CAPACITY. C) LOWER ENERGY CONSUMPTION AND LESS RISK OF OVERLOAD. D) EASE OF ENERGY DISTRIBUTION AND LESS POWER LOSS. 47) HOW IS A THREE-PHASE NETWORK CONSTITUTED? A) THREE PHASE CONDUCTORS AND ONE NEUTRAL CONDUCTOR. B) TWO PHASE CONDUCTORS AND ONE NEUTRAL CONDUCTOR. C) FOUR PHASE CONDUCTORS AND ONE NEUTRAL CONDUCTOR. D) ONE PHASE CONDUCTOR AND ONE NEUTRAL CONDUCTOR. 48) WHAT ARE THE MAIN PRECAUTIONS TO BE TAKEN WHEN TESTING ELECTRICAL COMPONENTS? A) USE PERSONAL PROTECTIVE EQUIPMENT, ENSURE THAT THE EQUIPMENT IS DISCONNECTED FROM THE POWER SUPPLY BEFORE STARTING TESTING AND FOLLOW THE MANUFACTURER'S INSTRUCTIONS. B) PERFORM TESTS IN HUMID ENVIRONMENTS, AVOID THE USE OF PERSONAL PROTECTIVE EQUIPMENT AND TEST THE COMPONENTS WITH THE POWER SUPPLY CONNECTED. C) IGNORE THE MANUFACTURER'S INSTRUCTIONS, DO NOT USE PERSONAL PROTECTIVE EQUIPMENT AND PERFORM TESTS WITH THE POWER SUPPLY CONNECTED. D) TESTING COMPONENTS AT HIGH VOLTAGE WITHOUT USING PERSONAL PROTECTIVE EQUIPMENT AND IGNORE RECOMMENDED SAFETY PROCEDURES.

49) HOW TO INTERPRET THE RESULT OBTAINED WHEN USING THE CONTINUITY SCALE ON A MULTIMETER WHEN TESTING AN ELECTRICAL COMPONENT? A) IF THE MULTIMETER EMITS AN AUDIBLE SIGNAL OR SHOWS A VALUE CLOSE TO ZERO, IT INDICATES THAT THERE IS CONTINUITY IN THE COMPONENT CIRCUIT. B) IF THE MULTIMETER DOES NOT EMIT ANY SOUND SIGNAL OR SHOWS AN INFINITE VALUE, IT INDICATES THAT THERE IS CONTINUITY IN THE COMPONENT CIRCUIT. C) IF THE MULTIMETER EMITS A BEEP OR SHOWS AN INFINITE VALUE, IT INDICATES THAT THERE IS CONTINUITY IN THE COMPONENT CIRCUIT. D) IF THE MULTIMETER DOES NOT EMIT ANY AUDIBLE SIGNAL OR SHOWS A VALUE CLOSE TO ZERO, IT INDICATES THAT THERE IS CONTINUITY IN THE COMPONENT CIRCUIT. 50) WHICH COMPONENT IS RESPONSIBLE FOR CONNECTING THE MOTOR DIRECTLY TO THE POWER SUPPLY DURING DIRECT STARTING? A) CONTACTOR. B) THERMAL RELAY. C) TIMER. D) CIRCUIT BREAKER. 51) WHAT IS THE MOST COMMONLY USED TYPE OF MOTOR IN DIRECT STARTING? A) DIRECT CURRENT MOTOR. B) SINGLE-PHASE INDUCTION MOTOR. C) THREE-PHASE INDUCTION MOTOR. D) SYNCHRONOUS MOTOR. 52) WHAT ARE THE BASIC COMPONENTS OF A THREE-PHASE MOTOR DIRECT STARTER SYSTEM? A) CIRCUIT BREAKER, OVERLOAD RELAY AND CONTACTORS. B) TIMER, THERMAL RELAY AND CONTACTOR. C) LIMIT SWITCH, PUSH BUTTON AND SIGNAL. D) FUSE, PHASE LACK RELAY AND ELECTRIC FLOAT.

53) WHAT HAPPENS TO THE ELECTRIC CURRENT DURING THE DIRECT STARTING OF A MOTOR? A) THE CURRENT REMAINS CONSTANT THROUGHOUT THE ENTIRE STARTING PROCESS. B) THE CURRENT INCREASES SIGNIFICANTLY DURING STARTING. C) THE CURRENT DECREASES GRADUALLY DURING STARTING. D) THE CURRENT VARIES ACCORDING TO THE MOTOR SPEED. 54) IN THE DIRECT STARTING WITH REVERSAL OF A THREE-PHASE MOTOR, HOW DOES THE DIRECTION OF ROTATION OF THE MOTOR CHANGE? A) BY INVERTING THE POLARITY OF THE MOTOR POWER SUPPLY. B) BY ACTIVATING SPECIFIC CONTACTS THAT CHANGE THE PHASES SEQUENCE. C) BY ADJUSTING THE MOTOR ROTATION SPEED ON THE CONTROL PANEL. D) BY USING A FREQUENCY INVERTER DEVICE. 55) DURING DIRECT STARTING WITH REVERSAL OF A THREE-PHASE MOTOR, HOW IS OVERCURRENT PROTECTION GUARANTEED? A) BY USING AN OVERLOAD RELAY THAT MONITORS THE ELECTRIC CURRENT AND TURNS OFF THE MOTOR IN THE EVENT OF OVERLOAD. B) BY USING FUSES THAT INTERRUPT THE CIRCUIT IN THE EVENT OF OVERCURRENT. C) BY ACTIVATING A THERMAL RELAY THAT MONITORS THE MOTOR TEMPERATURE AND TURNS IT OFF IN THE EVENT OF OVERHEATING. D) BY USING A CIRCUIT BREAKER THAT INTERRUPTS THE CIRCUIT IN THE EVENT OF OVERCURRENT. 56) WHAT IS THE MAIN PURPOSE OF THE STARTING STARTER IN A THREE-PHASE MOTOR? A) TO REDUCE ENERGY CONSUMPTION DURING STARTING. B) TO CONTROL THE MOTOR ROTATION SPEED. C) TO PROVIDE PROTECTION AGAINST ELECTRICAL OVERLOAD. D) TO ALLOW THE MOTOR TO START SOFTLY.

57) WHAT ARE THE STEPS OF THE STAR-DRIANGLE MATCH?

A) STAR DEPARTURE, TRIANGLE DEPARTURE, DIRECT DEPARTURE.
B) DIRECT START, STAR START, TRIANGLE START.
C) TRIANGLE DEPARTURE, STARTER DEPARTURE, DIRECT DEPARTURE.
D) STARTING IN STARTER, STARTING IN TRIANGLE, SHUTDOWN.

58) DURING STARTING STARTING, WHAT IS THE RELATIONSHIP BETWEEN THE STARTING CURRENT AND THE NOMINAL CURRENT OF THE MOTOR?

A) THE STARTING CURRENT IS GREATER THAN THE NOMINAL CURRENT.
B) THE STARTING CURRENT IS EQUAL TO THE NOMINAL CURRENT.
C) THE STARTING CURRENT IS LESS THAN THE NOMINAL CURRENT.
D) THE STARTING CURRENT VARIES ACCORDING TO THE APPLIED VOLTAGE.

59) WHEN IS IT RECOMMENDED TO USE A STARTER-DELTA STARTER IN A THREE-PHASE MOTOR?

A) FOR LOW POWER ENGINES.
B) FOR HIGH POWER ENGINES.
C) FOR ENGINES REQUIRING PRECISE SPEED CONTROL.
D) FOR MOTORS THAT WILL BE STARTED AND STOPPED FREQUENTLY.

60) IN STARTING STARTING, WHAT IS THE RELATIONSHIP BETWEEN THE VOLTAGE APPLIED TO THE MOTOR COILS DURING STARTING IN STARTING AND THE VOLTAGE APPLIED DURING STARTING IN TRIANGLE? A) THE VOLTAGE IS THE SAME IN BOTH STARTING PHASES.
B) THE VOLTAGE IS HIGHER IN THE STARTING IN STARTING IN STARTING IN DRIANGLE.
C) THE VOLTAGE IS LOWER IN THE STARTING IN STARTING IN STARTING IN DRIANGLE.
D) VOLTAGE VARIES ACCORDING TO THE MOTOR STARTING CURRENT.

61) WHAT IS THE MAIN DISADVANTAGE OF THE STAR-DELTA STARTER COMPARED TO THE DIRECT STARTER?

A) HIGHER ENERGY CONSUMPTION DURING THE MATCH.
B) HIGHER COST OF COMPONENTS REQUIRED FOR STARTING.
C) LOWER TORQUE AVAILABLE DURING STARTING.
D) HIGHER RISK OF DAMAGE TO THE MOTOR DUE TO VOLTAGE VARIATIONS.

62) IN A WATER PUMPING SYSTEM IN A TREATMENT PLANT, A THREE-PHASE MOTOR IS USED TO DRIVE THE PUMP. WHAT IS THE MAIN ADVANTAGE OF THE STAR-DELTA STARTER IN THIS APPLICATION?

A) GREATER ENERGY EFFICIENCY DURING THE STARTING.
B) PRECISE CONTROL OF PUMP ROTATION SPEED.
C) REDUCTION OF PUMP MECHANICAL WEAR.
D) PROTECTION AGAINST ELECTRICAL OVERLOAD.

63) IN A COMMERCIAL BUILDING'S AIR CONDITIONING SYSTEM, A THREE-PHASE MOTOR IS USED TO DRIVE A LARGE FAN. WHAT IS THE MAIN DISADVANTAGE OF THE STARTING STARTER IN THIS APPLICATION? A) EXCESSIVE ENERGY CONSUMPTION DURING STARTING.
B) DIFFICULTY IN CONTROLLING FAN SPEED.
C) RISK OF ELECTRICAL OVERLOAD OF THE SYSTEM.
D) REDUCTION OF ENGINE USEFUL LIFE.

64) IN A FOOD PRODUCTION INDUSTRY, A THREE-PHASE MOTOR IS USED TO DRIVE A HIGH-POWER MIXER. WHAT IS THE MAIN PURPOSE OF THE STAR-DELTA STARTER IN THIS APPLICATION? A) REDUCING MOTOR STARTING TIME.
B) PRECISE CONTROL OF MIXER ROTATION SPEED.
C) REDUCING CURRENT DEMAND DURING STARTING.
D) PROTECTION AGAINST ELECTRICAL FAILURES OF THE SYSTEM.

65) WHAT IS THE COMPONENT USED IN A SINGLE-PHASE MOTOR STARTER THAT HAS THE FUNCTION OF CREATING A PHASE DISPLACEMENT BETWEEN THE WINDINGS AND INITIATING THE MOTOR MOVEMENT? A) STARTING CAPACITOR.
B) OVERLOAD RELAY.
C) POWER CONTACTOR.
D) CURRENT TRANSFORMER.

ANSWER KEY

1) C 2) D 3) B 4) B 5) B 6) C 7) A 8) C 9) B 10) A

11) C
12) B
13) B
14) A
15) C
16) C
17) D
18) D
19) A
20) A

21) B
22) C
23) A
24) C
25) C
26) B
27) A
28) A
29) C
30) D

31) C
32) A
33) B
34) D
35) C
36) C
37) A
38) B
39) A
40) A

41) A
42) B
43) A
44) A
45) C
46) B
47) A
48) A
49) A
50) A

51) C
52) A
53) B
54) B
55) A
56) D
57) A
58) C
59) B
60) B

61) C
62) C
63) B
64) C
65) A

LEARNING LEVEL

GOT UP TO 33 QUESTIONS RIGHT (50%) - BEGINNER GOT

33 TO 46 QUESTIONS RIGHT (70%) - INTERMEDIATE GOT

46 TO 59 QUESTIONS RIGHT (90%) - COMPETENT GOT 59

TO 65 QUESTIONS RIGHT (100%) - EXPERT

BONUS

HOW MUCH TO CHARGE FOR A MATCH?

HOW TO CHARGE FOR THE INSTALLATION OF A CONTROL PANEL? EXAMPLE 01

CONSIDERING AN ELECTRICAL CONTROL PANEL WITH DIRECT STARTER FOR A SINGLE THREE-PHASE MOTOR OF 7.5 HP (5.5 KW).

COST OF COMPONENTS: TAKING INTO ACCOUNT QUALITY AND RELIABLE COMPONENTS, THE TOTAL COST OF COMPONENTS CAN BE R$ 1,500.00.

LABOR TIME: THE TIME REQUIRED TO ASSEMBLE AND TEST THE CONTROL PANEL MAY BE 8 HOURS, AND THE TIME TO INSTALL AND MAKE THE ELECTRICAL CONNECTION AT THE APPLICATION SITE MAY BE 6 HOURS, TOTALING 14 HOURS OF WORK. CONSIDERING A LABOR COST OF R$90.00 PER HOUR, THE TOTAL LABOR COST MAY BE (14H X R$90 = R$1,260.00).

PROFIT MARGIN: CONSIDERING A PROFIT MARGIN OF 40% ON THE TOTAL COST (COMPONENTS + LABOR = R$ 1,500 + R$ 1,260 = R$ 2,760), WE WILL HAVE A VALUE OF (R$ 2,760 X 0.4 = R$ 1,056.00)

CALCULATION PER ENGINE: ADDING THE VALUES OF THE COMPONENTS, LABOR AND PROFIT MARGIN, WE WILL HAVE A TOTAL VALUE OF (R$ 1,500 + R$ 1,260 + R$ 1,056 = R$ 3,816.00).

THIS VALUE CAN BE CONSIDERED AS A BASIS FOR CHARGING, BUT IT IS ALSO IMPORTANT TO EVALUATE THE MARKET AND LOCAL COMPETITORS TO SET A FAIR PRICE.

EXAMPLE 02

LET'S ASSUME THAT THE PROJECT IN QUESTION INVOLVES AN ELECTRICAL CONTROL PANEL WITH DIRECT STARTER OF 3 THREE-PHASE MOTORS, EACH WITH A POWER OF 5 HP (3.7 KW), TO DRIVE PUMPS IN A WATER SUPPLY SYSTEM.

COST OF COMPONENTS: TAKING INTO ACCOUNT QUALITY AND RELIABLE COMPONENTS, THE TOTAL COST OF COMPONENTS CAN BE R$ 3,000.00.

LABOR TIME: THE TIME REQUIRED TO ASSEMBLE AND TEST THE CONTROL PANEL MAY BE 10 HOURS, AND THE TIME TO INSTALL AND MAKE THE ELECTRICAL CONNECTION AT THE APPLICATION SITE MAY BE 8 HOURS, TOTALING 18 HOURS OF WORK. CONSIDERING A LABOR COST OF R$80.00 PER HOUR, THE TOTAL LABOR COST MAY BE (18H X R$80 = R$1,440.00).

PROFIT MARGIN: CONSIDERING A PROFIT MARGIN OF 30% ON THE TOTAL COST (COMPONENTS + LABOR = R$ 3,000 + R$ 1,440 = R$ 4,440), WE WILL HAVE A VALUE OF (R$ 4,440 X 0.3 = R$ 1,332.00).

CALCULATION PER ENGINE: TAKING INTO ACCOUNT THAT THERE ARE 3 ENGINES TO BE CONTROLLED, WE CAN DIVIDE THE TOTAL VALUE (COMPONENTS + LABOR + PROFIT MARGIN) BY THE NUMBER OF ENGINES, RESULTING IN A VALUE OF ((R$ 3,000 + R$ 1,440 + R$ 1,332) / 3 = R$ 1,924) PER ENGINE. MULTIPLYING THIS VALUE BY 3 ENGINES, WE WILL HAVE A TOTAL VALUE OF R$ 5,772.

EXAMPLE 03

LET'S ASSUME THAT THE PROJECT IN QUESTION INVOLVES AN ELECTRICAL CONTROL PANEL WITH A STARTER-DELTA STARTER TO DRIVE A 10 HP (7.5 KW) THREE-PHASE MOTOR IN A LOAD LIFTING SYSTEM.

COST OF COMPONENTS: TAKING INTO ACCOUNT QUALITY AND RELIABLE COMPONENTS, THE TOTAL COST OF COMPONENTS CAN BE R$ 2,800.00.

LABOR TIME: THE TIME REQUIRED TO ASSEMBLE AND TEST THE CONTROL PANEL MAY BE 12 HOURS, AND THE TIME TO INSTALL AND MAKE THE ELECTRICAL CONNECTION AT THE APPLICATION SITE MAY BE 8 HOURS, TOTALING 20 HOURS OF WORK. CONSIDERING A LABOR COST OF R$ 100.00 PER HOUR, THE TOTAL LABOR COST MAY BE (20H X R$ 100.00 = R$ 2,000.00).

PROFIT MARGIN: CONSIDERING A PROFIT MARGIN OF 35% ON THE TOTAL COST (COMPONENTS + LABOR = R$ 2,800 + R$ 2,000 = R$ 4,800), WE WILL HAVE A VALUE OF (R$ 4800 X 0.35 = R$ 1,680.00).

CALCULATION PER MOTOR: TAKING INTO ACCOUNT THAT THERE IS ONLY ONE MOTOR TO BE CONTROLLED, WE CAN ADD THE TOTAL VALUE (COMPONENTS + LABOR WORK + PROFIT MARGIN), RESULTING IN A VALUE OF (R$ 2.800 + R$ 2.000 + 1.680 = R$ 6.480,00).

EXAMPLE 04

LET'S SUPPOSE THAT A COMPONENT NEEDS TO BE REPLACED. AN AUXILIARY CONTACT OF A POWER CONTACT OF A CONTROL PANEL.

COMPONENT COST: TAKING INTO ACCOUNT A QUALITY AND RELIABLE AUXILIARY CONTACT, THE TOTAL COST OF THE COMPONENT CAN BE R$ 30.00.

LABOR TIME: THE TIME REQUIRED TO REPLACE THE AUXILIARY CONTACT MAY BE 1 HOUR, CONSIDERING THE DISASSEMBLY AND ASSEMBLY OF THE CONTROL PANEL, REMOVAL OF THE DEFECTIVE CONTACT, INSTALLATION OF THE NEW CONTACT AND CHECKING ITS OPERATION. CONSIDERING A LABOR COST OF R$90.00 PER HOUR, THE TOTAL LABOR COST MAY BE (1H X R$90 = R$90.00).

PROFIT MARGIN: CONSIDERING A PROFIT MARGIN OF 30% ON THE TOTAL COST (COMPONENT + LABOR = R$ 30.00 + R$ 90.00 = 120.OO), WE WILL HAVE A VALUE OF (R$ 120.00 X 0.3 = R$ 36.00.)

FINAL CALCULATION: ADDING THE VALUE OF THE COMPONENT, LABOR AND PROFIT MARGIN, WE WILL HAVE A TOTAL VALUE OF (R$ 30.00 + R$ 90.00 + 36.00 = R$ 156.00).

TOOLS

MAIN TOOLS FOR WORKING WITH CONTROL PANELS AND MOTOR STARTERS

MITER SAW.

SCREWDRIVER

MITER SAW.

STEP DRILL

PLIERS SET (UNIVERSAL, NOSE AND CUTTING)

PP ROPE UNCAPPING

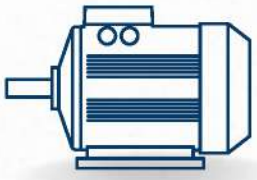
SET OF DRIVERS (SCREWDRIVER AND PHILIPS)

CLAMP METER

STRIPPER PLIERS

GRINDER

CONTROL PANEL



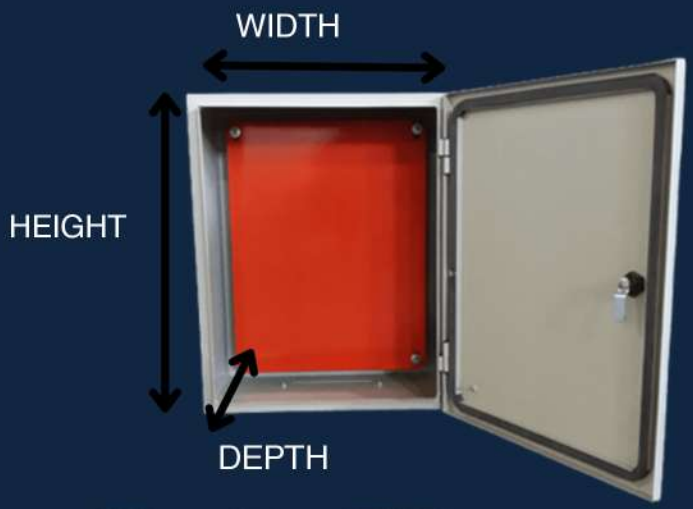
A CONTROL PANEL IS A METAL BOX OR PANEL THAT HOUSES ALL THE CIRCUIT BREAKERS, PUSHBUTTONS, TIMERS, RELAYS, PLCS AND DEVICES USED TO CONTROL A MOTOR STARTER. IT IS IMPORTANT TO NOTE THAT WHILE AN ELECTRICAL PANEL CAN HAVE THE FUNCTION OF BOTH DISTRIBUTING ENERGY AND CONTROLLING A SYSTEM, THE PURPOSE OF THE CONTROL PANEL IS TO COMMAND OR CONTROL THE SYSTEM.

CONTROL PANEL TYPES

METALLIC

PLASTIC

THE ELECTRICAL CONTROL PANEL IS DESIGNED AND USED TO CONTROL MECHANICAL EQUIPMENT, EACH CONTROL PANEL IS DESIGNED FOR A SPECIFIC ARRANGEMENT OF EQUIPMENT AND MAY INCLUDE SPECIFIC DEVICES THAT ALLOW AN OPERATOR TO CONTROL A SPECIFIC EQUIPMENT.



THERE ARE VARIOUS SIZES OF CONTROL

PANELS EX: 60 X 40 X 20 CENTIMETERS

(HEIGHT X WIDTH X DEPTH)

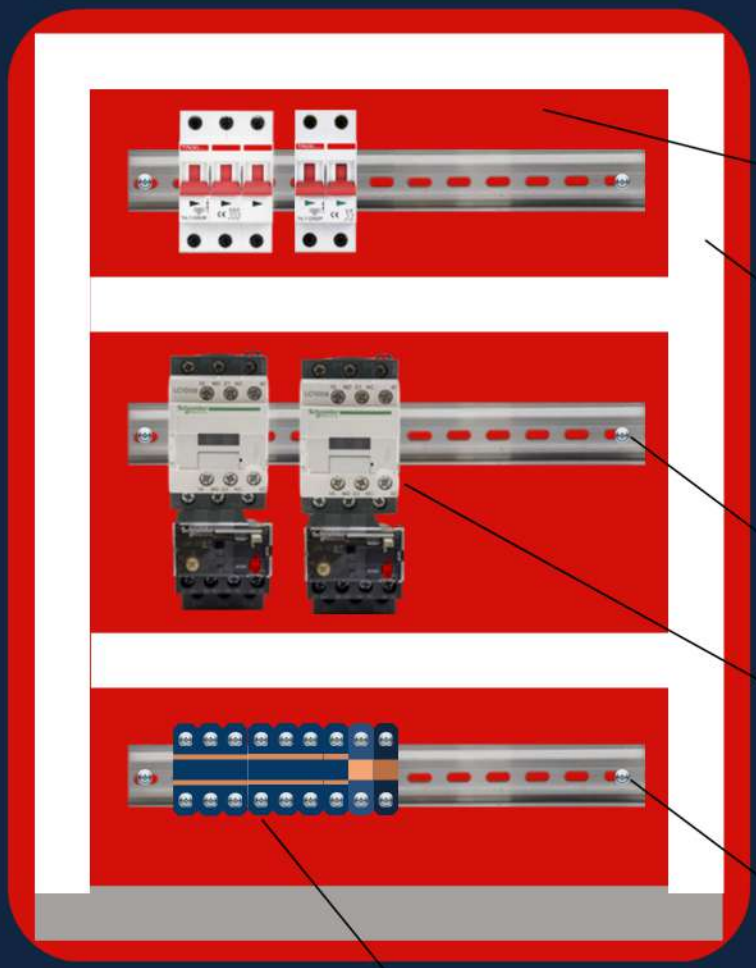
THE SIZE OF THE PANEL WILL DEPEND ON THE NUMBER OF COMPONENTS AND THE CIRCUIT TO BE ASSEMBLED

ELECTRIC CONTROL PANEL

PANEL DOOR

SIGNALERS

BUTTON BUCKLES



CHASSIS

GUTTER

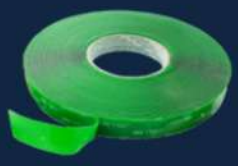
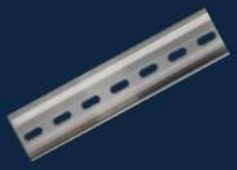
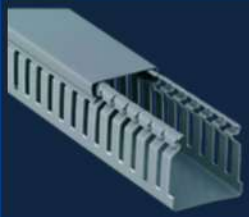
DIM RAIL

ELECTRICAL DEVICES

SCREW DRILL

CONNECTION TERMINALS

ELECTRICAL CONTROL PANEL INFRASTRUCTURE

IMAGE	NOMENCLATURE	FUNCTION
	CONTROL PANEL	RESPONSIBLE FOR PROTECTING ELECTRICAL COMPONENTS AND DEVICES
	DRILLING SCREW	USED TO FIX CHANNELS, RAILS AND DEVICES TO THE CONTROL PANEL CHASSIS
	EXIT DUPLAFACE	RESPONSIBLE FOR GLUING THE GUTTERS AND RAILS, BEFORE SCREWING
	DIM RAIL	RESPONSIBLE FOR SECURING CONTROL DEVICES, SUCH AS: CIRCUIT BREAKERS, CONTACTORS, TERMINALS, ETC.
	GUTTER	RESPONSIBLE FOR ORGANIZING THE ELECTRICAL CABLES WITHIN THE CONTROL PANEL
	CONNECTION TERMINAL	RESPONSIBLE FOR MAKING THE ELECTRICAL INTERCONNECTION BETWEEN THE CABLES ON THE EXTERNAL PART AND THE INTERNAL PART OF THE CONTROL PANEL
	POST OF FINALIZATION	RESPONSIBLE FOR PROVIDING BETTER FIXING OF CONNECTION TERMINALS

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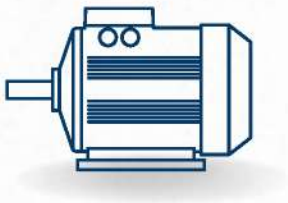

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