ECE471 INDUSTRIAL POWER SYSTEMS

Test # 2, Winter 2004 - 2005

Name_____

Box #_____

Attempt all four questions.
No partial credit unless you explain your solution procedure.
Write in the space below the question, and on the page facing the question.

Open Notes. Time Allowed - Two Periods.

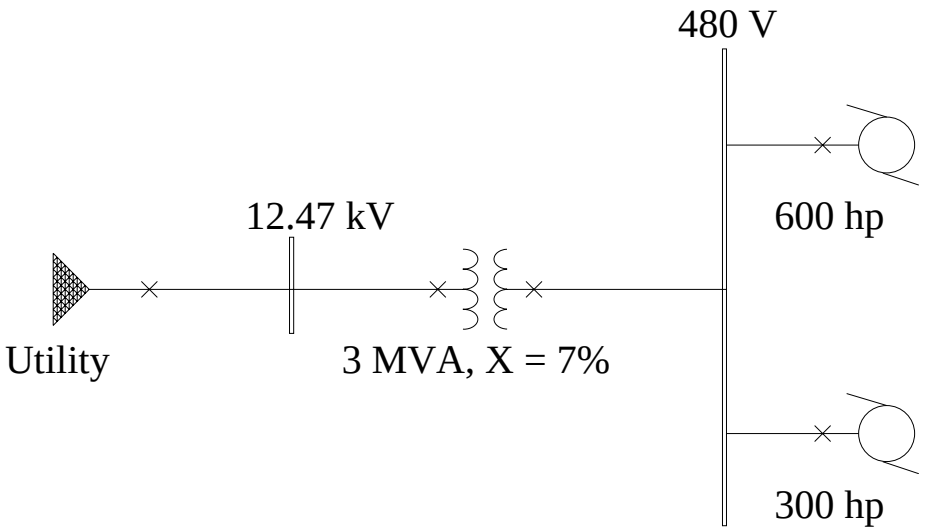
Question #	Possible Points	Awarded Points
1	25	
2	25	
3	25	
4	25	
Total	100	

1.

In the system shown below the utility has a three-phase fault level of 10 kA, the 600 hp motor is 80% efficient and operates at 0.9 lag, while the 300 hp motor is 75% efficient and operates at 0.85 lag. Show the calculations needed to estimate the three-phase fault level at:

a) The 480 V bus.
b) The primary breaker
c) The secondary breaker

Assume the motor contributions are 400% FLA.



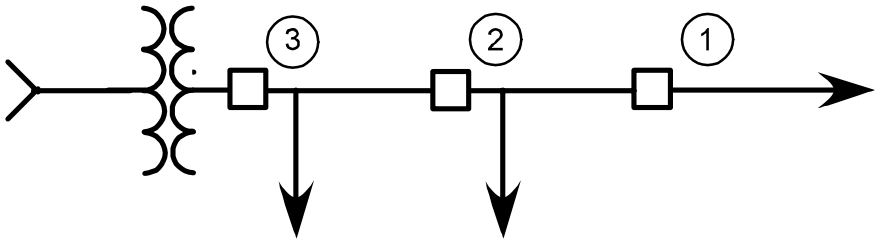
a) 47.67 kA
b) 1.65 kA
c) 43 kA

2.

The 12.47 kV feeders shown below are to be protected using CO-7 inverse-time overcurrent relays. The relays are to pick-up for currents in excess of the maximum continuous ratings of the section lines. Each relay is to allow 0.25 sec co-ordination margin plus 0.1 sec breaker operating time.

a) Select appropriate CT ratios that will make the secondary currents near to 5A.
b) Determine the necessary Current Tap Settings (Pick-up).
c) Determine the appropriate time-dial settings (to nearest 1/2).
d) How long will it take to clear a bolted fault on section 3?

Section 1 - maximum continuous rating = 140 A, fault level = 600 A
Section 2 - maximum continuous rating = 210 A, fault level = 900 A
Section 3 - maximum continuous rating = 340 A, fault level = 1400A



Available CT ratios are: 50:5, 100:5, 150:5, 200:5, 250:5, 300:5, 400:5, 450:5, and 500:5.

Be sure to mark the points you are reading on the graph.

a) $CTR_1 = 150 : 5$ $CTR_2 = 200 : 5$ $CTR_3 = 300 : 5$

b) $CTS_1 = 5$ A $CTS_2 = 6$ A $CTS_3 = 6$ A

c) $TDS_1 = ½$ $TDS_2 = 1$ $TDS_3 = 1½$

d) 0.7 sec

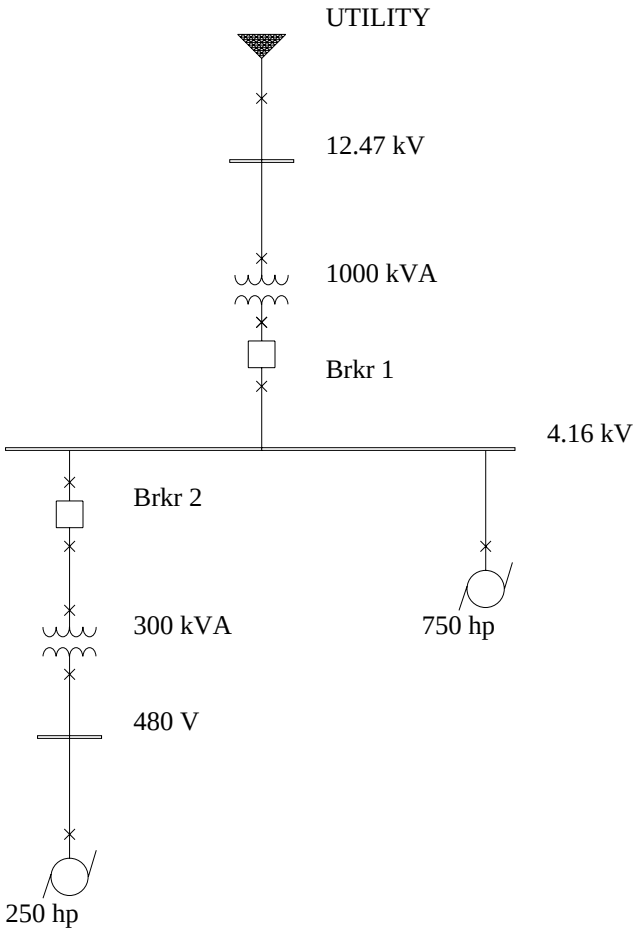
3.

In the system shown below, the utility has a three-phase fault level of 20 kA and a single-phase fault level of 10 kA; for both faults, the X to R ratio is 10. Each transformer has 5% reactance and is oil air (1.15 load factor). The 750 hp motor operates at 90% efficiency and 0.95 lag, while the 250 hp motor operates at 85% efficiency and 0.9 lag.

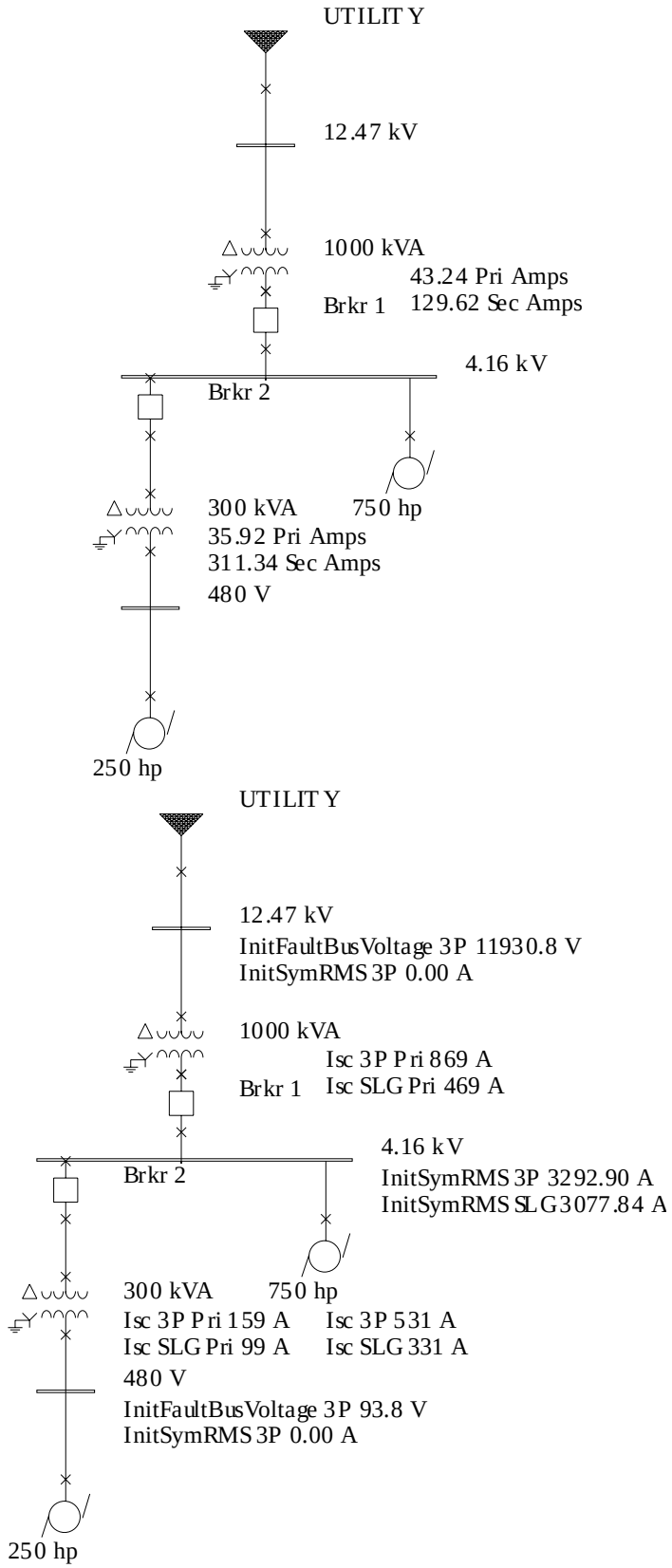
a) Input this into the PTW software, run the load flow and obtain branch currents.

b) Run a fault study for faults at the 4.16 kV bus only and obtain three-phase and single-phase branch and bus currents.

c) Next to Brkr 1 and Brkr 2, write the continuous, three-phase fault and single-phase fault currents.



Q3 Solution


UTILITY
12.47 kV
1000 kVA
43.24 Pri Amps
Brkr 1
129.62 Sec Amps
4.16 kV
Brkr 2
300 kVA
750 hp
35.92 Pri Amps
311.34 Sec Amps
480 V
250 hp
UTILITY
12.47 kV
InitFaultBusVoltage 3P 11930.8 V
InitSymRMS 3P 0.00 A
1000 kVA
Isc 3P Pri 869 A
Brkr 1
Isc SLG Pri 469 A
4.16 kV
Brkr 2
InitSymRMS 3P 3292.90 A
InitSymRMS SLG 3077.84 A
300 kVA
750 hp
Isc 3P Pri 159 A
Isc 3P 531 A
Isc SLG Pri 99 A
Isc SLG 331 A
480 V
InitFaultBusVoltage 3P 93.8 V
InitSymRMS 3P 0.00 A
250 hp

4.

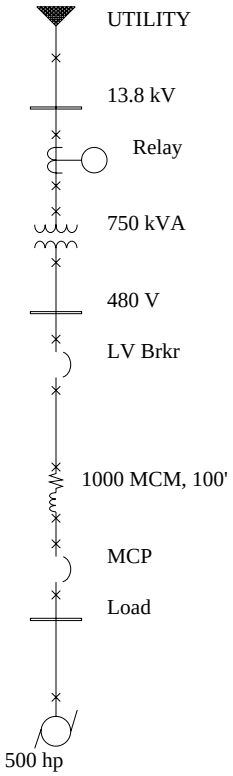
In the system shown below, the utility has a three-phase fault level of 20 kA and a single-phase fault level of 10 kA; for both faults, the X to R ratio is 10. The transformer has 5% reactance and is oil air (1.15 load factor). The 500 hp motor operates at 90% efficiency and 0.9 lag. The conductor is 3 Wire+Ground, 1000 MCM, 100 ft. (select Typical for manufacturer in the library). The MCP is Siemens, Type K Bimetal, Class 10, 0.27 - 180A, set for 300A Full-load. The LV breaker is Cutler-Hammer, CHND, RMS 310, LS, 400 - 1200A, Fixed, with sensor 800 and plug 400. A TCC study was performed on the system from the 500 hp motor up to the LV breaker and the results are shown on the next page.

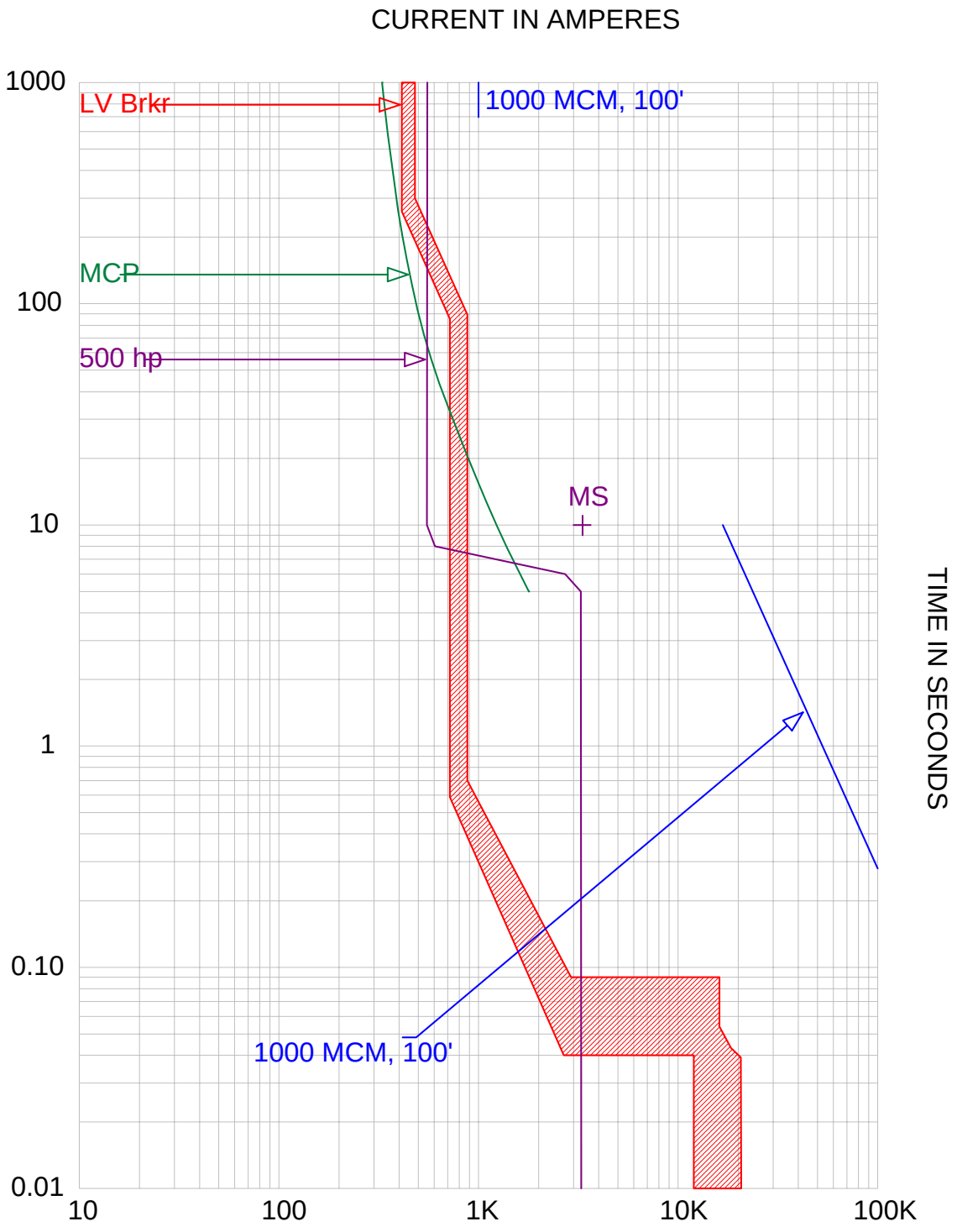
a) List all the things that are wrong with this study.

b) Input the data into the PTW software, run a fault study and then perform the TCC study up to the LV breaker.

c) Adjust the settings to improve the study. It has been suggested that the LV breaker will work better with segments 2, 3 & 4 being LTD (fixed), what other adjustments are needed?

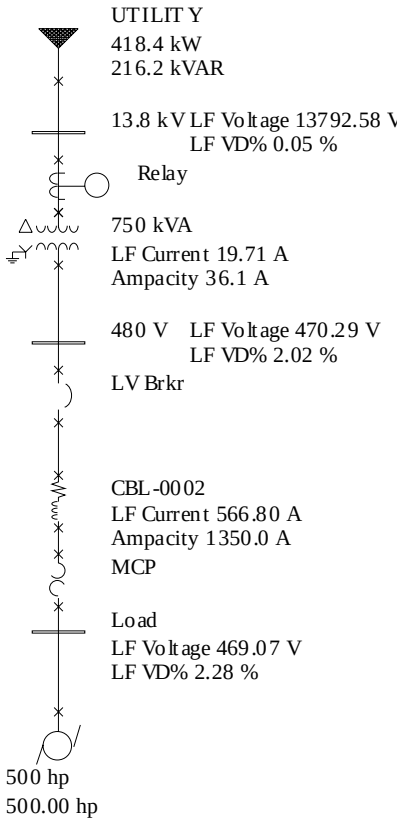
d) Print your final TCC diagram and attach it to your exam.

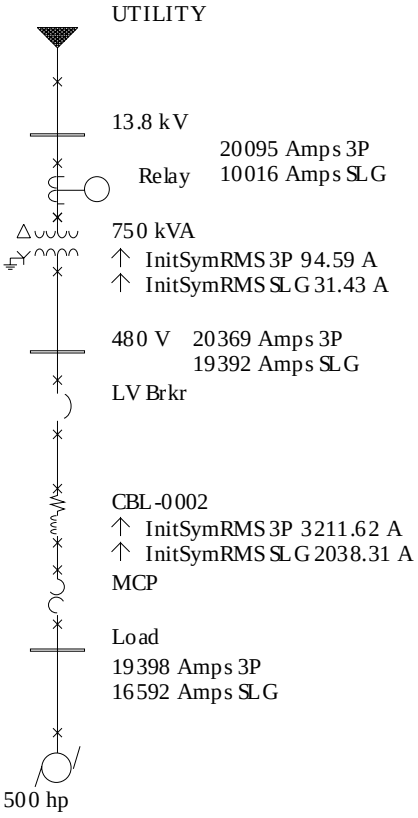


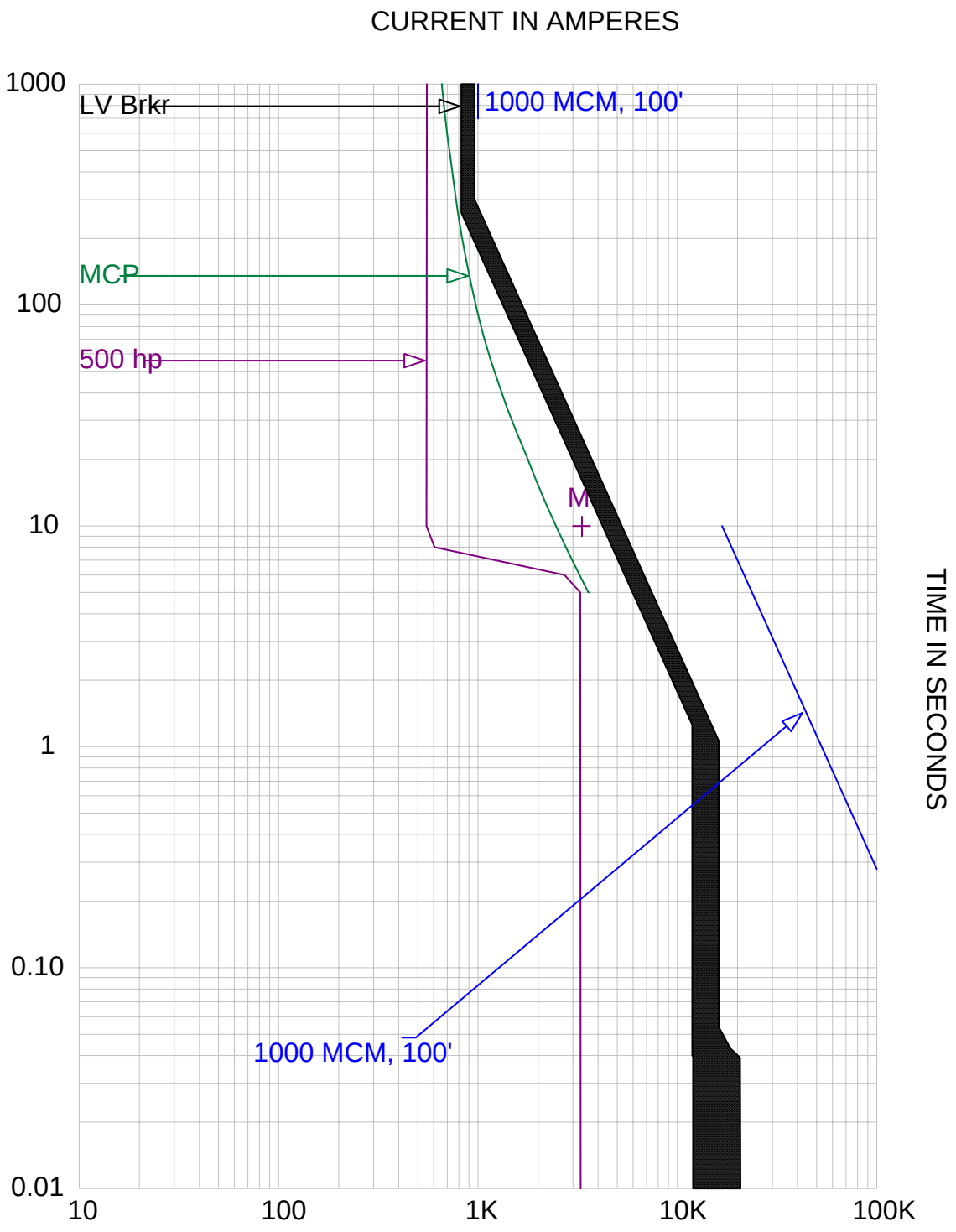


500 to LV.tcc Ref. Voltage: 480 Current Scale x10^0 1Line001.drw

Q4 Solution


UTILITY
418.4 kW
216.2 kVAR
13.8 kV LF Voltage 13792.58 V
LF VD% 0.05 %
Relay
750 kVA
LF Current 19.71 A
Ampacity 36.1 A
480 V LF Voltage 470.29 V
LF VD% 2.02 %
LV Brkr
CBL-0002
LF Current 566.80 A
Ampacity 1350.0 A
MCP
Load
LF Voltage 469.07 V
LF VD% 2.28 %
500 hp
500.00 hp


UTILITY
13.8 kV
20095 Amps 3P
Relay
10016 Amps SLG
750 kVA
InitSymRMS 3P 94.59 A
InitSymRMS SLG 31.43 A
480 V 20369 Amps 3P
19392 Amps SLG
LV Brkr
CBL-0002
InitSymRMS 3P 3211.62 A
InitSymRMS SLG 2038.31 A
MCP
Load
19398 Amps 3P
16592 Amps SLG
500 hp



500 to LV.tcc Ref. Voltage: 480 Current Scale x10^0 1Line001.drw