1501319 Fundamental of Electrical Engineering

Course Description:
Basic DC and AC circuit analysis; voltage; current and power; transformers; introduction to electrical machinery; generators, motors and their uses; concepts of three-phase systems; method of power transmission; Electrical System for Industrial*; Safety Standards*.
(*modified in the framework of an Erasmus + project: Asean Factori 4.0 Across South East Asian Nations: From Automation and Control Training to the Overall Roll-out of Industry 4.0 609854-EPP-1-2019-1-FR-EPPKA2-CBHE-JP)

Learning outcome:
1. Students can discuss the content of electrical engineering.
2. Students can analyze the behavior of electrical components.
3. Students aware of the electrical safety for Industrial.

Lecturer:
Assoc. Prof. Punnarumol Temdee, Ph.D.
Asst. Prof. Roungsan Chaisricharoen, Ph.D.
Asst. Prof. Santichai Wicha, Ph.D.
Lect. Chayapol Kamyod, Ph.D.

Credit: 3(3-0)
Lecture: 45 Hours (9 hours of modified content)

Assessments:

Attendance	10%
HW/CW	20%
Midterm	25%
Final	25%
Project	20%

Lecture (seminar):

Content	Hours
DC and AC circuits	12
Electrical machines	12
Electrical transmission	12
Electrical standard for industrial*	3
Electrical hardware for industrial*	3
Industrial safety standards*	3

(*modified in the framework of an Erasmus + project: Asean Factori 4.0 Across South East Asian Nations: From Automation and Control Training to the Overall Roll-out of Industry 4.0 609854-EPP-1-2019-1-FR-EPPKA2-CBHE-JP)

1501319 Fundamental of Electrical Engineering

Program: Bachelor program in Computer Engineering

Credit: 3(3-0) Lecture: 45 Hours

1st Semester, Academic Year: 2023

Assoc. Prof. Punnarumol Temdee, Ph.D.

Asst. Prof. Roungsan Chaisricharoen, Ph.D.

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FACTORI 4.0 Erasmus +

Co-funded by the Erasmus+ Programme of the European Union

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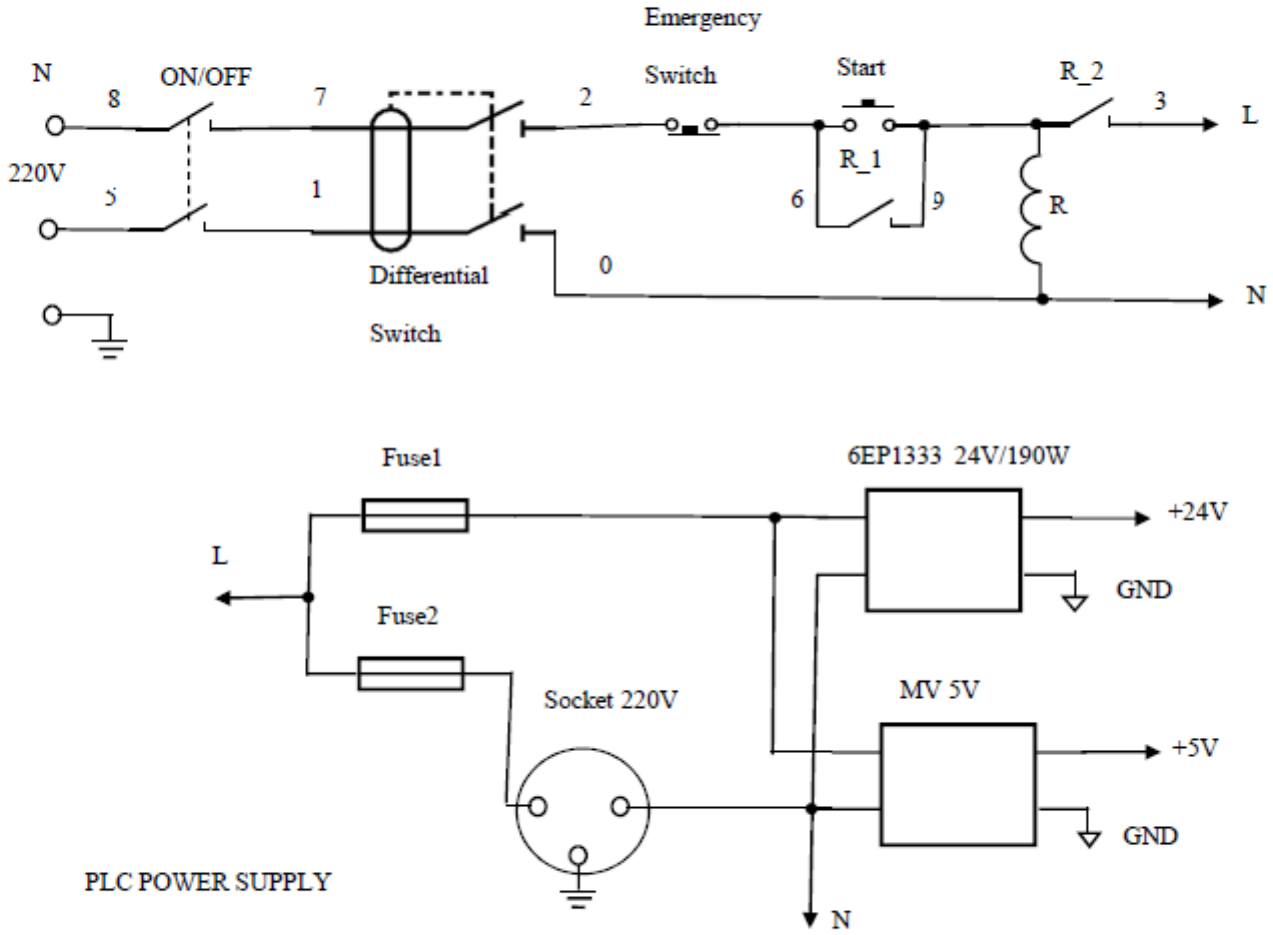
609854-EPP-1-2019-1-FR-EPPKA2-CBHE-JP

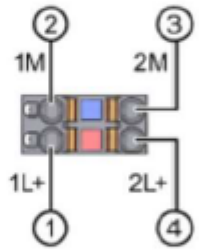
Lecture 01: Electrical standard for industrial

Industrial Grade Power Supply



SIMATIC S7 Power Supply

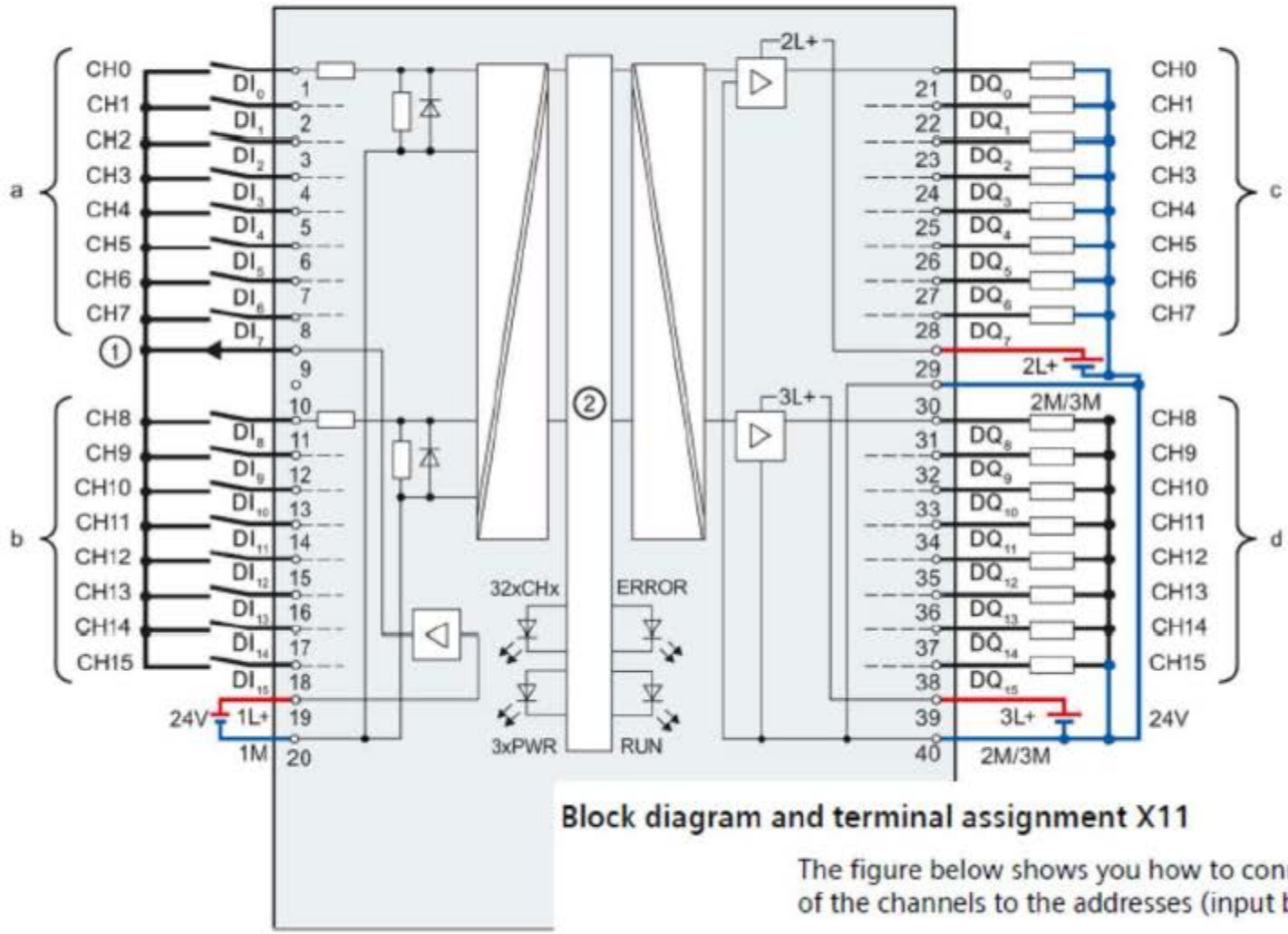
Table 4- 1 Pin assignment 24 V DC supply voltage

View Connector	Signal name [1]		Description
	1	1L+	+ 24 V DC of the supply voltage
	2	1M	Ground of the supply voltage
	3	2M	Ground of the supply voltage for loop-through [2]
	4	2L+	+ 24 V DC of the supply voltage for loop-through [2]

1) 1L+ and 2L+ as well as 1M and 2M are bridged internally

2) Maximum 10 A permitted

X11, X12 Digital I/O

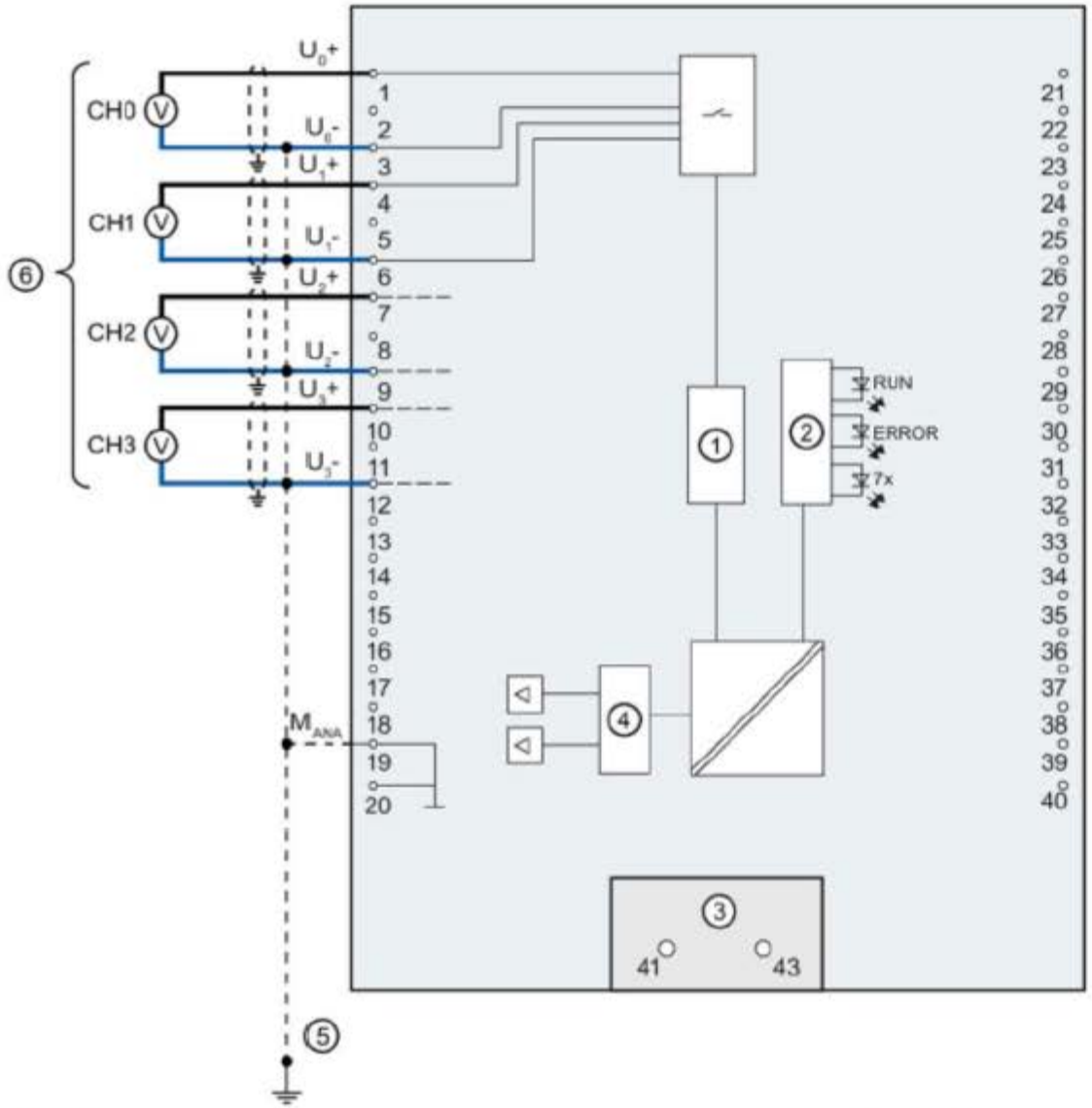


Block diagram and terminal assignment X11

①	Encoder supply for the digital inputs
②	CPU interface
xL+	Connection for 24 V DC supply voltage
xM	Connection for ground
CHx	Channel or channel status LED (green)
RUN	Status display LED (green)
ERROR	Error display LED (red)
PWR	POWER supply voltage LED (green)

The figure below shows you how to connect the digital on-board I/O X11 and the assignment of the channels to the addresses (input byte a and b, output byte c and d).

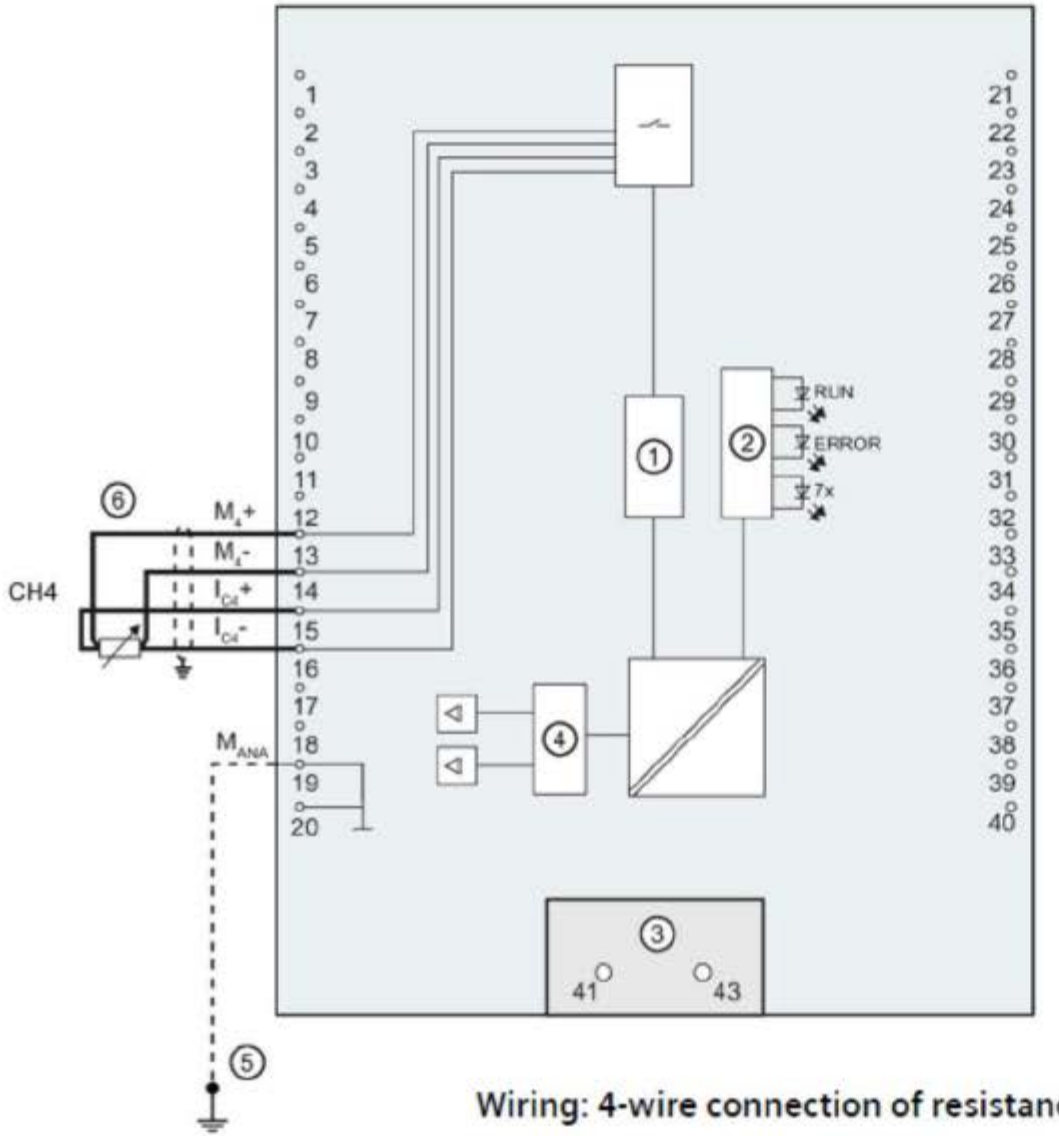
X10 Voltage Measurement (ADC)



Wiring: Voltage measurement

① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ Voltage measurement

X10 4 Wire Connection (ADC)

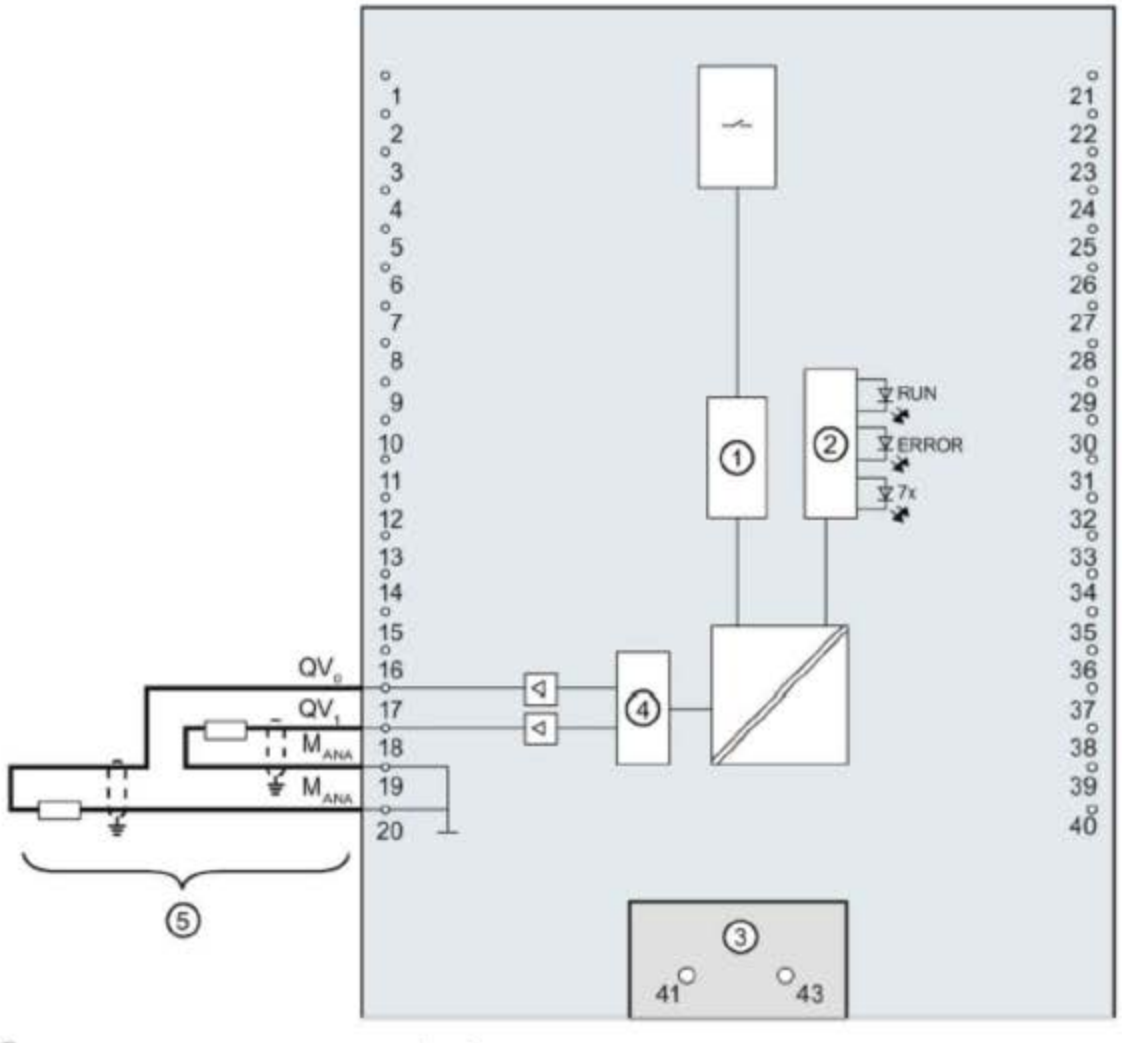


① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Equipotential bonding cable (optional)
⑥ 4-wire connection

This input is for special applications.
Please refer to the technical documentation of the PLC for more information !

Wiring: 4-wire connection of resistance-type sensors or thermal resistors (RTD)

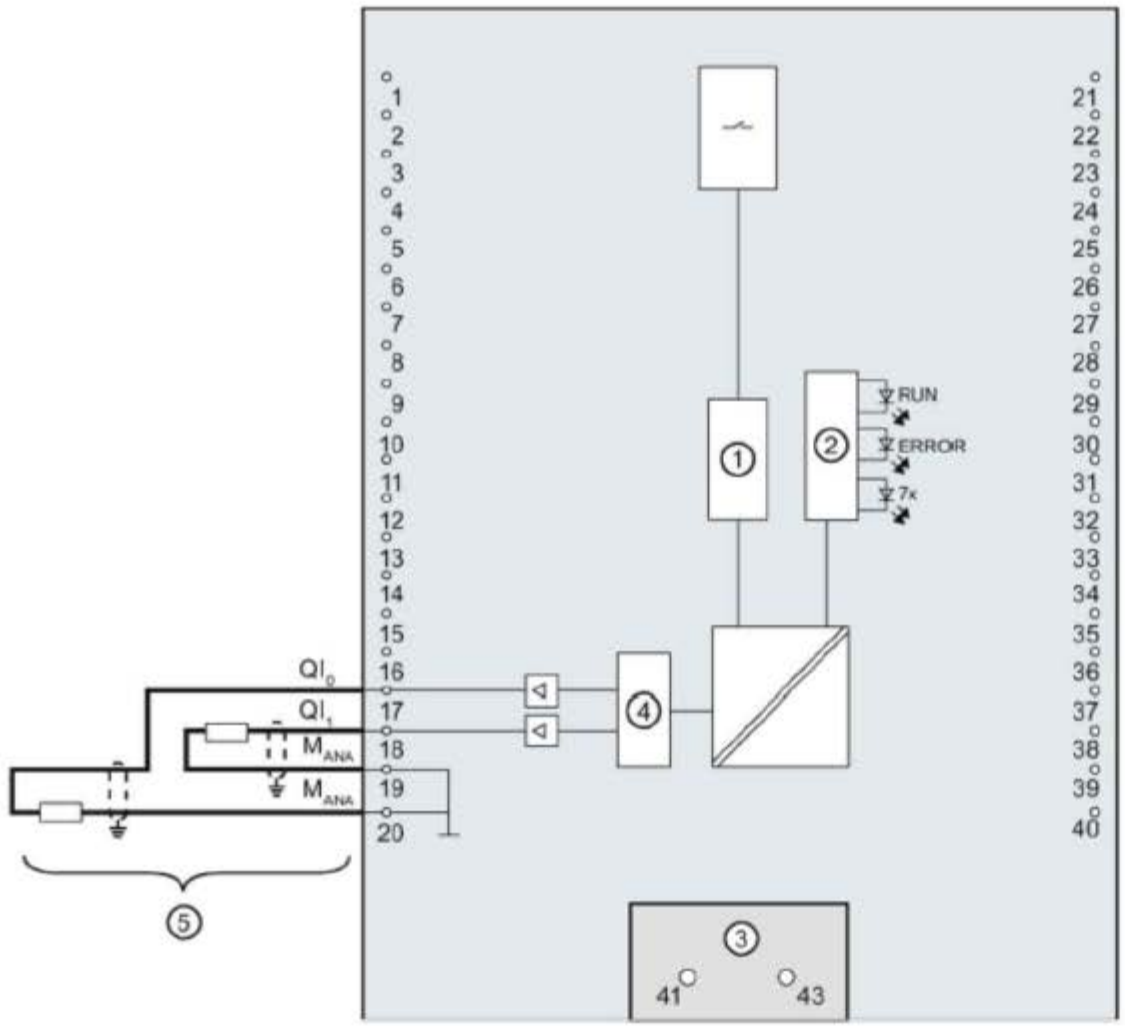
X10 Voltage Output (DAC)



Wiring: Voltage output

① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ 2-wire connection CH0 and CH1

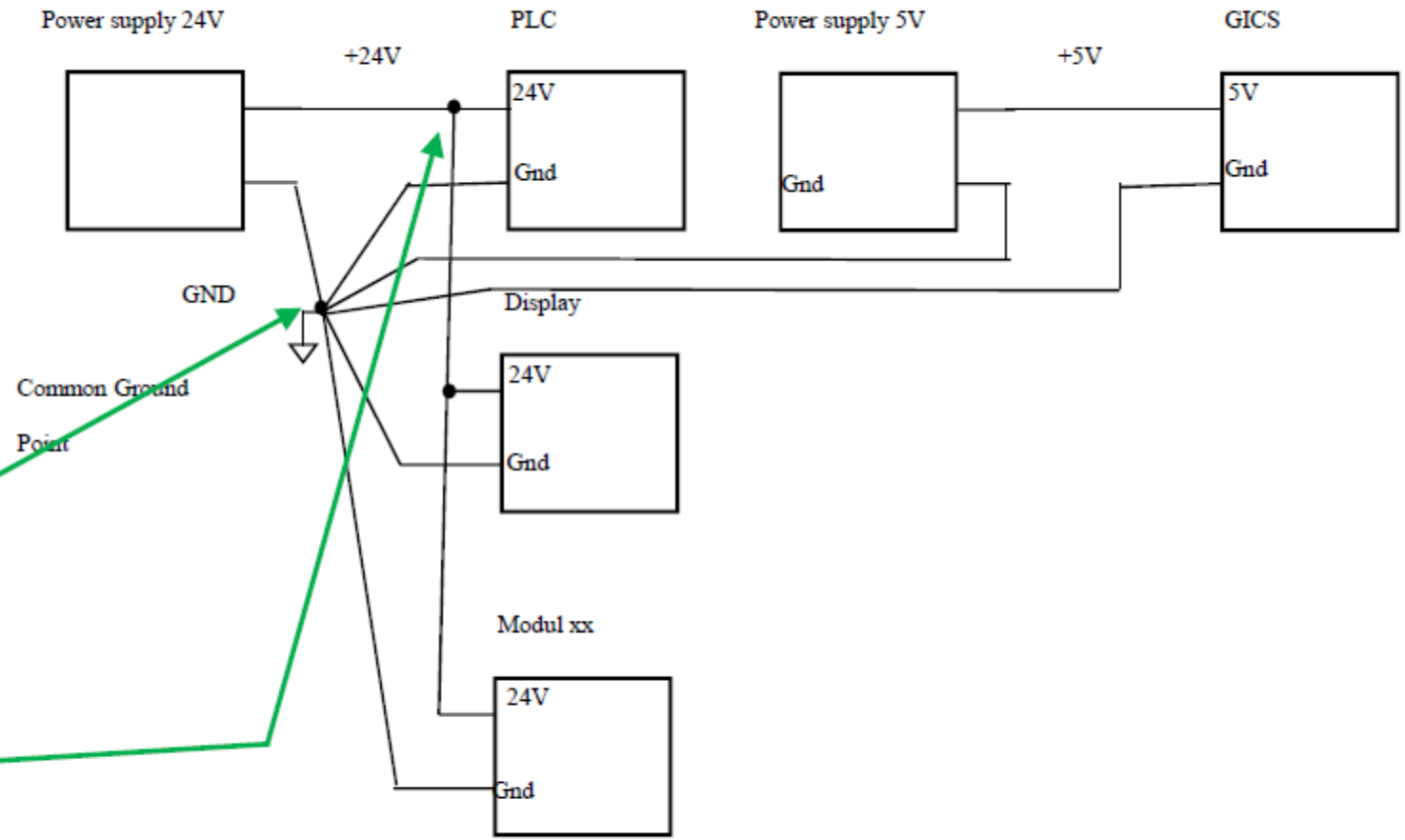
X10 Current Output (DAC)



Wiring: Current output

① Analog-to-digital converter (ADC)
② LED interface
③ Infeed element (for shielding only)
④ Digital-to-analog converter (DAC)
⑤ Current output CH0 and CH1

Electromagnetic Compatibility



IEC 60038	IEC standard voltages
IEC 60051 series	Direct acting indicating analogue electrical measuring instruments and their accessories
IEC 60071-1	Insulation co-ordination - Definitions, principles and rules
IEC 60076-1	Power transformers - General
IEC 60076-2	Power transformers - Temperature rise for liquid immersed transformers
IEC 60076-3	Power transformers - Insulation levels, dielectric tests and external clearances in air
IEC 60076-5	Power transformers - Ability to withstand short-circuit
IEC 60076-7	Power transformers - Loading guide for oil-immersed power transformers
IEC 60076-10	Power transformers - Determination of sound levels
IEC 60076-11	Power transformers - Dry-type transformers
IEC 60076-12	Power transformers - Loading guide for Dry-type power transformers
IEC 60146-1-1	Semiconductor converters - General requirements and line commutated converters - Specifications of basic requirements
IEC 60255-1	Measuring relays and protection equipment - Common requirements
IEC 60269-1	Low-voltage fuses - General requirements

IEC 60269-2	Low-voltage fuses - Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) - Examples of standardized systems of fuses A to K
IEC 60282-1	High-voltage fuses - Current-limiting fuses
IEC 60287-1-1	Electric cables - Calculation of the current rating - Current rating equations (100% load factor) and calculation of losses - General
IEC 60364-1	Low-voltage electrical installations - Fundamental principles, assessment of general characteristics, definitions
IEC 60364-4-41	Low-voltage electrical installations - Protection for safety - Protection against electric shock
IEC 60364-4-42	Low-voltage electrical installations - Protection for safety - Protection against thermal effects
IEC 60364-4-43	Low-voltage electrical installations - Protection for safety - Protection against overcurrent
IEC 60364-4-44	Low-voltage electrical installations - Protection for safety - Protection against voltage disturbances and electromagnetic disturbances
IEC 60364-5-51	Low-voltage electrical installations - Selection and erection of electrical equipment - Common rules
IEC 60364-5-52	Low-voltage electrical installations - Selection and erection of electrical equipment - Wiring systems
IEC 60364-5-53	Low-voltage electrical installations - Selection and erection of electrical equipment - Isolation, switching and control
IEC 60364-5-54	Low-voltage electrical installations - Selection and erection of electrical equipment - Earthing arrangements and protective conductors
IEC 60364-5-55	Low-voltage electrical installations - Selection and erection of electrical equipment - Other equipment

IEC 60364-5-56	Low-voltage electrical installations - Selection and erection of electrical equipment - Safety services
IEC 60364-6	Low-voltage electrical installations - Verification
IEC 60364-7-701	Low-voltage electrical installations - Requirements for special installations or locations - Locations containing a bath or shower
IEC 60364-7-702	Low-voltage electrical installations - Requirements for special installations or locations - Swimming pools and fountains
IEC 60364-7-703	Low-voltage electrical installations - Requirements for special installations or locations - Rooms and cabins containing sauna heaters
IEC 60364-7-704	Low-voltage electrical installations - Requirements for special installations or locations - Construction and demolition site installations
IEC 60364-7-705	Low-voltage electrical installations - Requirements for special installations or locations - Agricultural and horticultural premises
IEC 60364-7-706	Low-voltage electrical installations - Requirements for special installations or locations - Conducting locations with restrictive movement
IEC 60364-7-708	Low-voltage electrical installations - Requirements for special installations or locations - Caravan parks, camping parks and similar locations
IEC 60364-7-709	Low-voltage electrical installations - Requirements for special installations or locations - Marinas and similar locations
IEC 60364-7-710	Low-voltage electrical installations - Requirements for special installations or locations - Medical locations
IEC 60364-7-711	Low-voltage electrical installations - Requirements for special installations or locations - Exhibitions, shows and stands
IEC 60364-7-712	Low-voltage electrical installations - Requirements for special installations or locations - Solar photovoltaic (PV) power supply systems
IEC 60364-7-713	Low-voltage electrical installations - Requirements for special installations or locations - Furniture

IEC 60364-7-714	Low-voltage electrical installations - Requirements for special installations or locations - External lighting installations
IEC 60364-7-715	Low-voltage electrical installations - Requirements for special installations or locations - Extra-low-voltage lighting installations
IEC 60364-7-717	Low-voltage electrical installations - Requirements for special installations or locations - Mobile or transportable units
IEC 60364-7-718	Low-voltage electrical installations - Requirements for special installations or locations - Communal facilities and workplaces
IEC 60364-7-721	Low-voltage electrical installations - Requirements for special installations or locations - Electrical installations in caravans and motor caravans
IEC 60364-7-722	Low-voltage electrical installations - Requirements for special installations or locations - Supplies for electric vehicles
IEC 60364-7-729	Low-voltage electrical installations - Requirements for special installations or locations - Operating or maintenance gangways
IEC 60364-7-740	Low-voltage electrical installations - Requirements for special installations or locations - Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses
IEC 60364-7-753	Low-voltage electrical installations - Requirements for special installations or locations - Heating cables and embedded heating systems
IEC60364-8-1	Low-voltage electrical installations - Energy efficiency
IEC 60445	Basic and safety principles for man-machine interface, marking and identification - Identification of equipment terminals, conductors terminations and conductors
IEC 60479-1	Effects of current on human beings and livestock - General aspects
IEC 60479-2	Effects of current on human beings and livestock - Special aspects
IEC 60479-3	Effects of current on human beings and livestock - Effects of currents passing through the body of livestock
IEC 60529	Degrees of protection provided by enclosures (IP code)
IEC 60644	Specification for high-voltage fuse-links for motor circuit applications

IEC 60715	Dimensions of low-voltage switchgear and controlgear. Standardized mounting on rails for mechanical support of electrical devices in switchgear and controlgear installations.
IEC 60724	Short-circuit temperature limits of electric cables with rated voltages of 1 kV (Um = 1.2 kV) and 3 kV (Um = 3.6 kV)
IEC 60755	General requirements for residual current operated protective devices
IEC 60787	Application guide for the selection of high-voltage current-limiting fuses-link for transformer circuit
IEC 60831-1	Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V - Part 1: General - Performance, testing and rating - Safety requirements - Guide for installation and operation
IEC 60831-2	Shunt power capacitors of the self-healing type for a.c. systems having a rated voltage up to and including 1000 V - Part 2: Ageing test, self-healing test and destruction test
IEC 60947-1	Low-voltage switchgear and controlgear - General rules
IEC 60947-2	Low-voltage switchgear and controlgear - Circuit-breakers
IEC 60947-3	Low-voltage switchgear and controlgear - Switches, disconnectors, switch-disconnectors and fuse-combination units
IEC 60947-4-1	Low-voltage switchgear and controlgear - Contactors and motor-starters - Electromechanical contactors and motor-starters
IEC 60947-6-1	Low-voltage switchgear and controlgear - Multiple function equipment - Transfer switching equipment
IEC 61000 series	Electromagnetic compatibility (EMC)
IEC 61140	Protection against electric shocks - common aspects for installation and equipment
IEC 61201	Use of conventional touch voltage limits – Application guide
IEC/TR 61439-0	Low-voltage switchgear and controlgear assemblies - Guidance to specifying assemblies
IEC 61439-1	Low-voltage switchgear and controlgear assemblies - general rules
IEC 61439-2	Low-voltage switchgear and controlgear assemblies - power switchgear and controlgear assemblies

IEC 61439-3	Low-voltage switchgear and controlgear assemblies - distribution boards intended to be operated by ordinary persons (DBO)
IEC 61439-4	Low-voltage switchgear and controlgear assemblies - Particular requirements for assemblies for construction sites (ACS)
IEC 61439-5	Low-voltage switchgear and controlgear assemblies - Assemblies for power distribution in public networks
IEC 61439-6	Low-voltage switchgear and controlgear assemblies - Busbar trunking systems (busways)
IEC 61557-1	Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - General requirements
IEC 61557-8	Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Insulation monitoring devices for IT systems
IEC 61557-9	Electrical safety in low voltage distribution systems up to 1000 V a.c. and 1500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Equipment for insulation fault location in IT systems
IEC 61557-12	Electrical safety in low voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. - Equipment for testing, measuring or monitoring of protective measures - Performance measuring and monitoring devices (PMD)
IEC 61558-2-6	Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1100 V - Particular requirements and test for safety isolating transformers and power supply units incorporating isolating transformers
IEC 61643-11	Low-voltage surge protective devices - Surge protective devices connected to low-voltage power systems - Requirements and test methods
IEC 61643-12	Low-voltage surge protective devices - Surge protective devices connected to low-voltage power distribution systems - Selection and application principles
IEC 61643-21	Low voltage surge protective devices - Surge protective devices connected to telecommunications and signalling networks - Performance requirements and testing methods
IEC 61643-22	Low-voltage surge protective devices - Surge protective devices connected to telecommunications and signalling networks - Selection and application principles
IEC 61921	Power capacitors - Low-voltage power factor correction banks

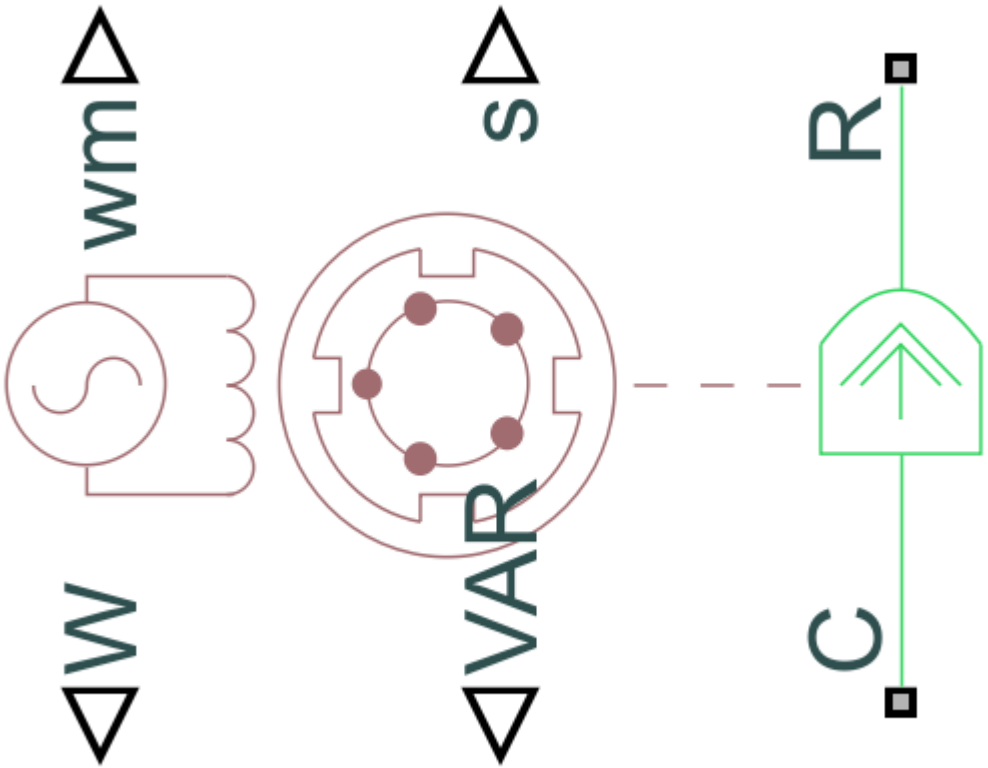
IEC 61936-1	Power installations exceeding 1 kV a.c. - Part 1: Common rules
IEC 62271-1	High-voltage switchgear and controlgear - Common specifications
IEC 62271-100	High-voltage switchgear and controlgear - Alternating-current circuit-breakers
IEC 62271-101	High-voltage switchgear and controlgear - Synthetic testing
IEC 62271-102	High-voltage switchgear and controlgear - Alternating current disconnectors and earthing switches
IEC 62271-103	High-voltage switchgear and controlgear - Switches for rated voltages above 1 kV up to and including 52 kV
IEC 62271-105	High-voltage switchgear and controlgear - Alternating current switch-fuse combinations for rated voltages above 1 kV up to and including 52 kV
IEC 62271-200	High-voltage switchgear and controlgear - Alternating current metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
IEC 62271-202	High-voltage switchgear and controlgear - High-voltage/low voltage prefabricated substations
IEC 62305-1	Protection against lightning - Part 1: General principles
IEC 62305-2	Protection against lightning - Part 2: Risk management
IEC 62305-3	Protection against lightning - Part 3: Physical damage to structures and life hazard
IEC 62305-4	Protection against lightning - Part 4: Electrical and electronic systems within structures
IEC 62586-2	Power quality measurement in power supply systems - Part 2: Functional tests and uncertainty requirements
IEC TS 62749	Assessment of power quality - Characteristics of electricity supplied by public networks

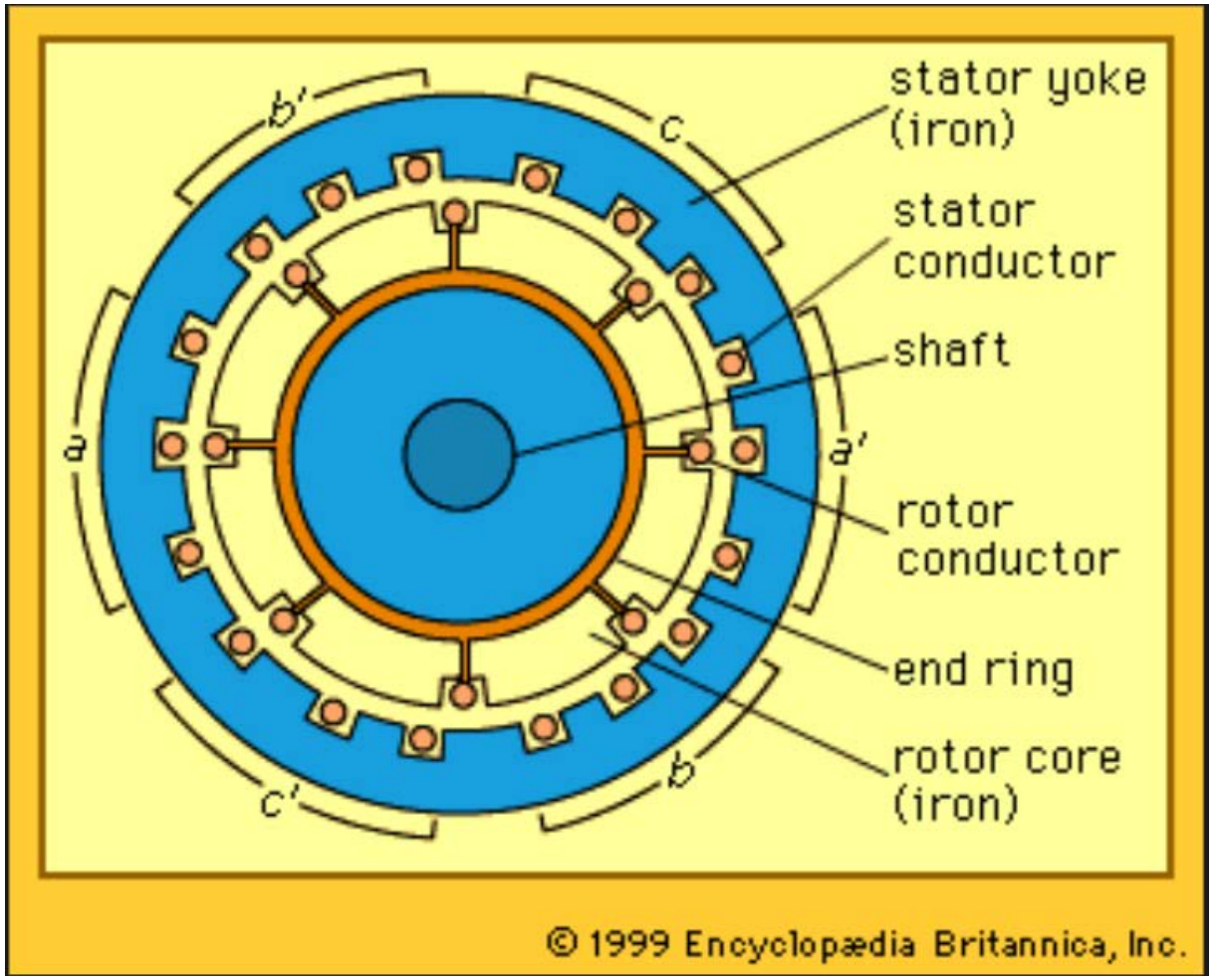
Classwork

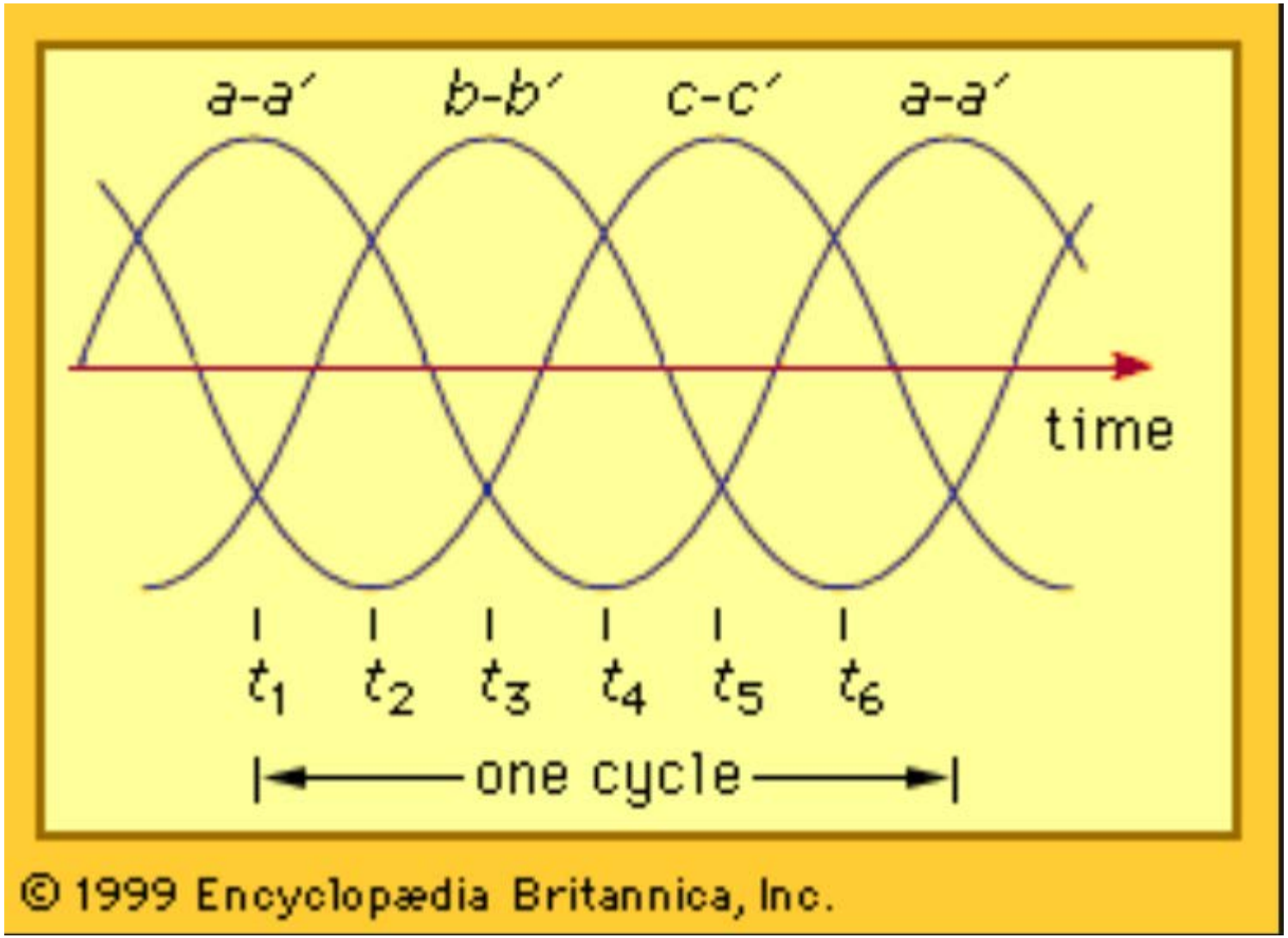
- Select one of the IEC standards
  - Summarize
  - Discuss
  - Provide sample applications

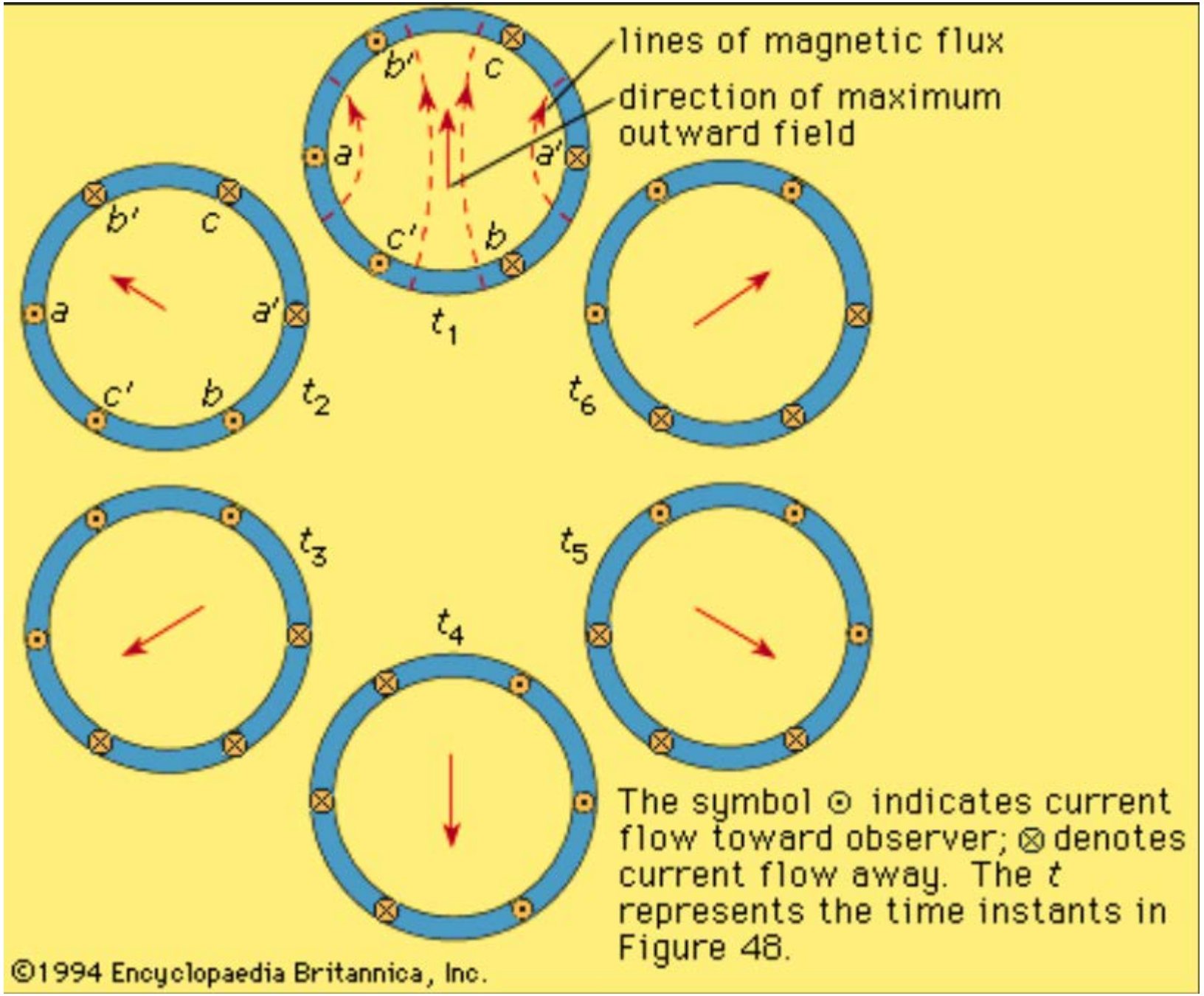
Lecture 02: Electrical hardware for industrial

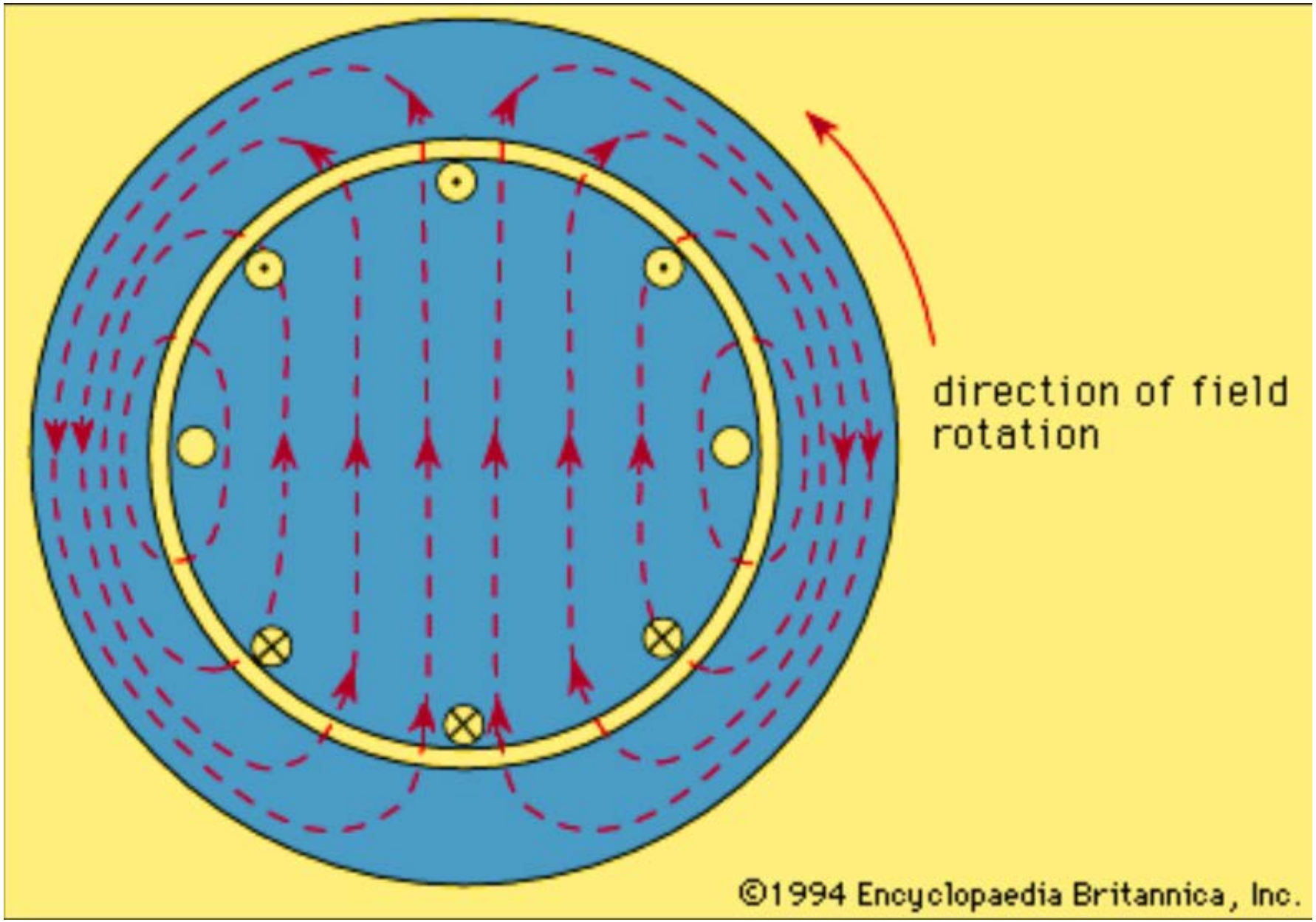
Induction Motor

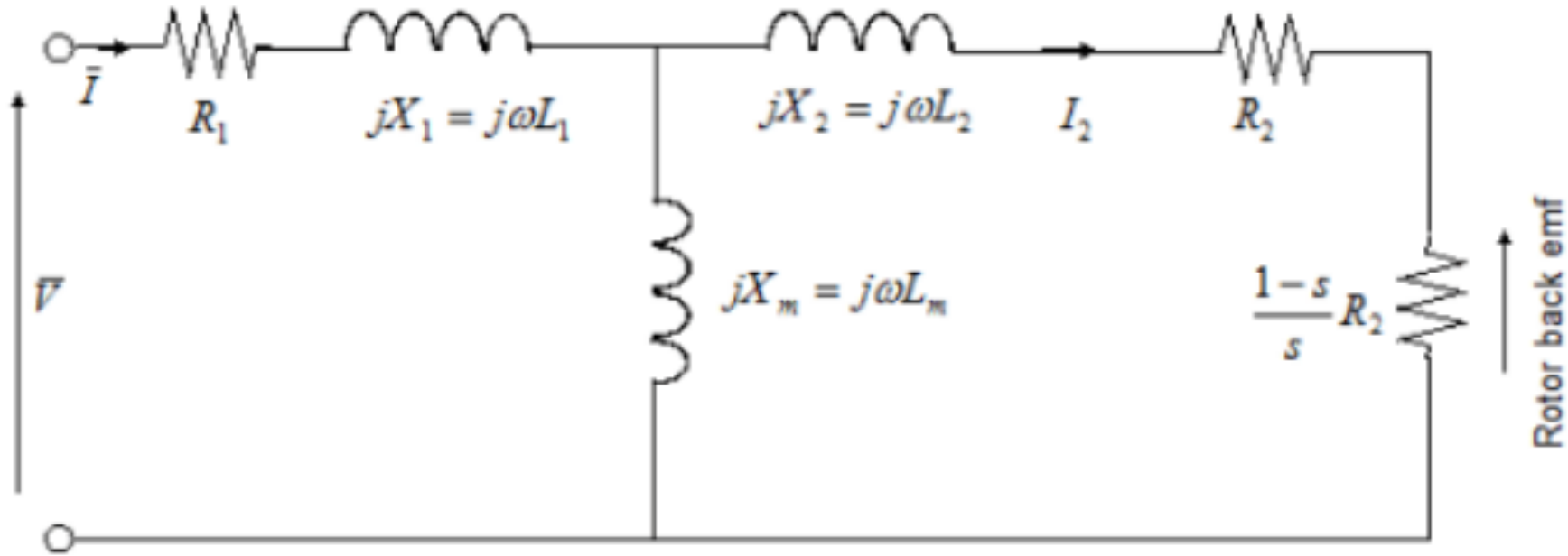







lines of magnetic flux
direction of maximum outward field
b'
c
a
a'
c'
b
t_1
t_2
t_3
t_4
t_5
t_6
The symbol ⊙ indicates current flow toward observer; ⊗ denotes current flow away. The t represents the time instants in Figure 48.
©1994 Encyclopaedia Britannica, Inc.


direction of field
rotation
©1994 Encyclopaedia Britannica, Inc.



In the figure:

- R_1 is the stator resistance.
- R_2 is the rotor resistance with respect to the stator.
- L_1 is the stator inductance.
- L_2 is the rotor inductance with respect to the stator.
- L_m is magnetizing inductance.
- s is the rotor slip.
- $\overline{V}$ and $\overline{I}$ are the sinusoidal supply voltage and current phasors.

Rotor slip s is defined in terms of the mechanical rotational speed ω_m, the number of pole pairs p, and the electrical supply frequency ω by

$$s = 1 - \frac{p\omega_m}{\omega}$$

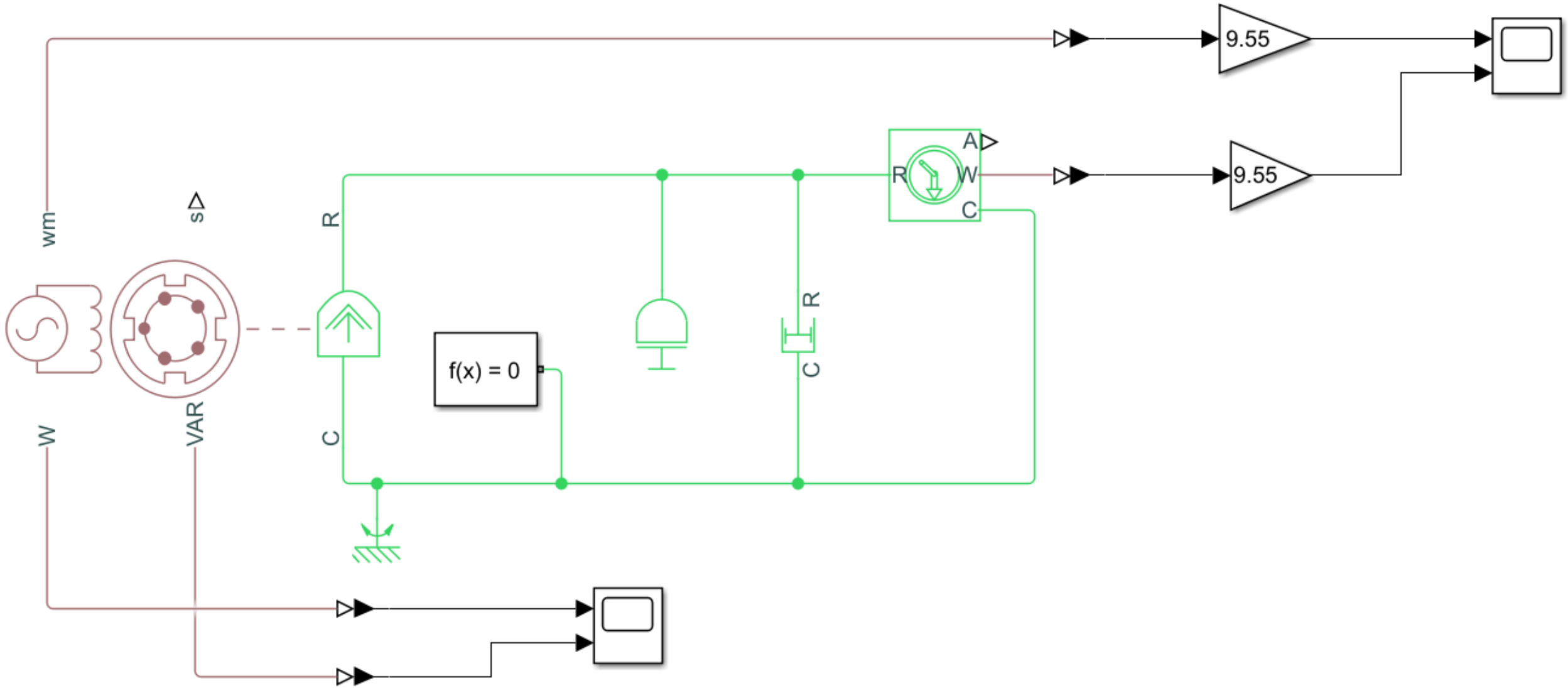
This means that the slip is one when starting, and zero when running synchronously with the supply frequency.

For an n-phase induction motor the torque-speed relationship is given by:

$$T = \frac{npR_2}{s\omega} \frac{{V_{rms}}^2}{\left(R_1 + R_2 + \frac{1-s}{s}R_2\right)^2 + (X_1 + X_2)^2}$$

where:

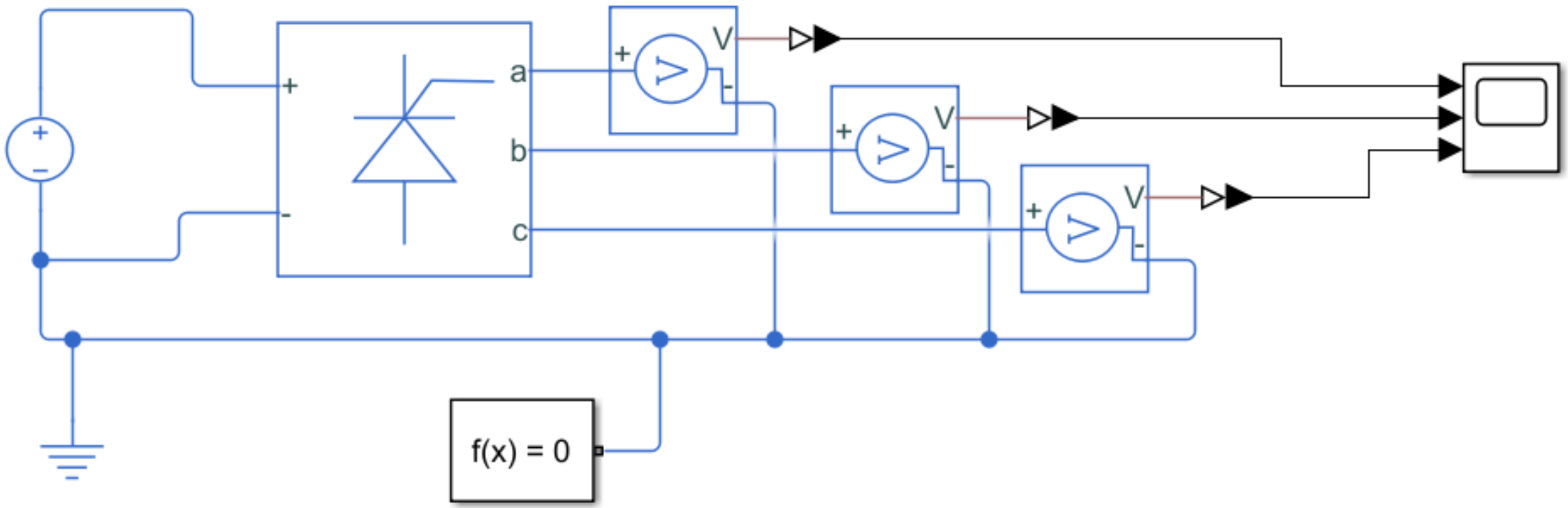
- V_{rms} is the line-neutral supply voltage for a star-configuration induction motor, and the line-to-line voltage for a delta-configuration induction motor.
- n is the number of phases.


wm
s
W
VAR
R
C
f(x) = 0
R
C
A
R
W
C
9.55
9.55

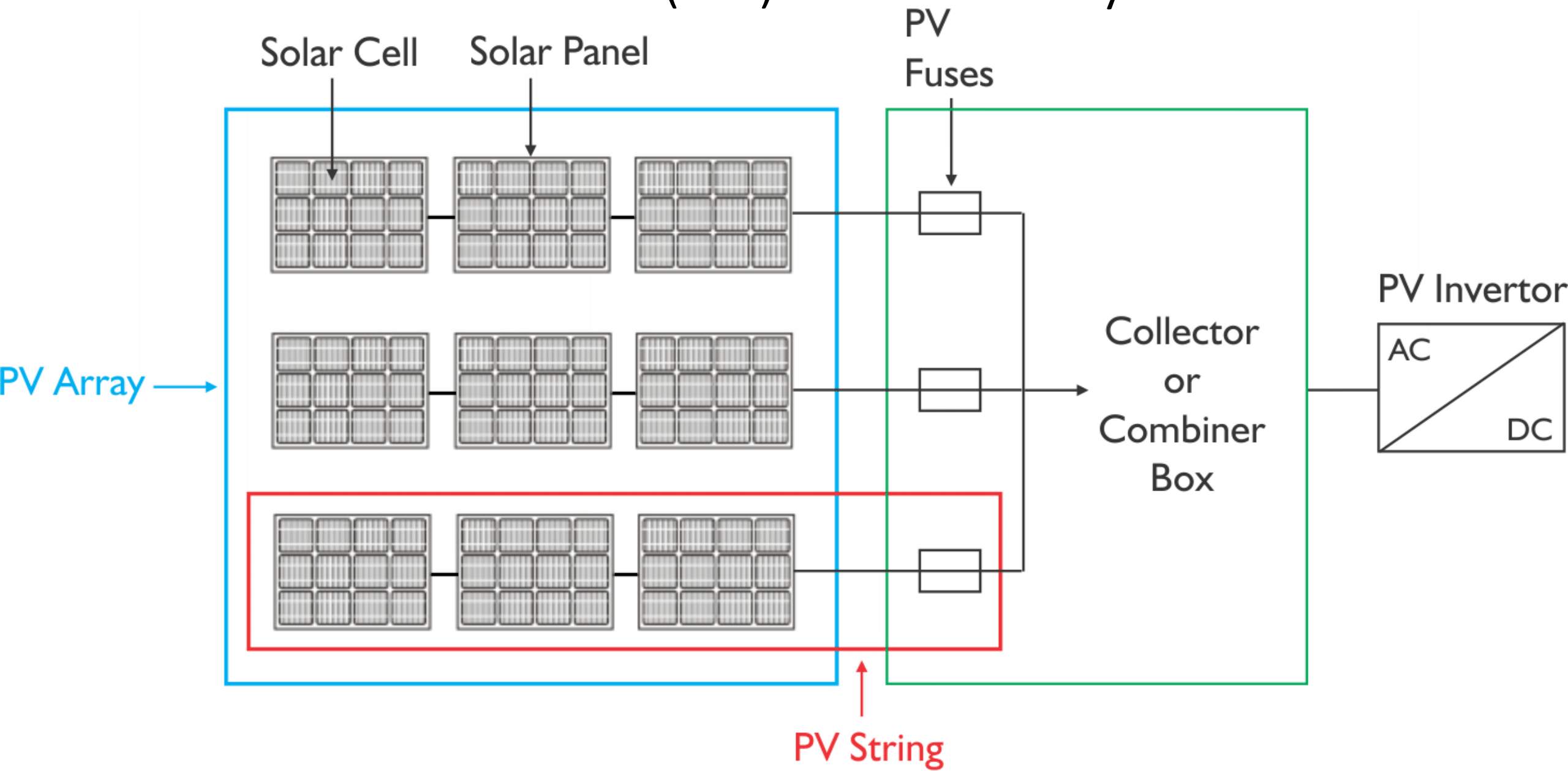
How electric vehicles move

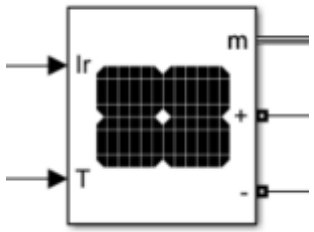
EV's are like an automatic car. They have a forward and reverse mode. When you place the vehicle in gear and press on the accelerator pedal these things happen:

- Power is converted from the DC battery to AC for the electric motor
- The accelerator pedal sends a signal to the controller which adjusts the vehicle's speed by changing the frequency of the AC power from the inverter to the motor
- The motor connects and turns the wheels through a cog
- When the brakes are pressed or the car is decelerating, the motor becomes an alternator and produces power, which is sent back to the battery


+
-
a
b
c
V
f(x) = 0

Solar Photovoltaics (PV) and Battery





Block Parameters: PV Array

PV array (mask) (link)

Implements a PV array built of strings of PV modules connected in parallel. Each string consists of modules connected in series.
Allows modeling of a variety of preset PV modules available from NREL System Advisor Model (Jan. 2014) as well as user-defined PV module.

Input 1 = Sun irradiance, in W/m2, and input 2 = Cell temperature, in deg.C.

Parameters | Advanced

Array data

Parallel strings: 1

Series-connected modules per string: 4

Module data

Module: User-defined

Maximum Power (W): 213.15

Cells per module (Ncell): 60

Open circuit voltage Voc (V): 36.3

Short-circuit current Isc (A): 7.84

Voltage at maximum power point Vmp (V): 29

Current at maximum power point Imp (A): 7.35

Temperature coefficient of Voc (%/deg.C): -0.36099

Temperature coefficient of Isc (%/deg.C): 0.102

Display I-V and P-V characteristics of ...

array @ 1000 W/m2 & specified temperatures

T_cell (deg. C): [45 25]

Plot

Model parameters

Light-generated current IL (A): 7.8654

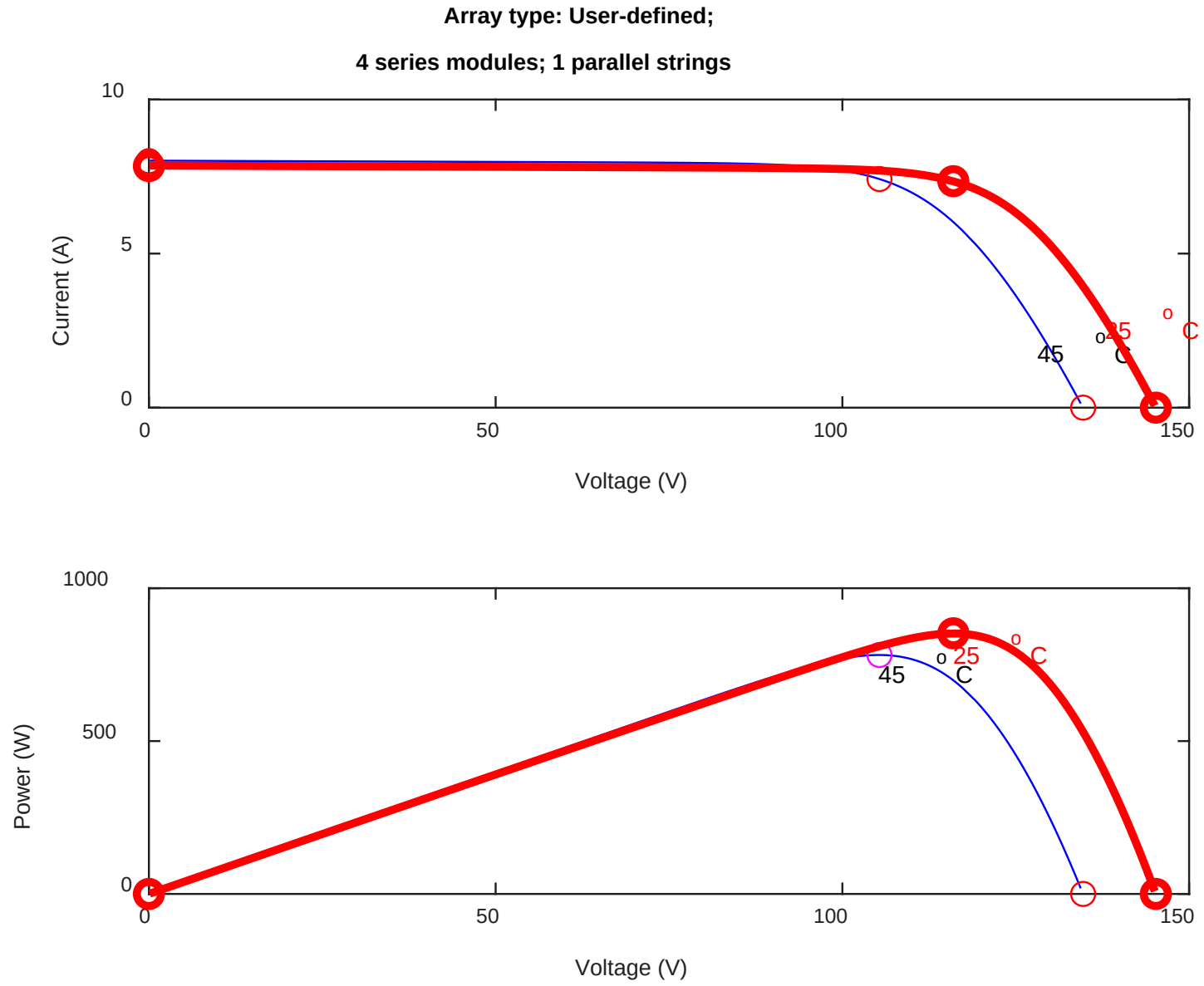
Diode saturation current I0 (A): 2.9273e-10

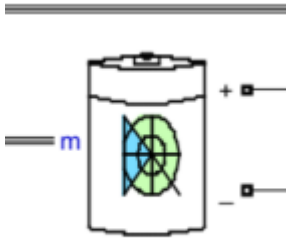
Diode ideality factor: 0.98119

Shunt resistance Rsh (ohms): 313.0553

Series resistance Rs (ohms): 0.39381

OK | Cancel | Help | Apply


Array type: User-defined;
4 series modules; 1 parallel strings
10
5
0
Current (A)
0
50
100
150
Voltage (V)
45
25
C
1000
500
0
Power (W)
0
50
100
150
Voltage (V)
45
25
C



Block Parameters: Battery

Battery (mask) (link)

Implements a generic battery model for most popular battery types. Temperature and aging (due to cycling) effects can be specified for Lithium-Ion battery type.

Parameters | Discharge

Type: Lithium-Ion

Temperature

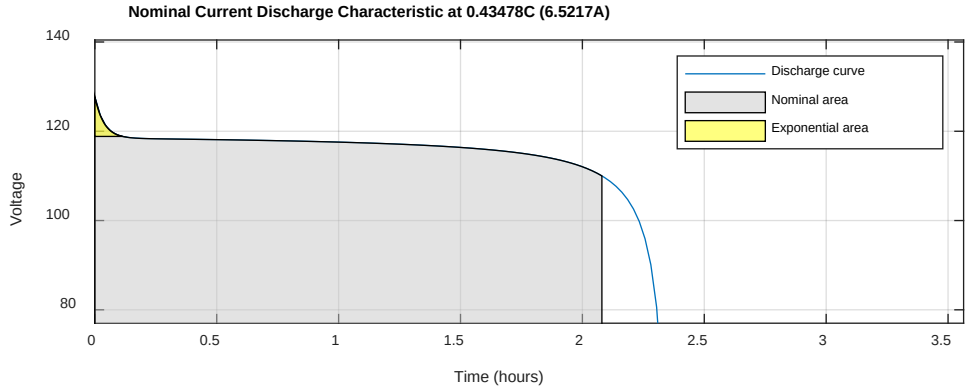
☐ Simulate temperature effects

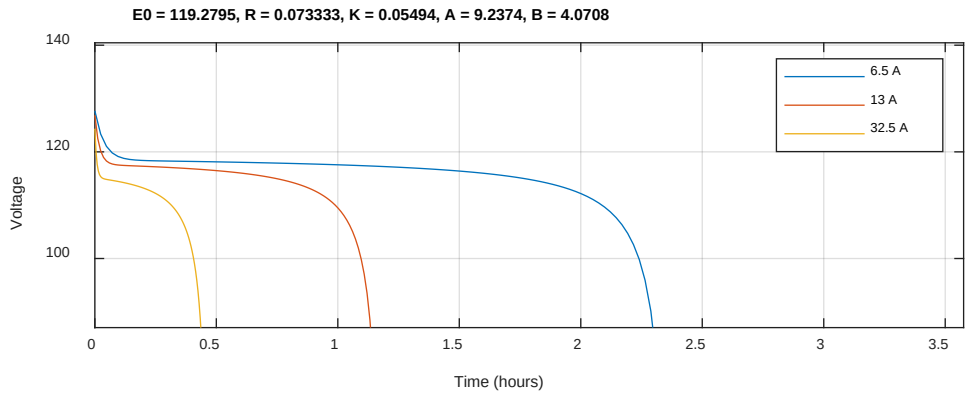
Aging

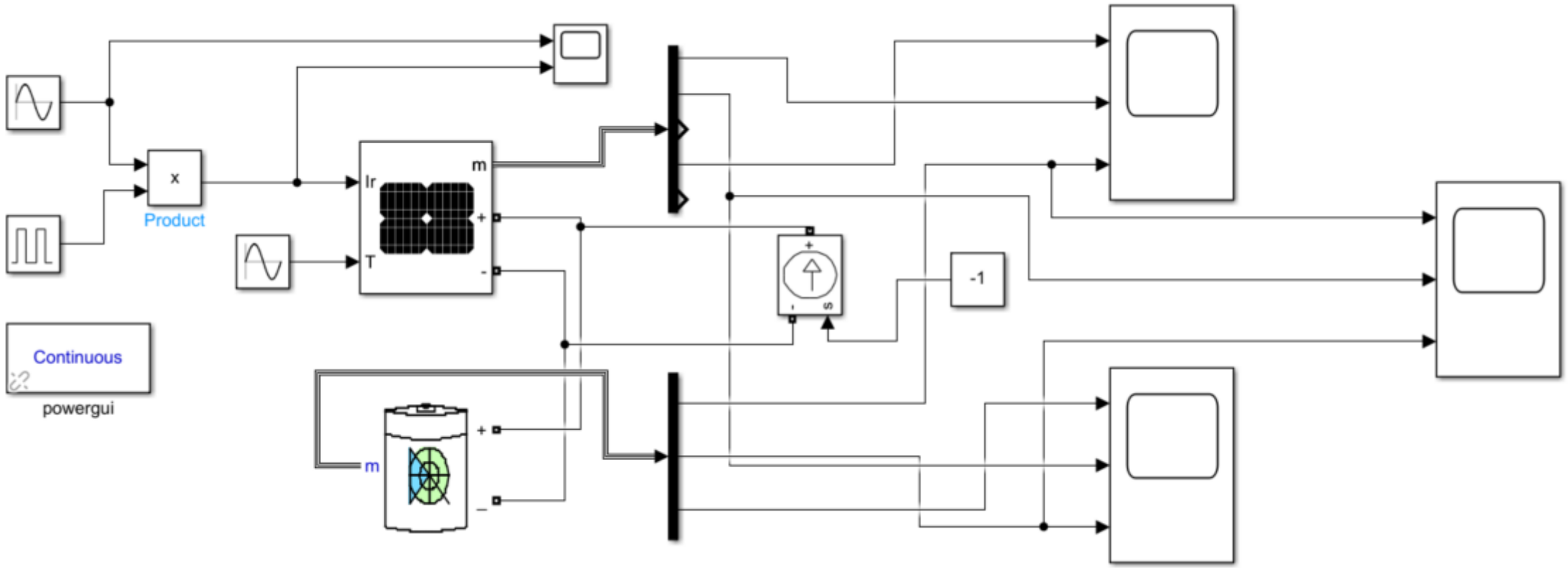
☐ Simulate aging effects

Nominal voltage (V)	110
Rated capacity (Ah)	15
Initial state-of-charge (%)	10
Battery response time (s)	30

OK | Cancel | Help | Apply



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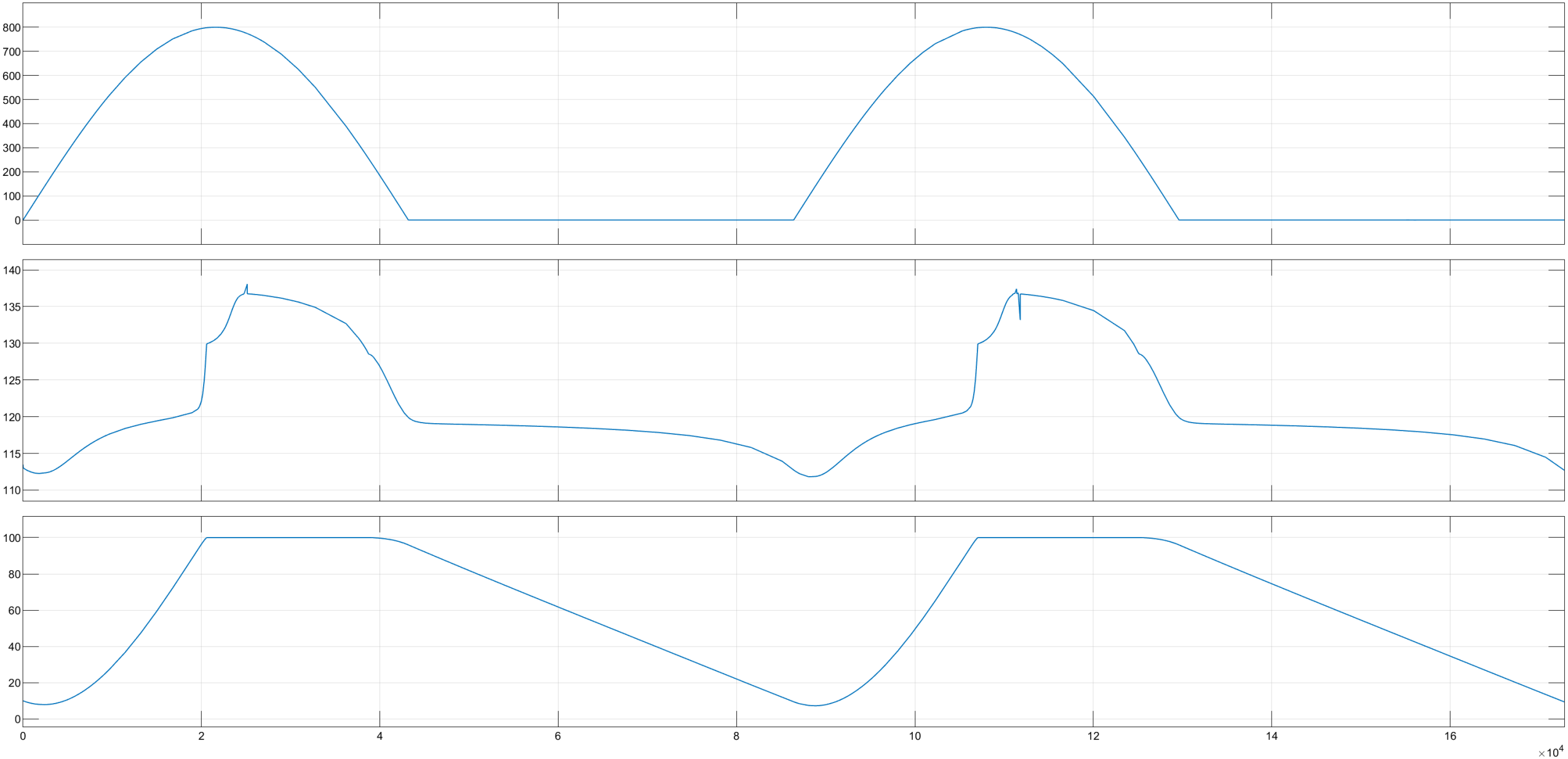
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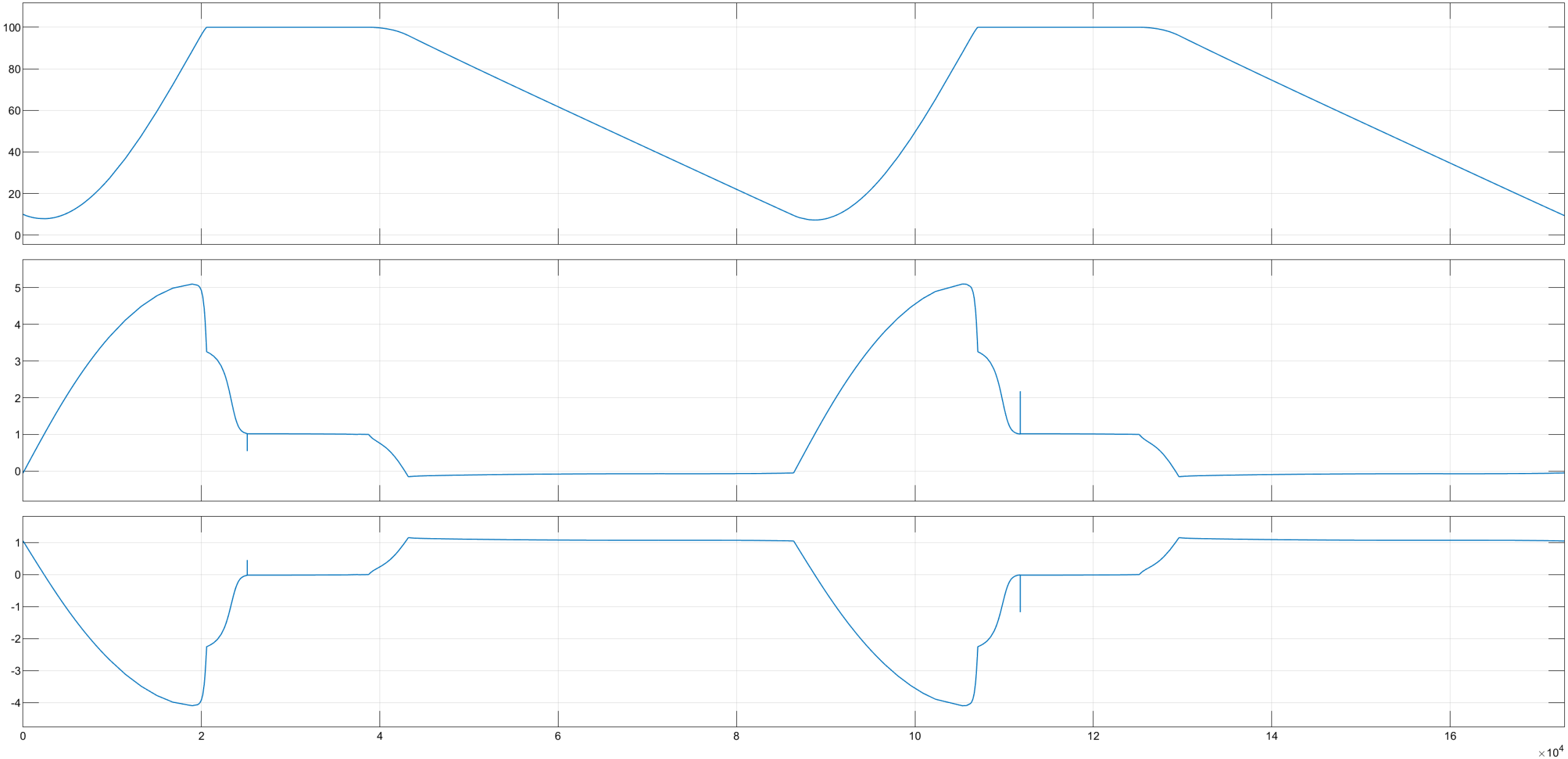
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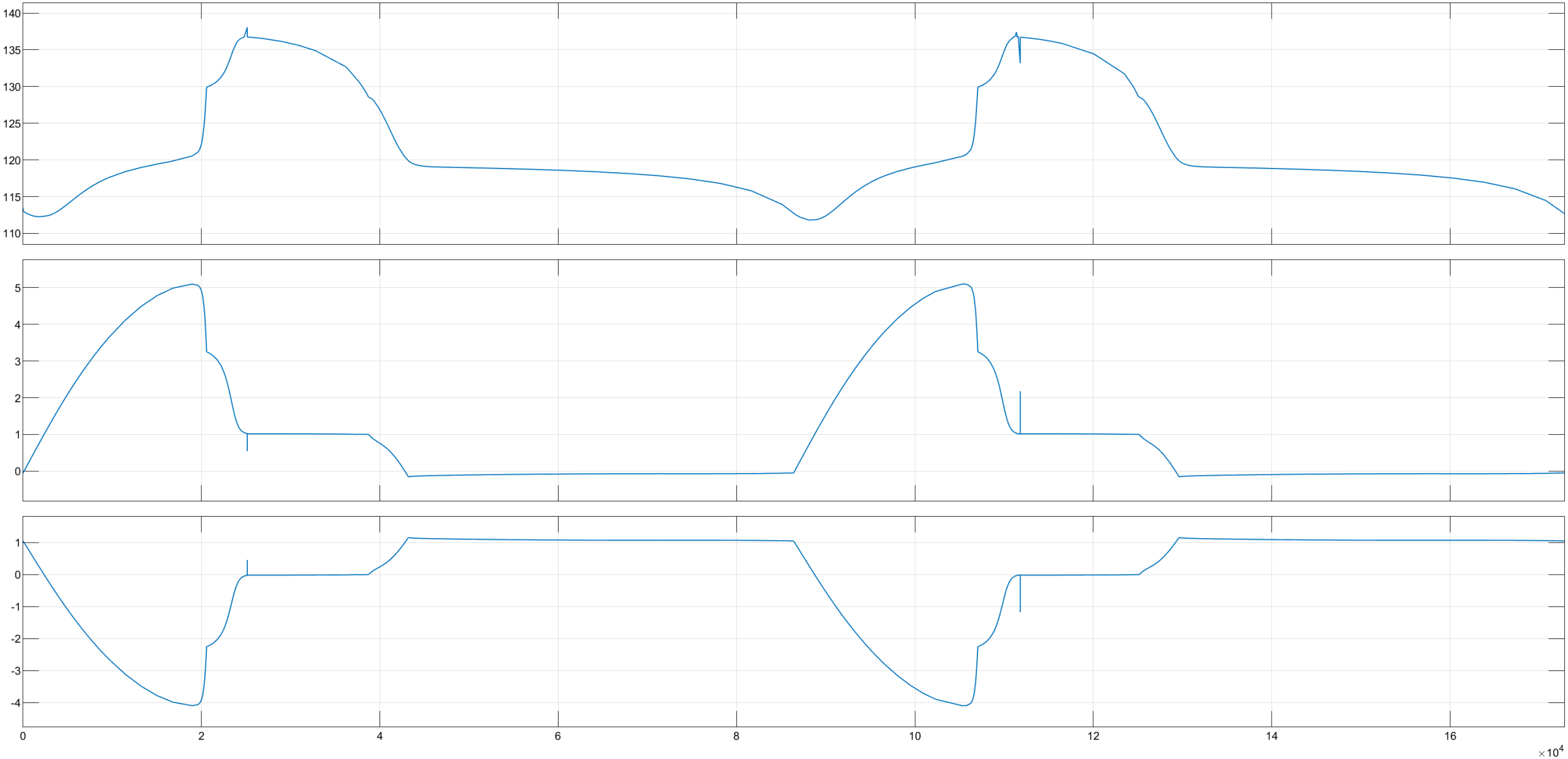
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Classwork

- Model and simulate an induction motor in Simulink

Lecture 03: Industrial safety standards

Functional safety: Safety Integrated Level (SIL)

- Generic standard IEC-**61508**/IEC-61511

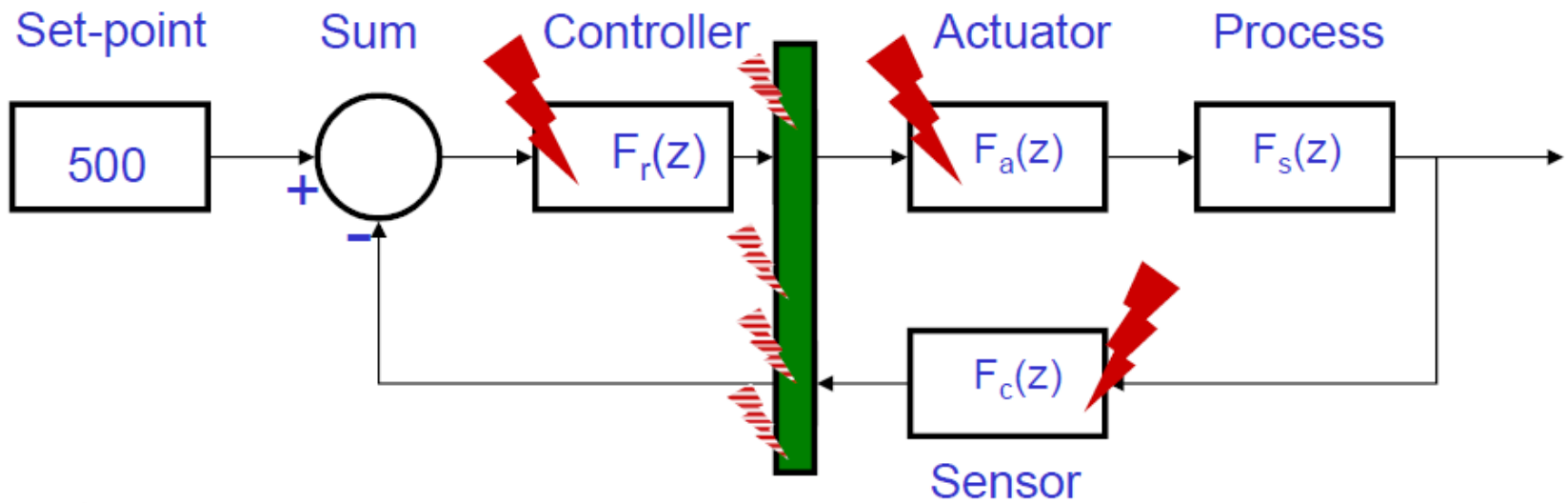
  Functional safety of electrical/electronic/programmable electronic safety-related systems

- SIL (*Safety Integrated Level*)

Problems:
- SIL of a component
- SIL of physical architecture
- SIL of a functional architecture
- SIL of a computer and network-based architecture

Prescriptions of a security system and corresponding SIL levels		
SIL	Demand operation Average **probability of failure on demand (PFD)** Failure rate per year	Continuous operation λ Failure rate per hour
SIL4	$10^{-4} < PFDavg < 10^{-5}$	$10^{-8} < \lambda < 10^{-9}$
SIL3	$10^{-3} < PFDavg < 10^{-4}$	$10^{-7} < \lambda < 10^{-8}$
SIL2	$10^{-2} < PFDavg < 10^{-3}$	$10^{-6} < \lambda < 10^{-7}$
SIL1	$10^{-1} < PFDavg < 10^{-2}$	$10^{-5} < \lambda < 10^{-6}$

Failures integration



Permanent failure

Transient failure (wired, wireless)

Failure Modes

- Continuous/sampled
- Discrete events

Time scales

-Speed (modulation rate, throughput) of the networks

-System time constant

-Time between failures

Safety = RISKS ANALYSIS => Risk Management

To Identify failures in a more exhaustive manner

- Crashing of hardware disks
- Burning down, or flooding of premises containing backups
- Open ports on a network

To evaluate the severity of each failure (level of risk)

To envisage the failures (use of evolution models)

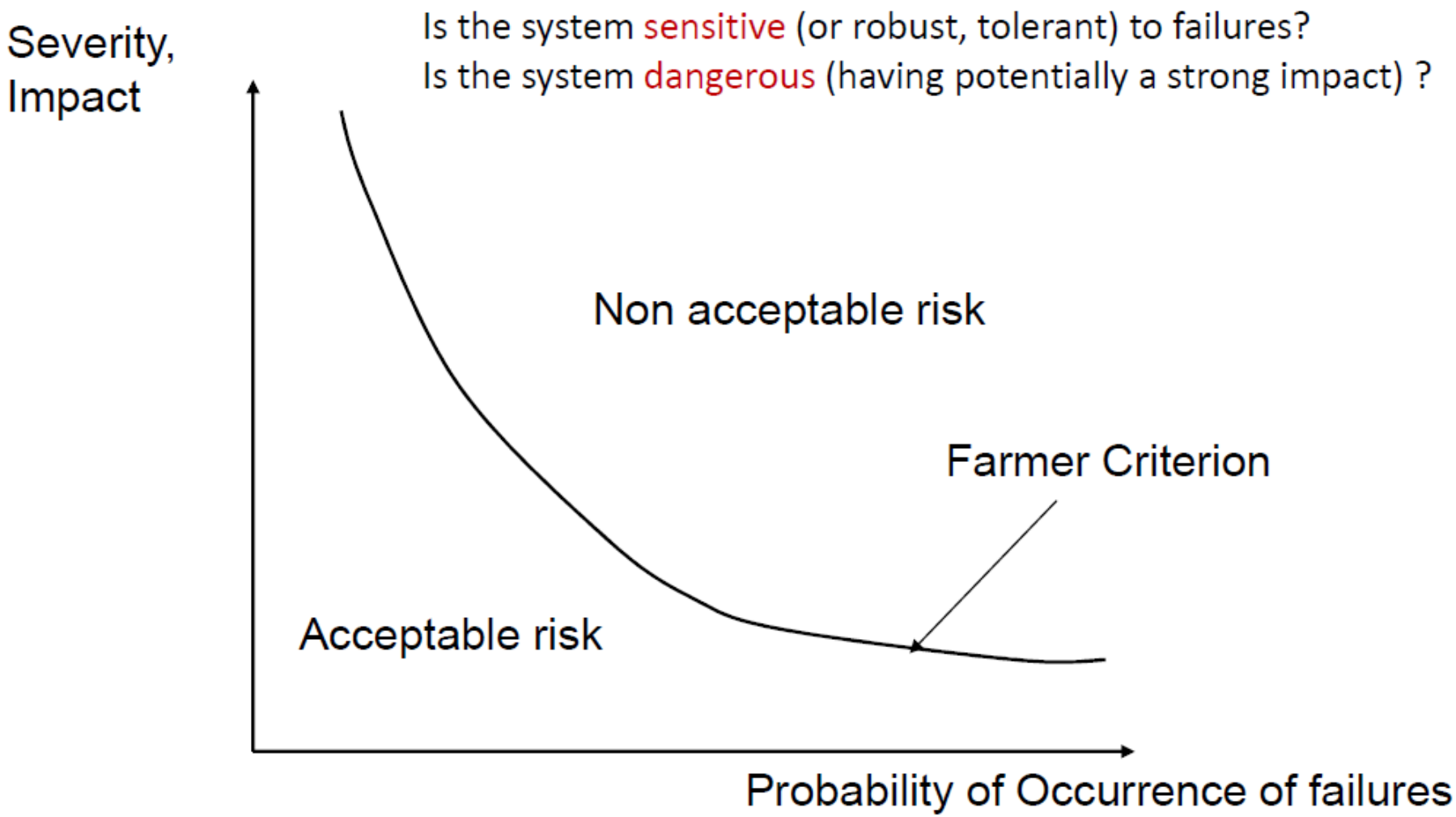
- 'Outdatedness' of the data-processing components
- Probability of attacks by third parties on vulnerable ports

At each **observation** of a failure, we should associate the appropriate **measurement** (statistical) => to improve the forecasting models

To control the failures

- Reduction of their frequency
- Preventive measures against the consequences (reduction of the impact)
- Tolerance

Risk analysis: Severity-probability



Elements of risks (asset, threat, vulnerability)

Asset (*actif*)

- Represented by monetary value
- Anything of worth that can be damaged, compromised, or destroyed by an accidental or deliberate action
- A asset's worth is generally far more than the simple costs of replacement (image, legal issues…)

Elements of risks (asset, threat, vulnerability)

Threat (*menace*)

- Potential event that, if realized, would cause an undesirable impact
- Two factors plays in the severity of a threat: degree of loss and likelihood of occurrence

Exposure factor: degree of loss (percentage of asset loss if a threat is realized) – ex: if we estimate that a fire will cause a 70 % loss of asset values if it occurs, the exposure factor is 70 % or 0.7

Annual rate of occurrence: likelihood that that a given threat would be realized in a single year in the event of a complete absence of control – ex : if we stimate that a fire will occur every three years, the annual rate of occurrence will be 33 %, or 0.33

=> A threat can be calculated as a percentage by multiplying the exposure factor by the annual rate of occurrence. Ex : 0.7*0.33 = 0.231 or 23,1 %

Elements of risks (asset, threat, vulnerability)

Vulnerability (*vulnérabilité*)

- Absence or weakness of cumulative controls protection in a particular asset

Estimated as percentages based on the level of control weakness

Control Deficiency (cd) is calculated by subtracting the effectiveness of the control by 100% - ex : if we estimate that our industrial espionage controls are 70 % effective, so 100 % - 70 % = 30 % (CD)

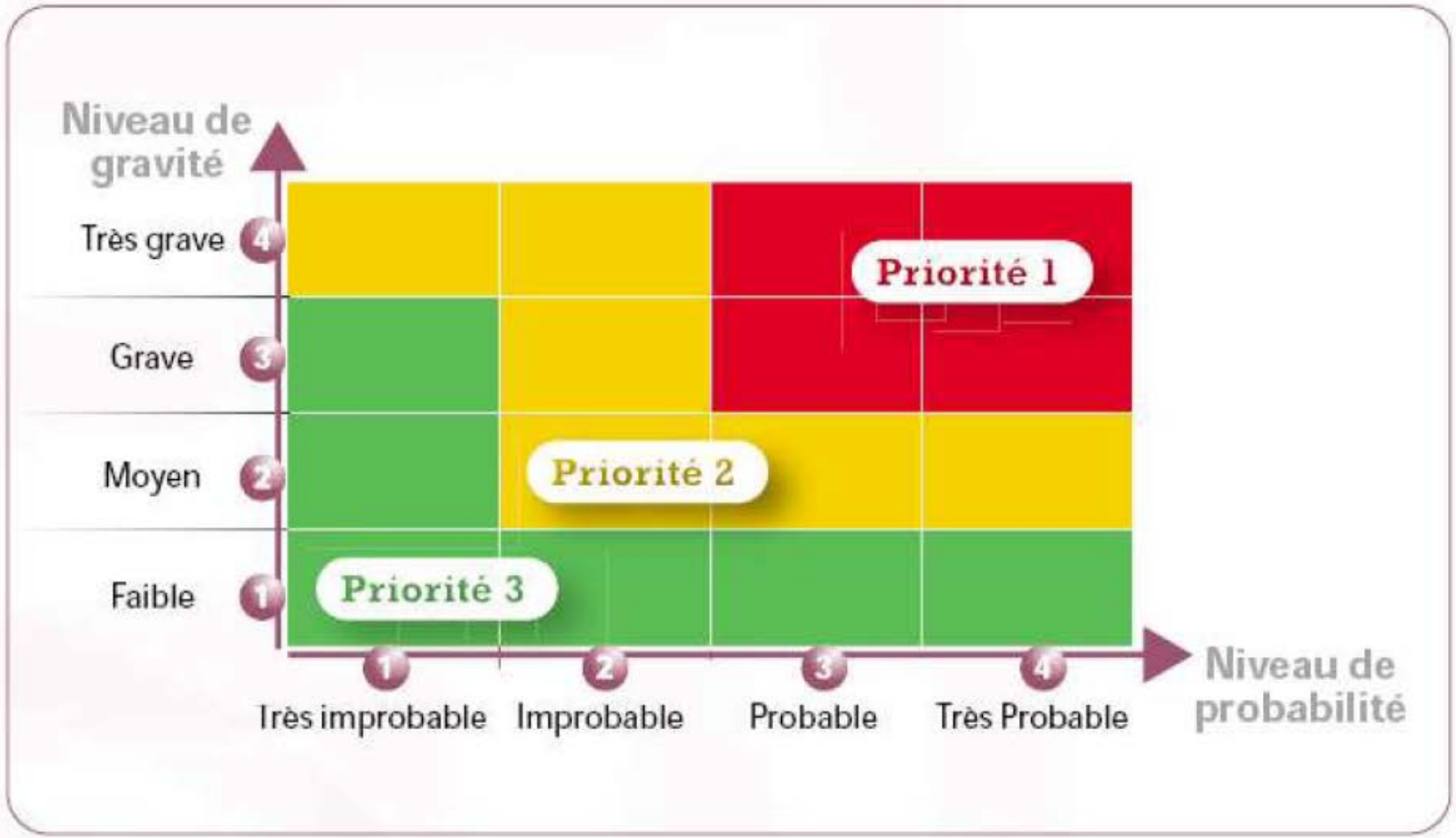
- Most of the time, more than one control is employed to protect an asset.

Ex : the threat is an employee stealing trade secrets and selling them to the competitio

To counter this threat, we may

- implement an information classification policy,
- monitor outgoing e-mail,
- prohibit the use of portable storage devices
- ...

Risks evaluation, evaluation of the severity



Example

Danger (cause)	Dange-rous situa-tion	Dange-rous event	Risk of…	Conse-quence	Severi-ty	Proba-bility	Priori-ties	Obser-vations
Explo-sion of a tyre	Car sliding	Screw in the tyre	Acci-dent	Killing people in the car	4 (high)	1 (low)	1 (low)	Having a spare wheel…

Prescriptions, Methods for risk analysis

Methods

1. FMEA (Failure Mode and Effect Analysis)/AMDE
2. HAZOP (Hazard and Operability Study)
3. Preliminary Hazard Analysis
4. MEHARI (Method for Harmonized Analysis of Risk) (FR, CLUSIF)
5. EBIOS (Expression des Besoins et Identification des Objectifs de Sécurité, FR, ANSSI)
6. OCTAVE (Operationally Critical Threat, Asset and Vulnerability Evaluation, US-CERT)
7. CRAMM (CCTA Risk Analysis and Management Method, UK CCTA (Central Communication and Telecommunication Agency))

Prescriptions

1. US standard NERC-CIP-002-3 Critical Cyber Asset Identification
2. US standard NIST.IR 7628 Guidelines for smart gris security
3. ISA/IEC 62443 Security for Industriel Automation and Control Systems
4. EU efforts about smart grid security
5. ANSSI Classification method and key measures

Classwork

- Present a case of electrical machine and discuss its safety