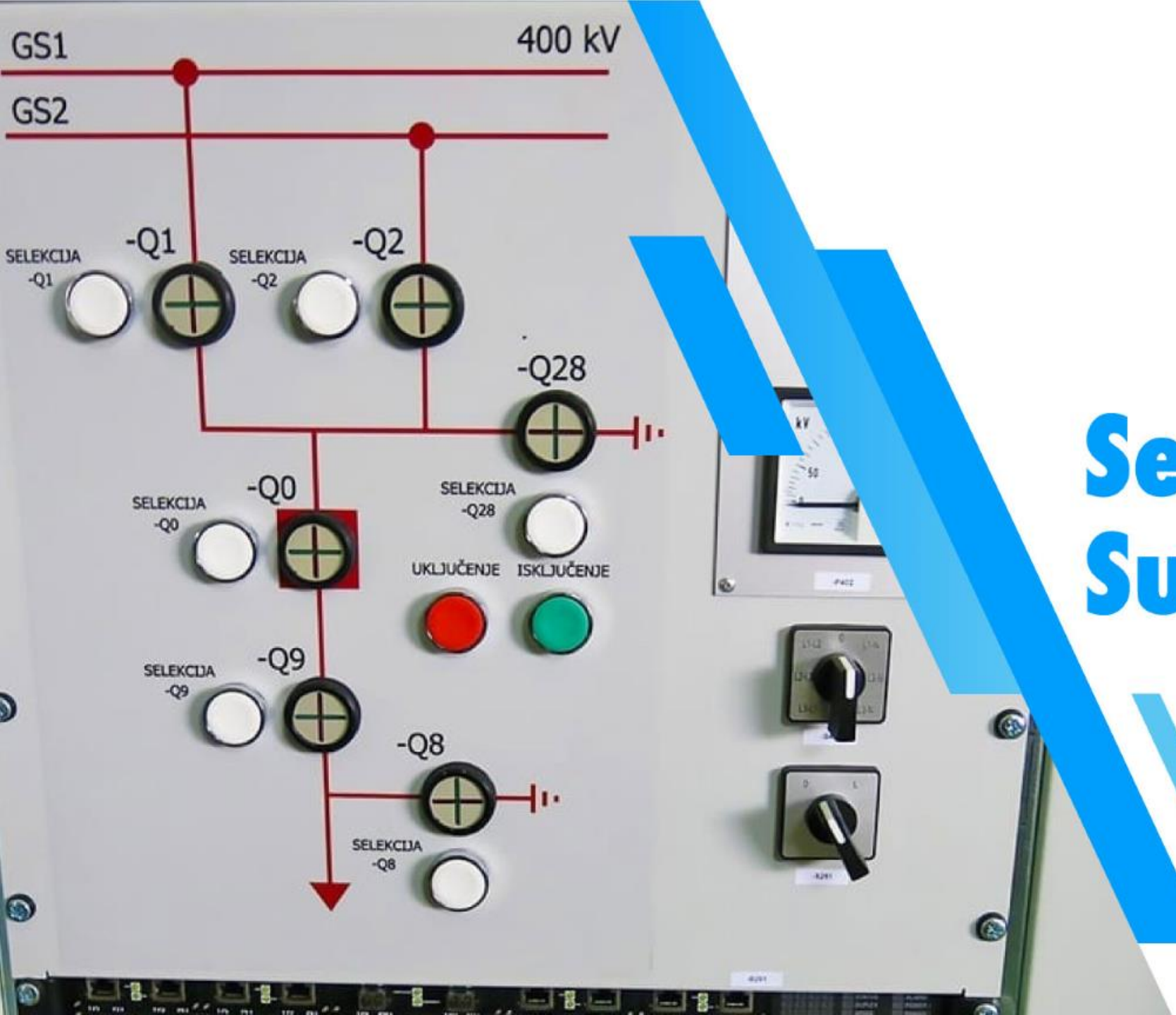


WEBINAR

Diseño Secundario de Subestaciones

inel
Engineering Education

Kamal Arreaza

Gerente de Ingeniería y Construcción

Venezolano

Educación

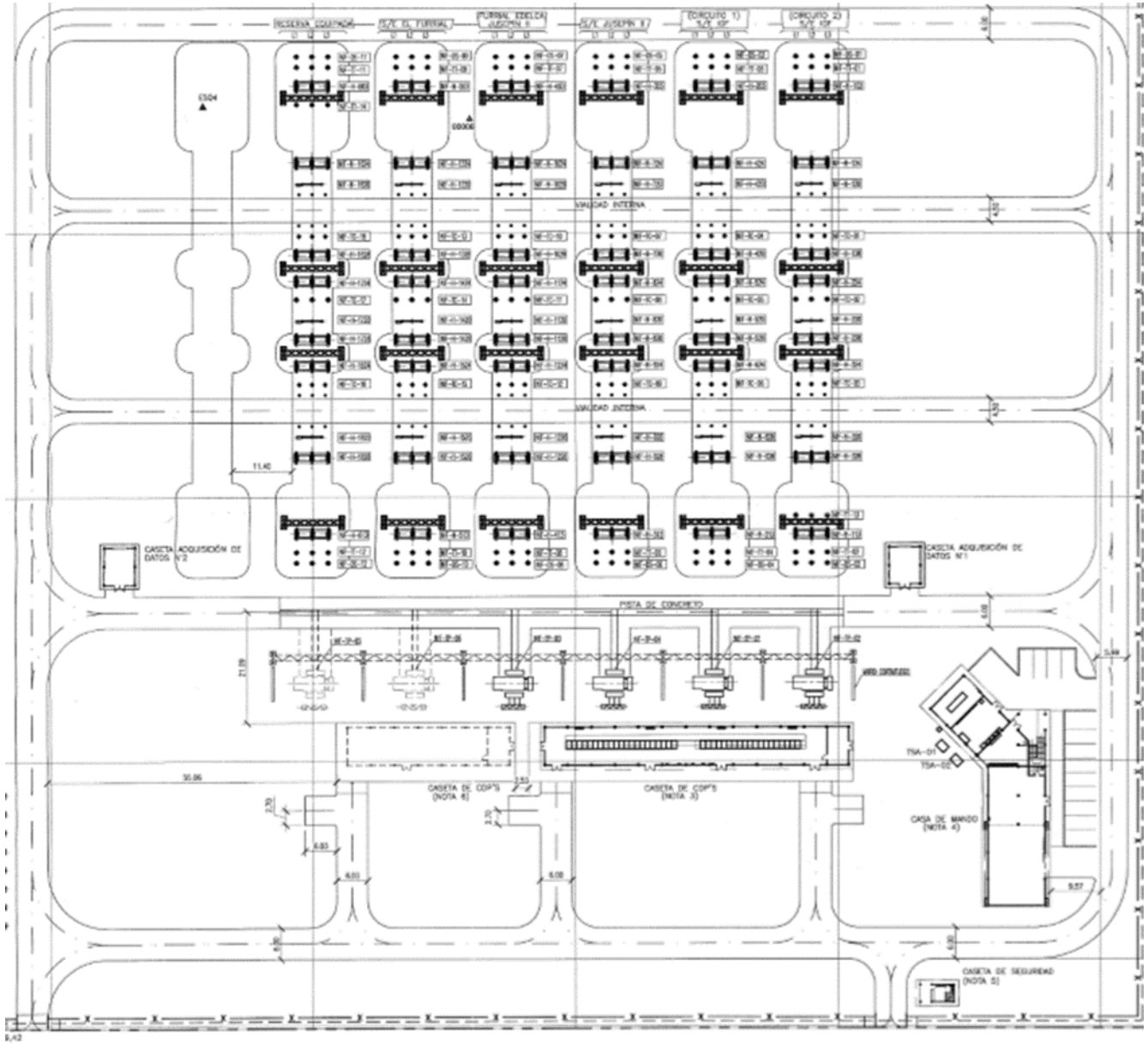
Egresado de Ingeniería Eléctrica de la Universidad de Oriente (UDO), Venezuela. Con una Maestría en Ingeniería Eléctrica en la UNEXPO, Venezuela.

Experiencia

Catorce (14) años de experiencia en el diseño y construcción de grandes proyectos de Ingeniería para clientes en varios países de Latinoamérica incluyendo: Venezuela, Chile, Perú, México, Colombia y Ecuador. Ha revisado Ingeniería de líneas y subestaciones eléctricas en calidad de interventor para empresas de Estados Unidos.

INTRODUCCION

Disposicion física de equipos



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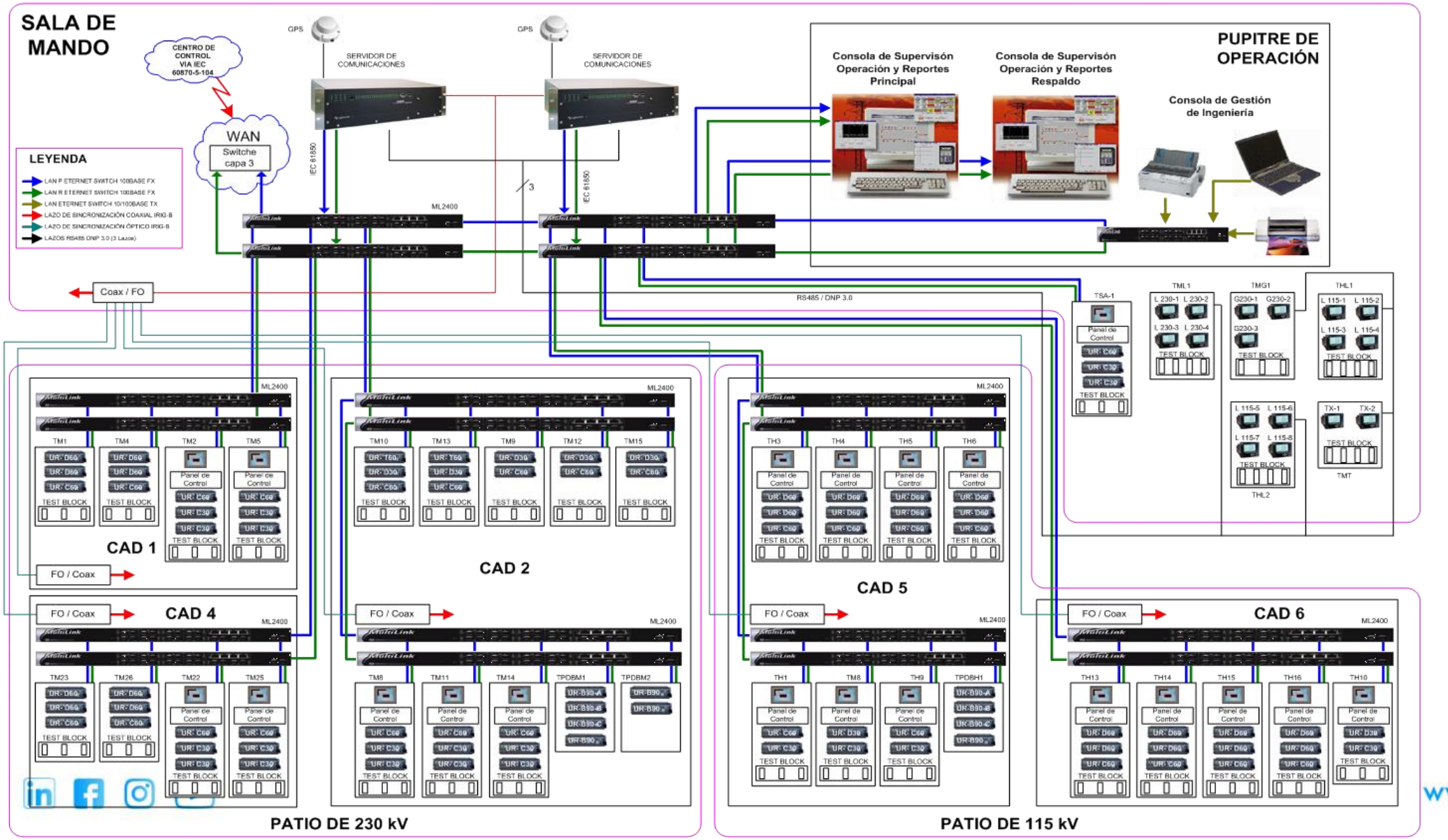

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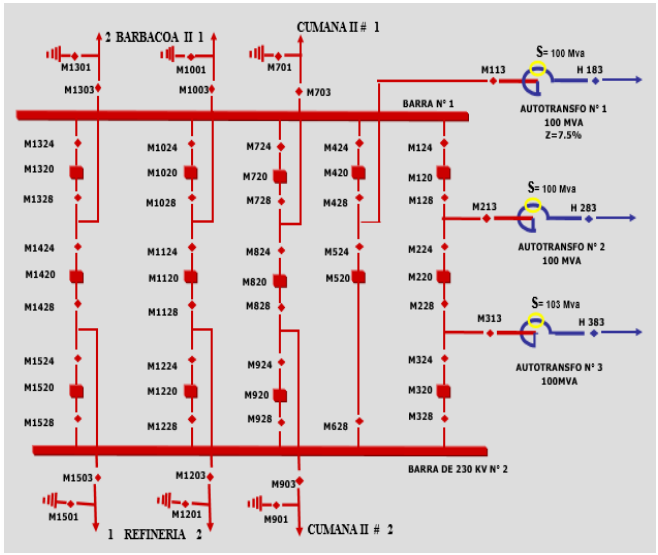
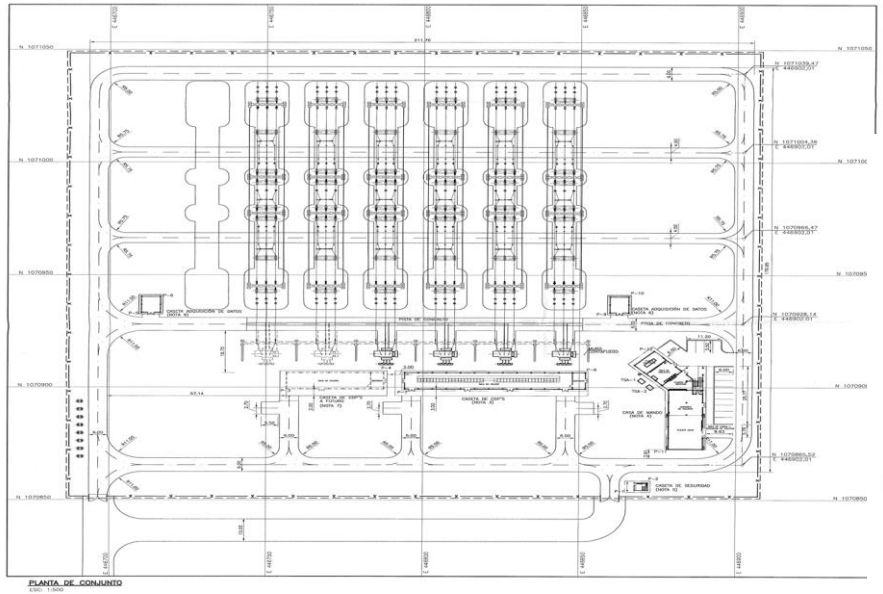
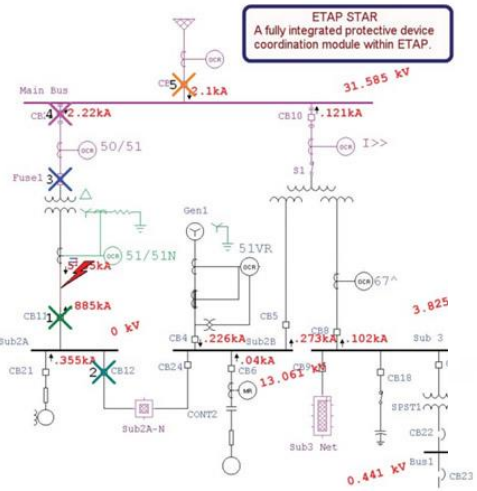
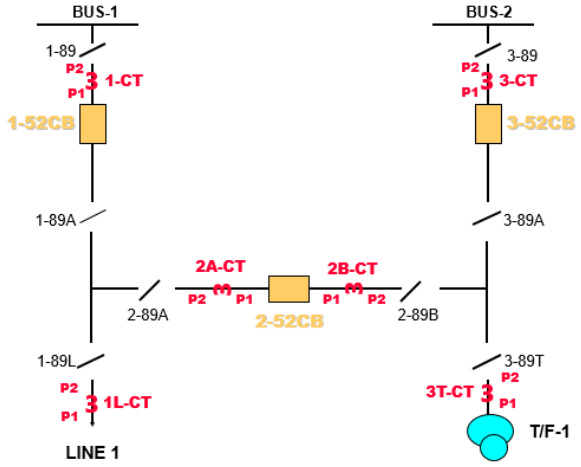
TAREAS INVOLUCRDAS

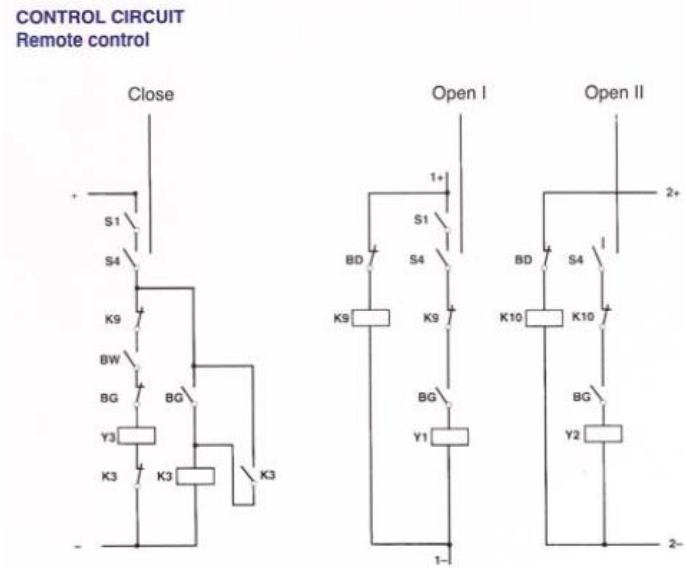






ONE & HALF BREAKER SYSTEM
(6CT METHOD)





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CONFIGURACIÓN Y ESQUEMAS DE BARRAS SUBESTACIONES

ESQUEMAS DE BARRAS

4.1 Single bus single breaker arrangement (SBSB)

The single bus single breaker arrangement shown in Figure 1 consists of one main bus that contains positions for several circuits. The circuits are normally connected via circuit breakers but can be connected via circuit switchers, which are motor or manually operated switches. The single bus single breaker arrangement is generally applied in substations from distribution voltage through 121 kV to 161 kV and in locations where system reliability is not critical.

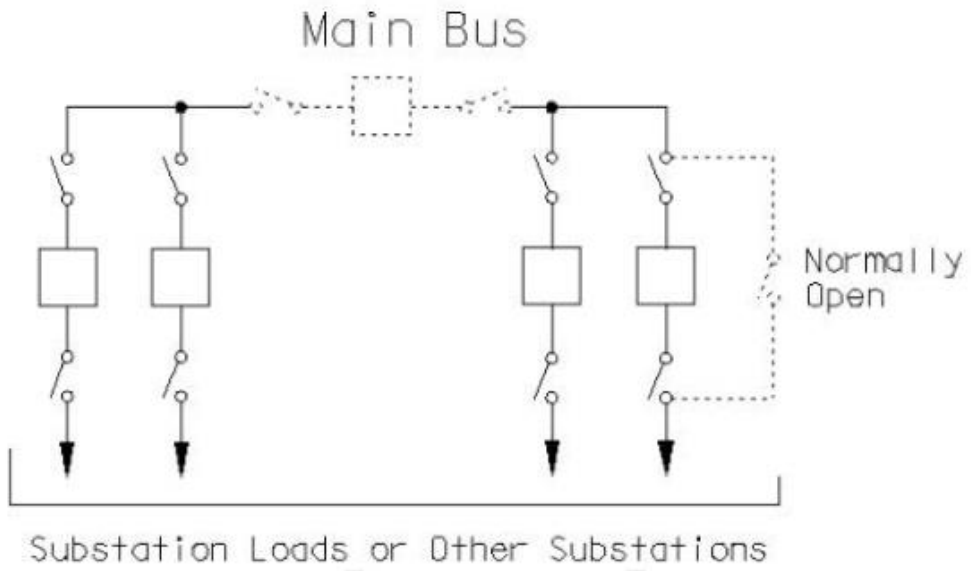


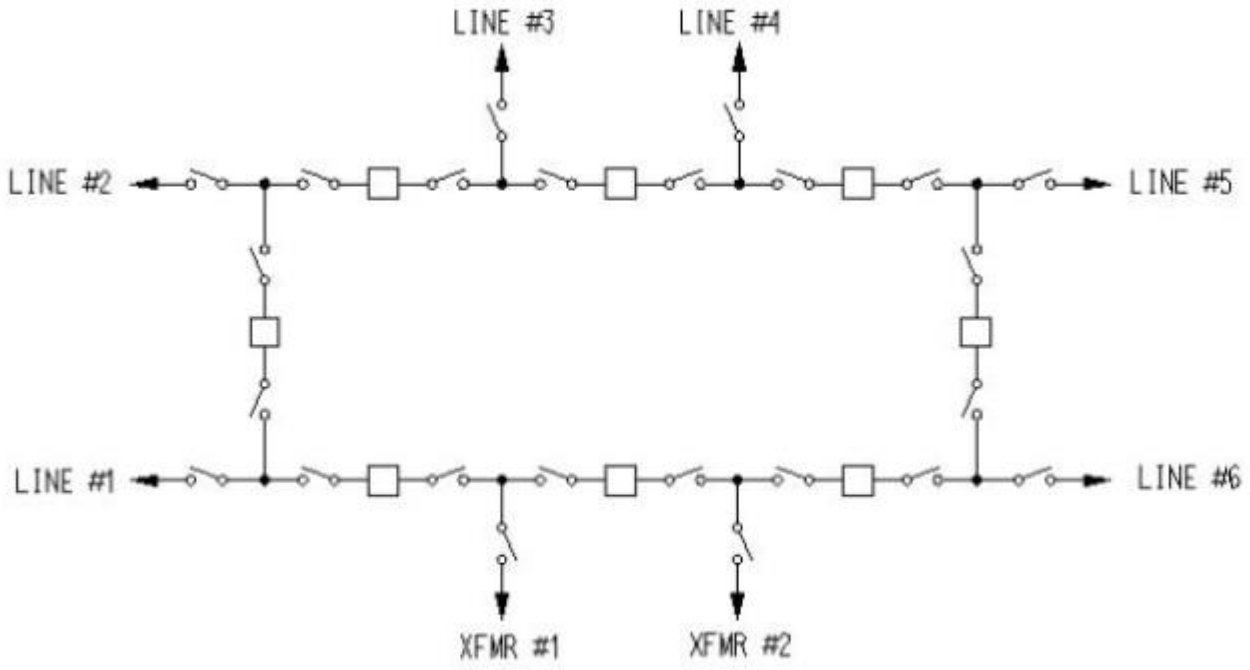
Figure 1—Single bus breaker

IEEE 605-2008

ESQUEMAS DE BARRAS

4.4 Ring bus arrangements (RB)

In the ring bus arrangement, each circuit is connected between two breakers. The breakers are arranged in a series connection to form the "ring." In the ring bus arrangement, one breaker per circuit is possible as shown in Figure 4. The switchyard is normally operated with all breakers in the closed position. Power flow is evenly distributed because the ring bus operates as a single node.



IEEE 605-2008

Figure 4—Ring bus arrangement (eight breakers—eight circuits[13])

ESQUEMAS DE BARRAS

Engineering Education

4.5 Breaker and half bus arrangement (B-1/2)

The breaker and half bus arrangement shown in Figure 5 consists of two main buses that are normally energized. Three breakers are required to serve two circuits. The middle breaker is common between two circuits and, hence, the name breaker and half bus arrangement. Any breaker or bus can be taken out of service without interruption of service. Faults on one circuit do not affect the other circuit unless the associated breaker fails to trip.

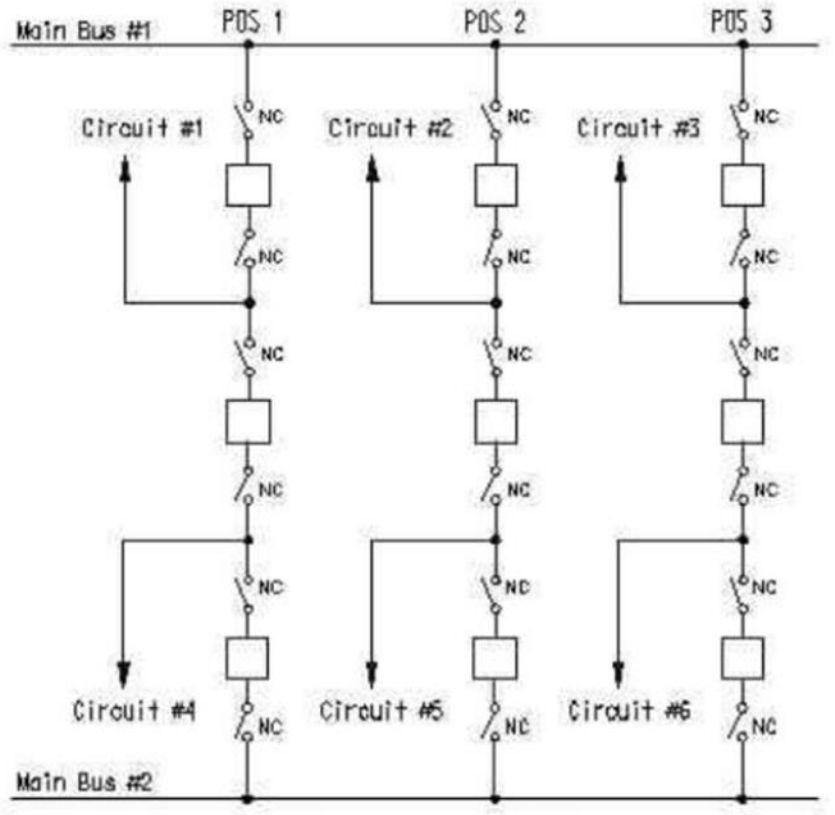


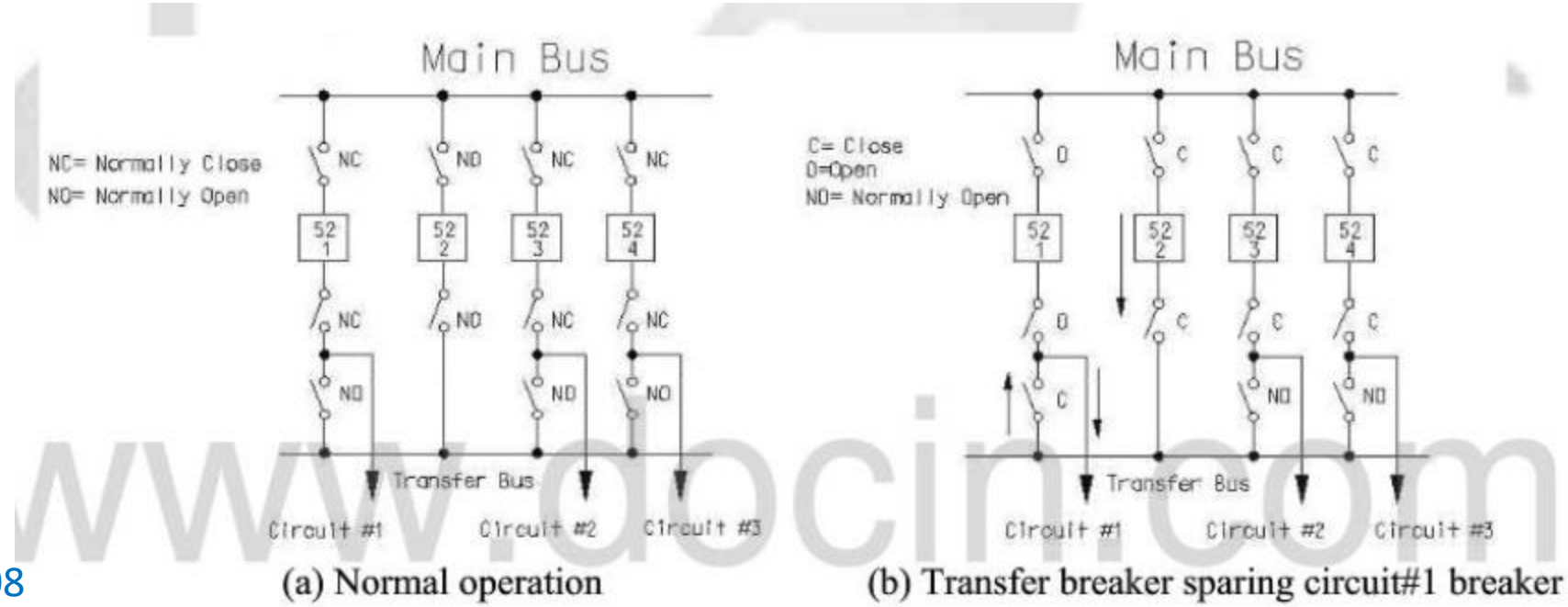
Figure 5—Breaker and half bus arrangement

IEEE 605-2008

ESQUEMAS DE BARRAS

4.2 Main and transfer bus arrangement (MTB)

The main and transfer bus arrangement is a modification to the single bus arrangement as shown in Figure 2. This arrangement consists of two buses, a main and a transfer. Each circuit bay consists of one breaker and three switches, except the transfer breaker bay, which requires only two switches. The main bus is normally energized, and all circuits are serviced from the main bus as shown in Figure 2(a).



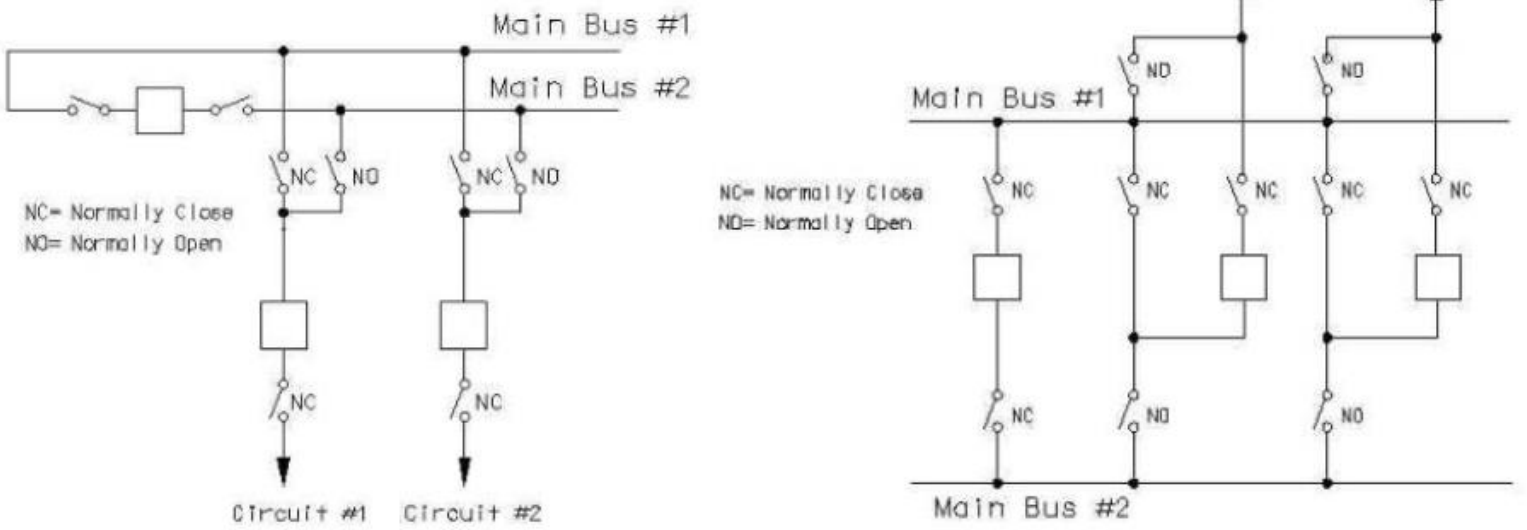
IEEE 605-2008

Figure 2—Main and transfer bus arrangement

ESQUEMAS DE BARRAS

4.3 Double bus single breaker arrangement (DBSB)

The double bus single breaker arrangement shown in Figure 3 is a modification of the sectionalized radial single bus. This arrangement consists of two main buses connected together through a circuit breaker. Each circuit uses a circuit breaker and three disconnect switches and can be connected to either bus through disconnect switches. This arrangement allows all circuits to be connected to one bus in case of an outage on the other bus.



IEEE 605-2008

Figure 3—Double bus single breaker arrangement

ESQUEMAS DE BARRAS

4.6 Double bus double breaker arrangement (DBDB)

This bus arrangement, shown in Figure 6, consists of two main buses with two breakers and four switches per circuit. Any breaker or bus can be taken out of service for maintenance without an interruption to service. Split bus operation is possible. This bus arrangement is considered to be the most reliable.

This arrangement requires a large ground area. It is the most expensive one because it requires the most equipment per circuit. This bus arrangement requires a considerable amount of material for mounting structures.

This bus arrangement is rarely used at this time due to its cost and the space required.

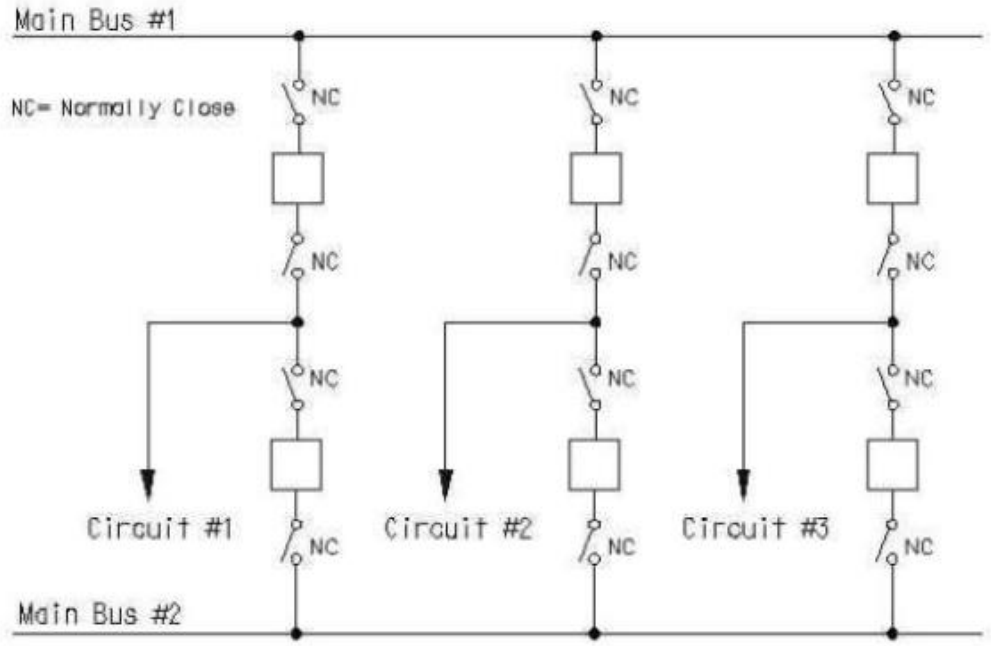


Figure 6—Double bus double breaker arrangement

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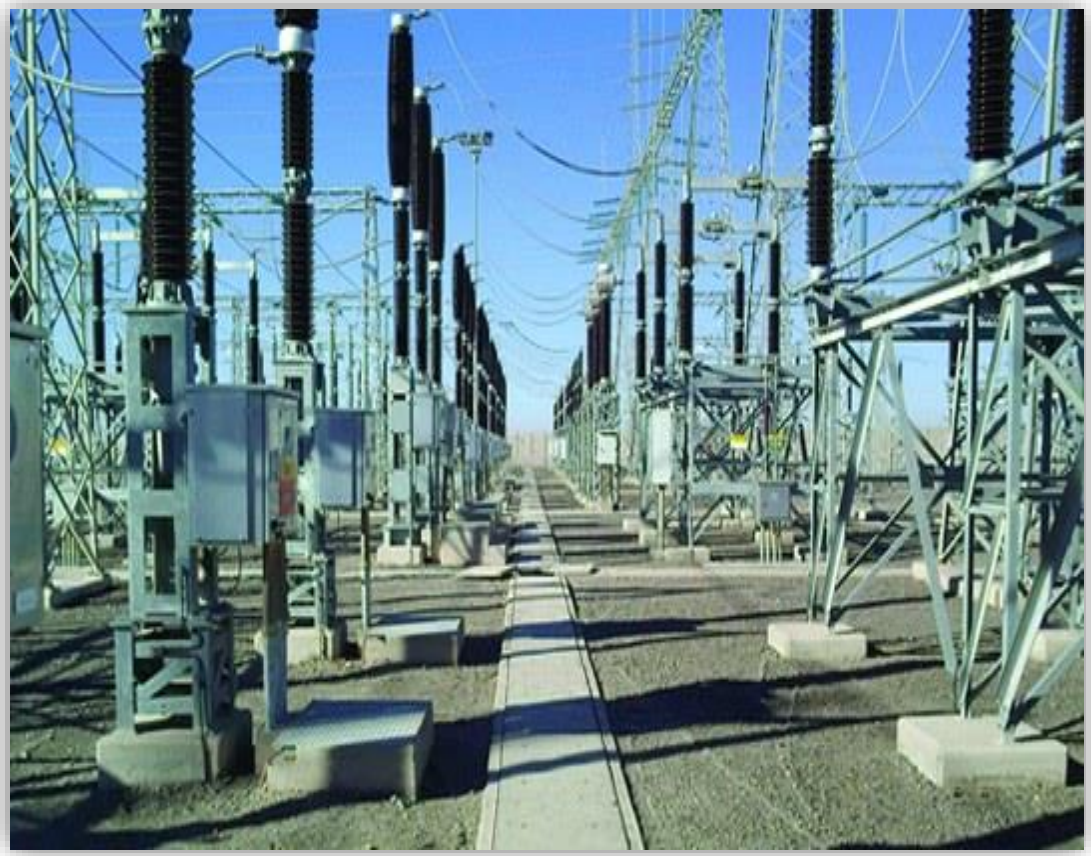
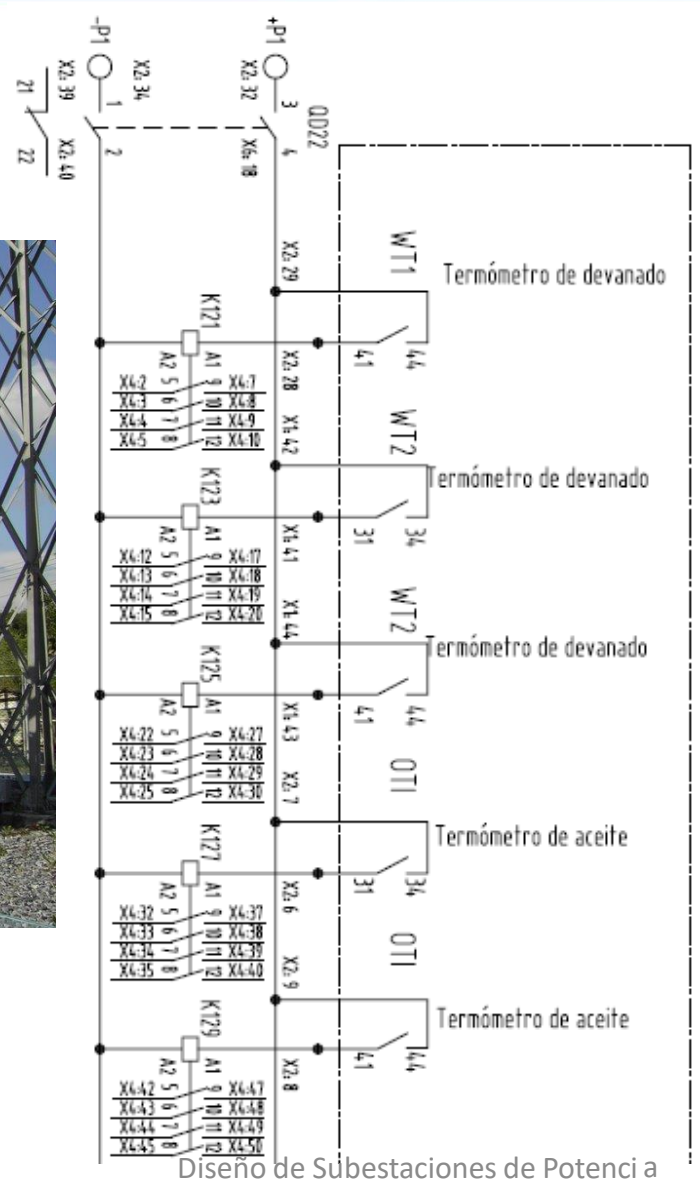
COMPONENTES Y EQUIPOS PRINCIPALES ELECTROMECÁNICOS

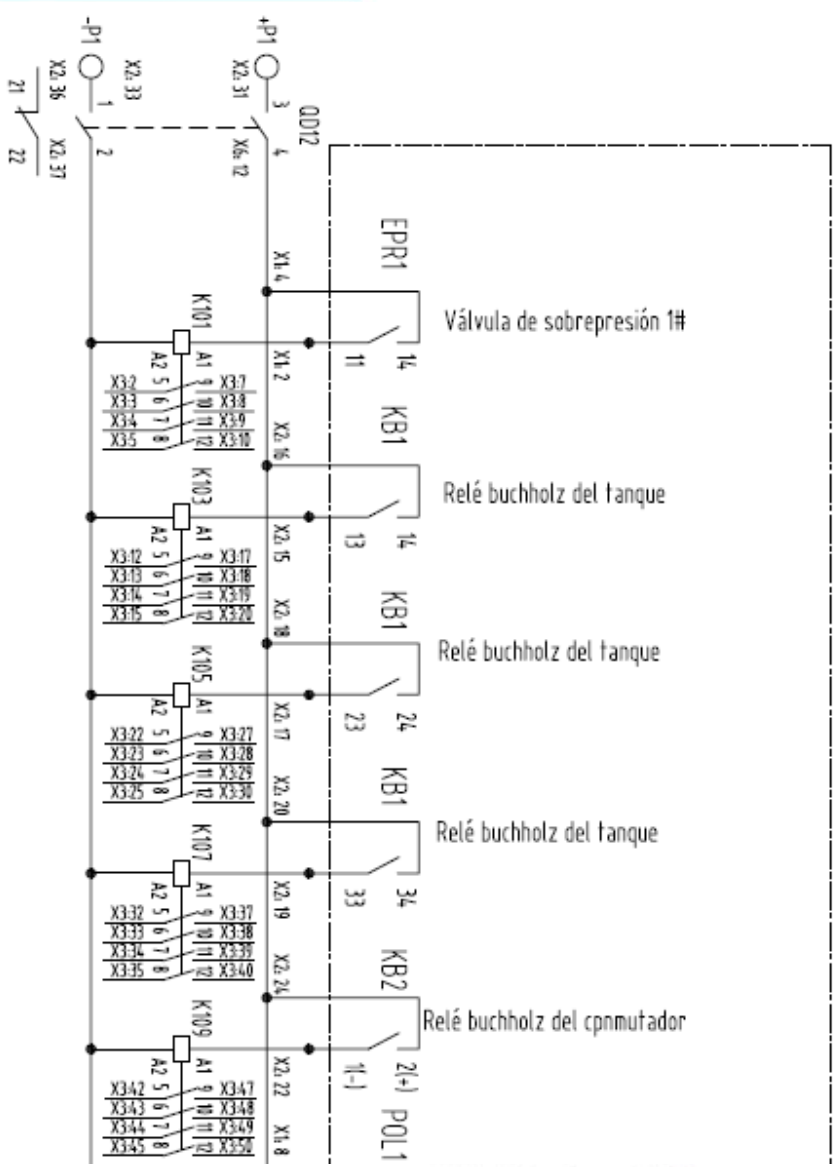
PATIO DE LLAVES



COMPONENTES Y EQUIPOS

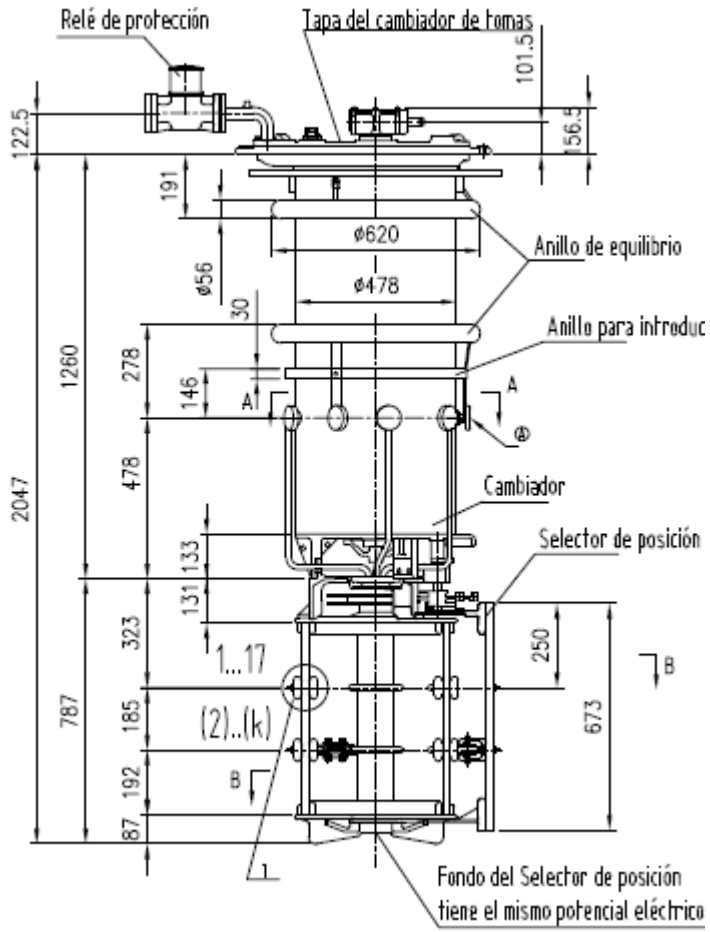
TRANSFORMADOR

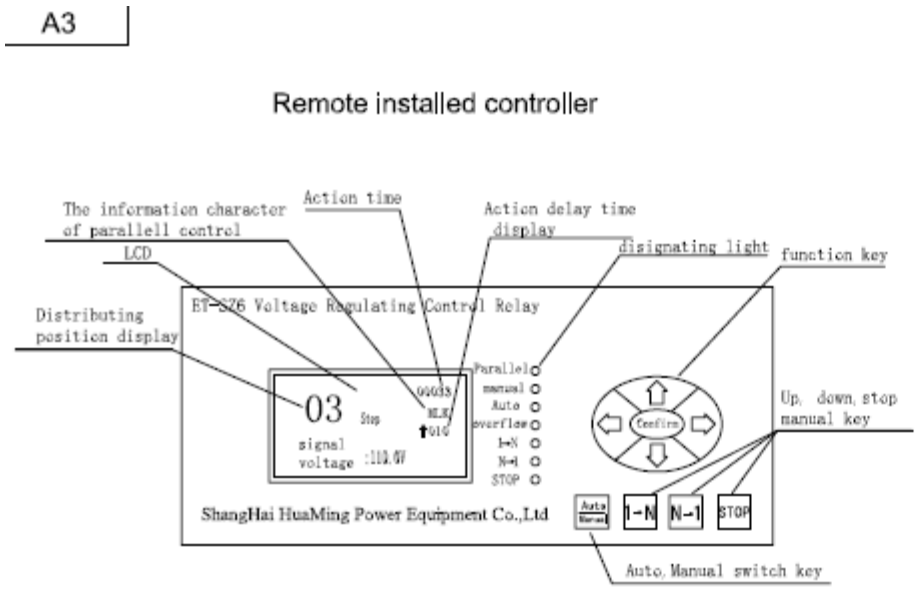


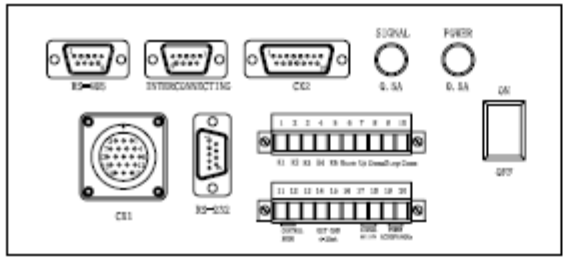


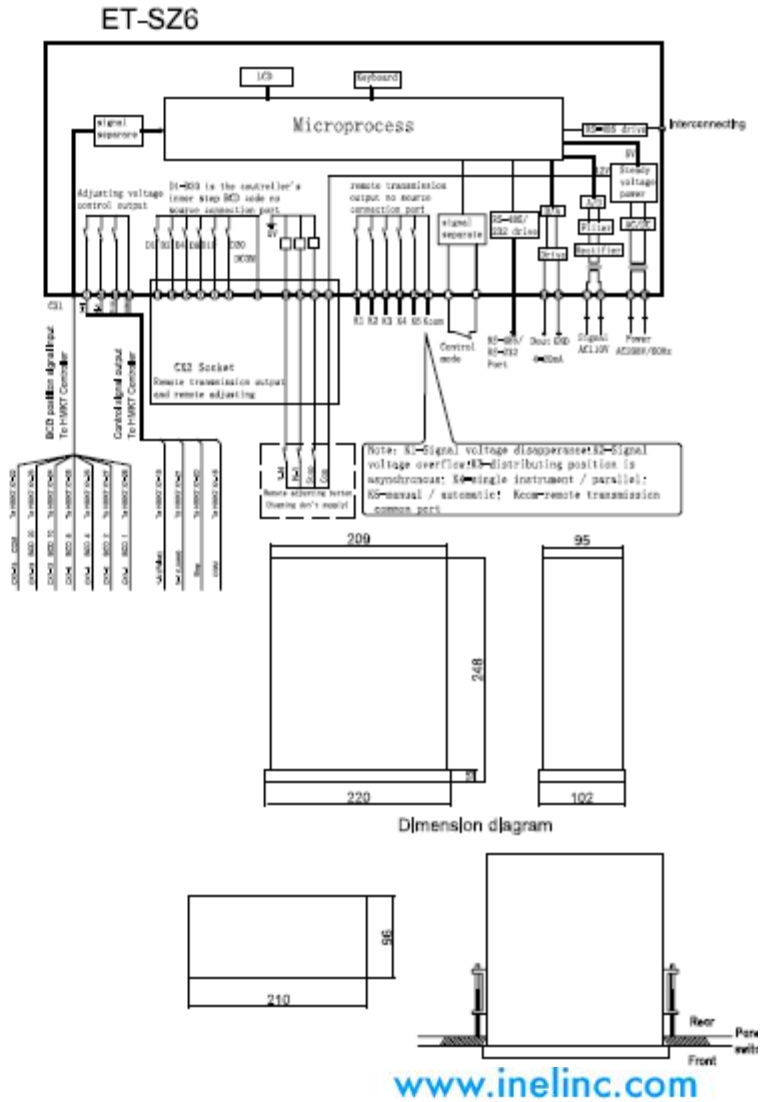
COMPONENTES Y EQUIPOS

Cambiador de tomas





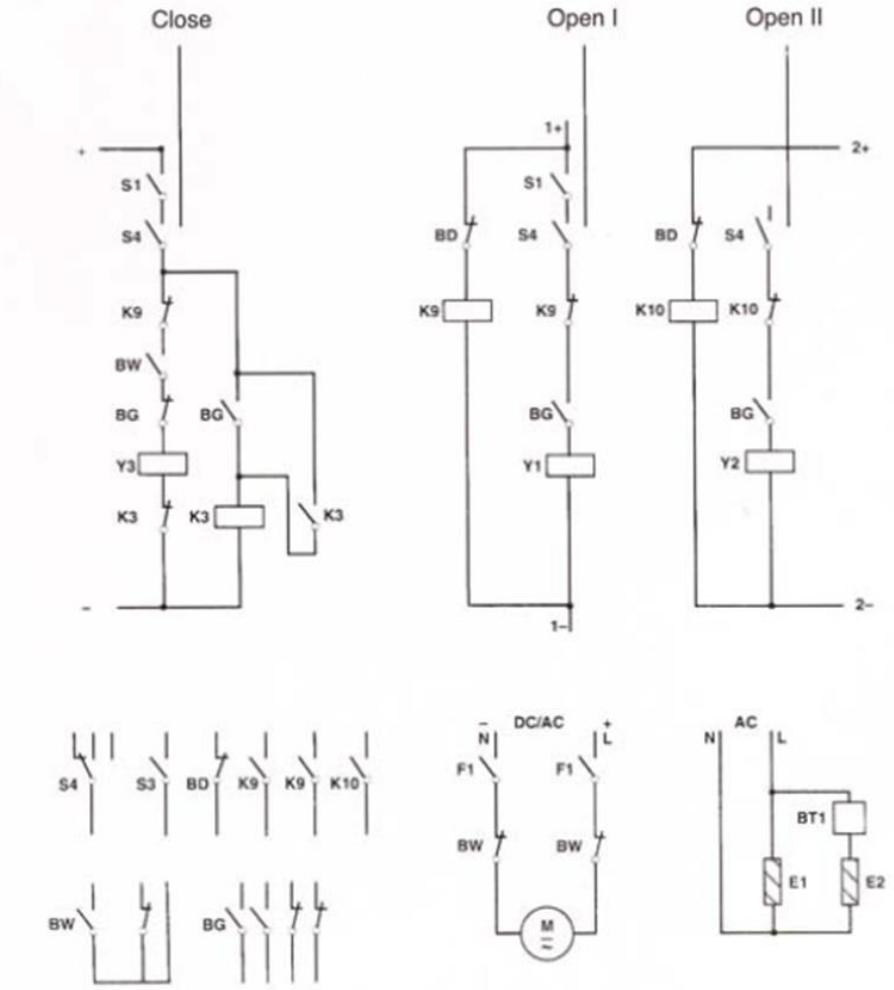




INTERRUPTOR DE POTENCIA

INTERRUPTOR DE POTENCIA

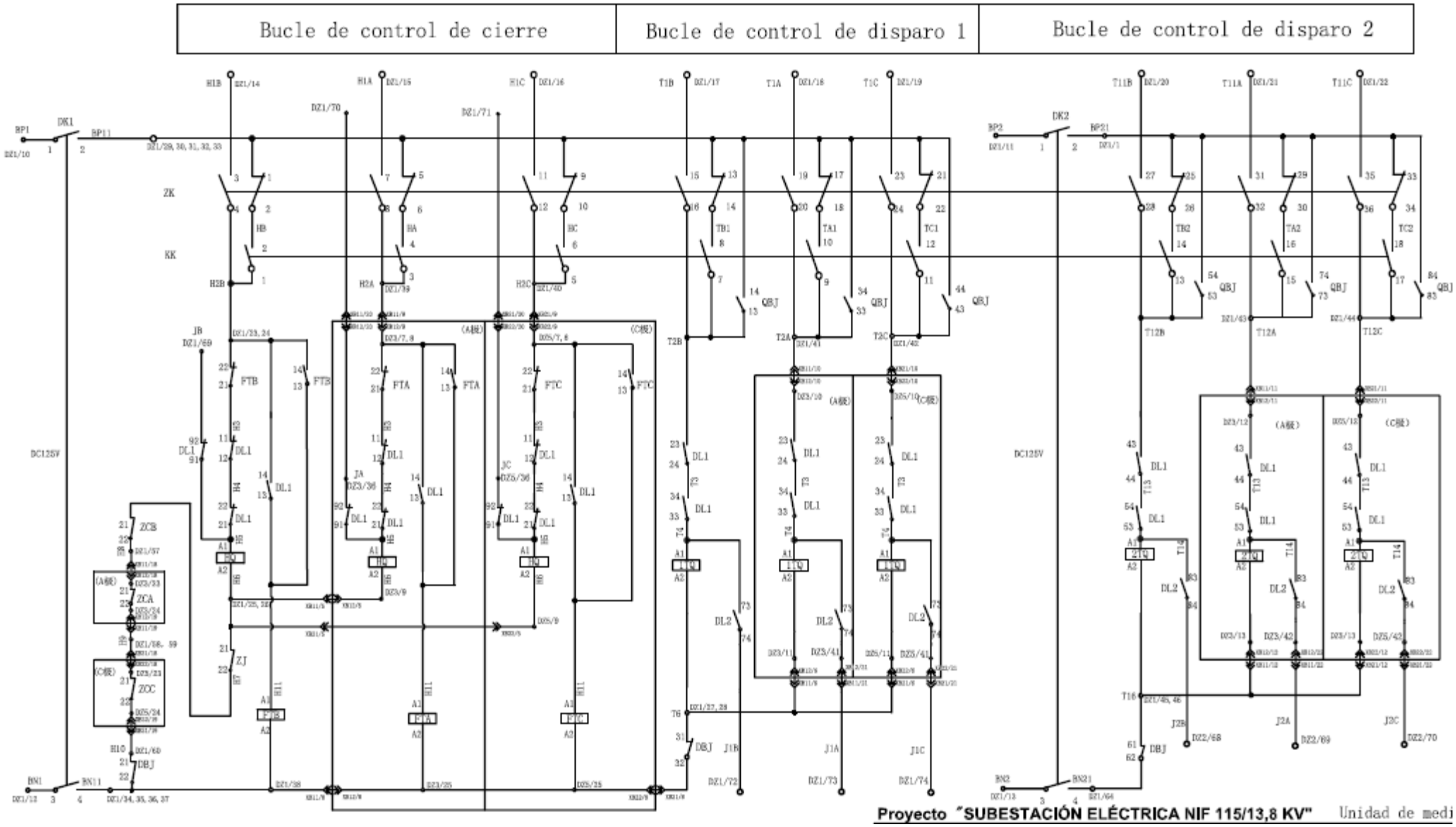
CONTROL CIRCUIT
Remote control



BD	Density switch
BG	Auxiliary contact
BT1	Thermostat
BW	Limit switch
E1,E2	Heater
F1	Direct-on-line motorstarter
K3	Antipumping relay
K9	Interlocking relay(close/trip1)
K10	Interlocking relay(trip 2)
M	Motor
S1	Selector switch(trip/close)
S4	Selector switch (remote/local/disconnect)
Y1,Y2	Shunt trip coils
Y3	Closing coil

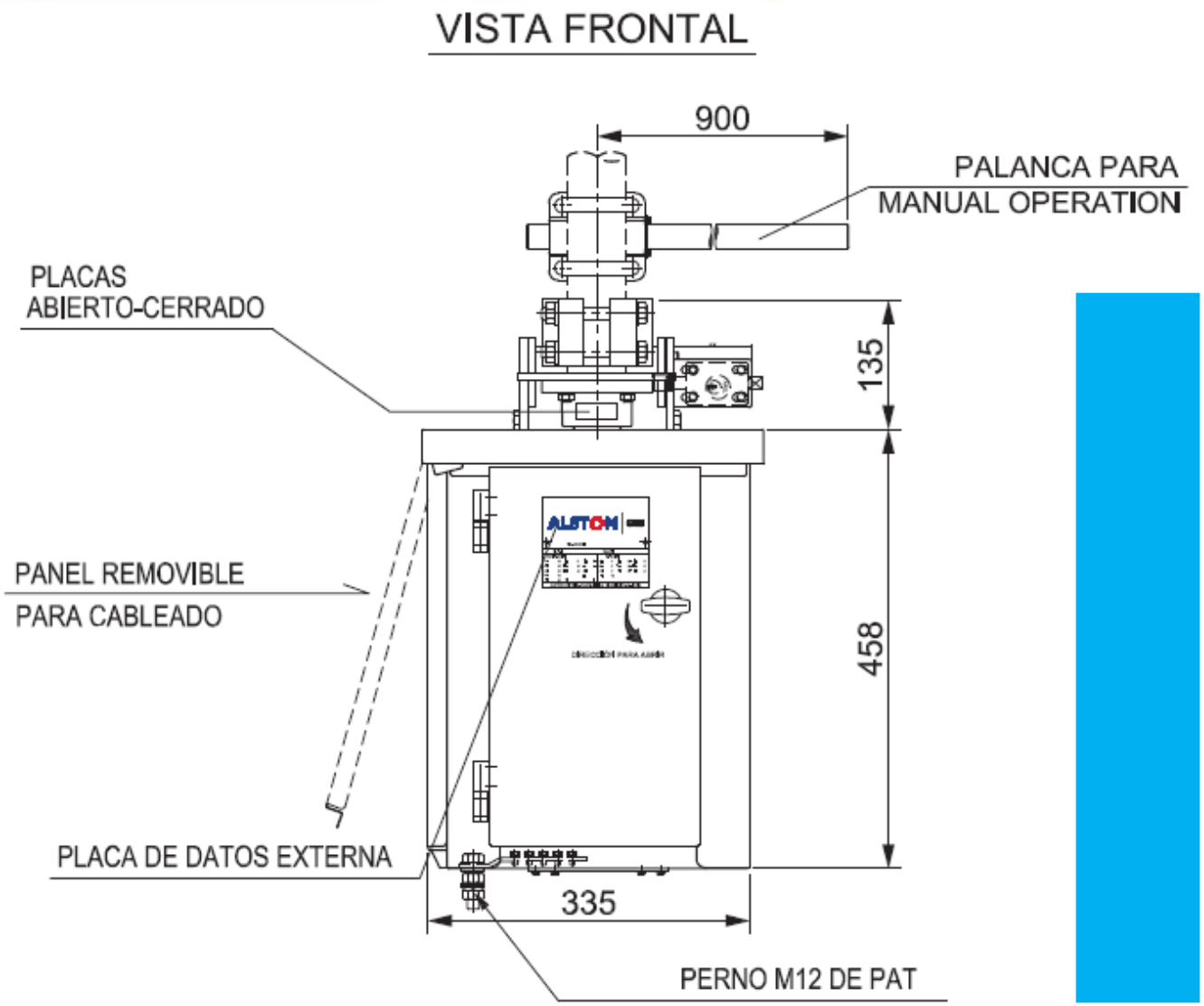
Circuit diagram shows operating mechanism when circuit-breaker is in OFF position.Not pressurized,closing springs uncharged,no power supply connected and selector switch in pos. DISCONNECTED.

INTERRUPTOR DE POTENCIA



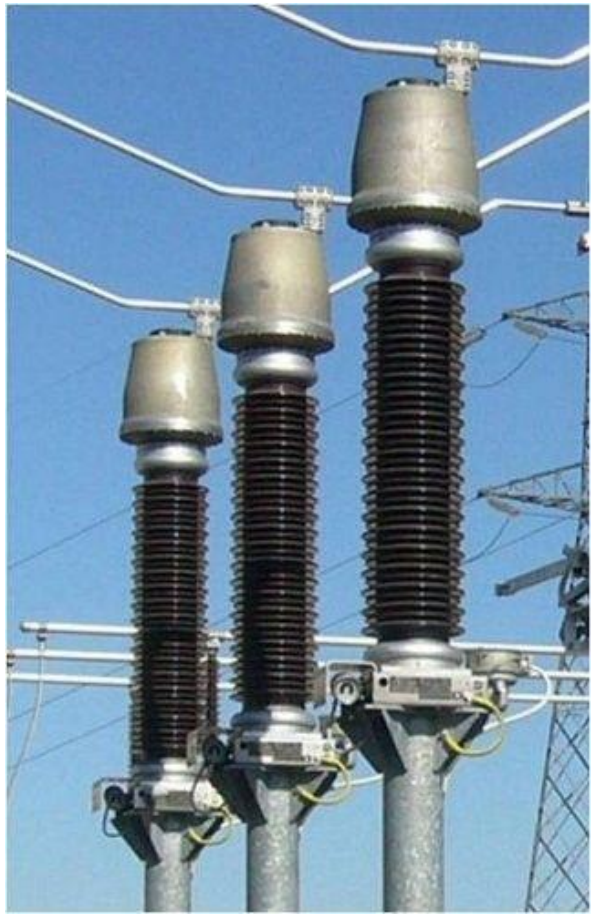
COMPONENTES Y EQUIPOS

SECCIONADOR DE POTENCIA

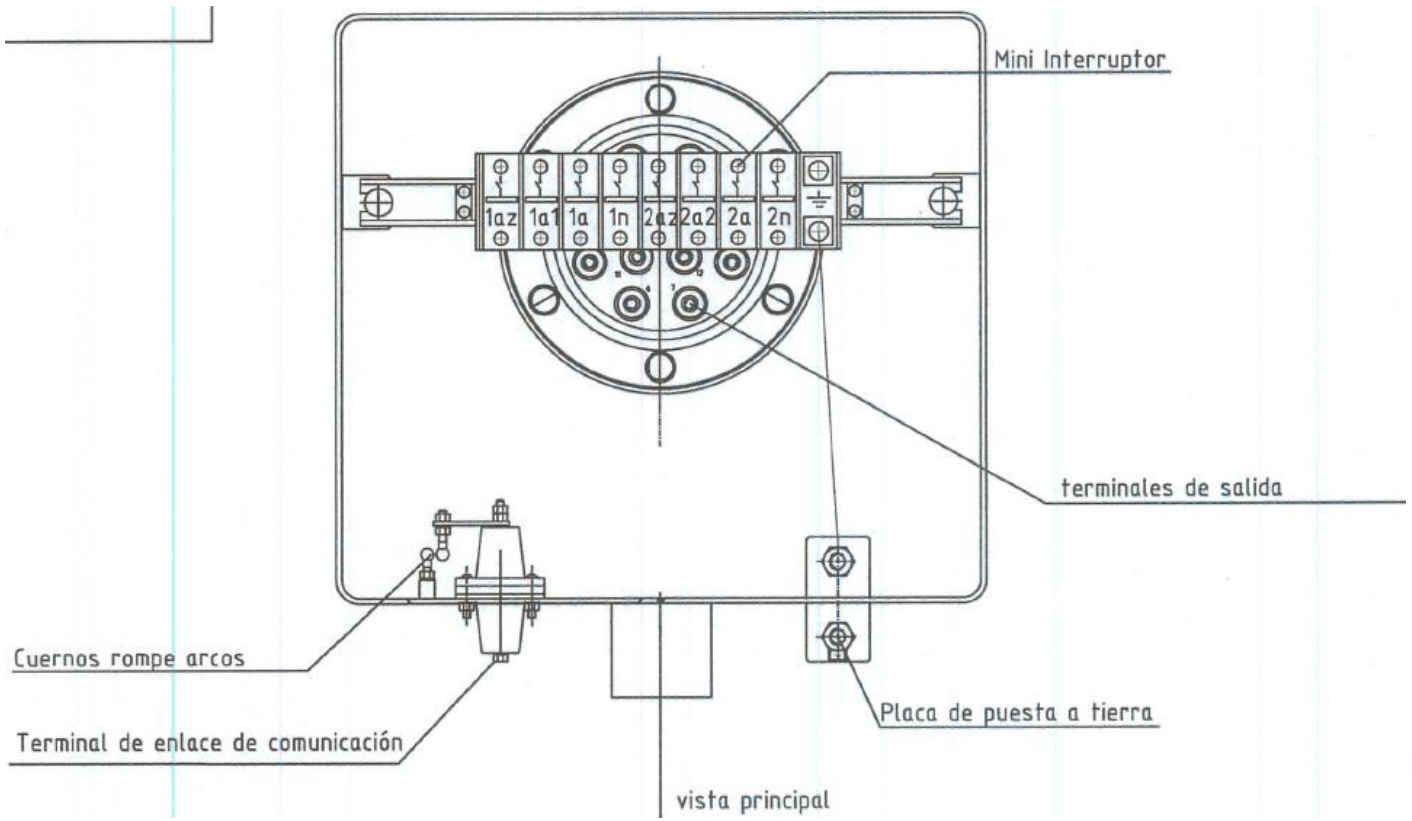


COMPONENTES Y EQUIPOS

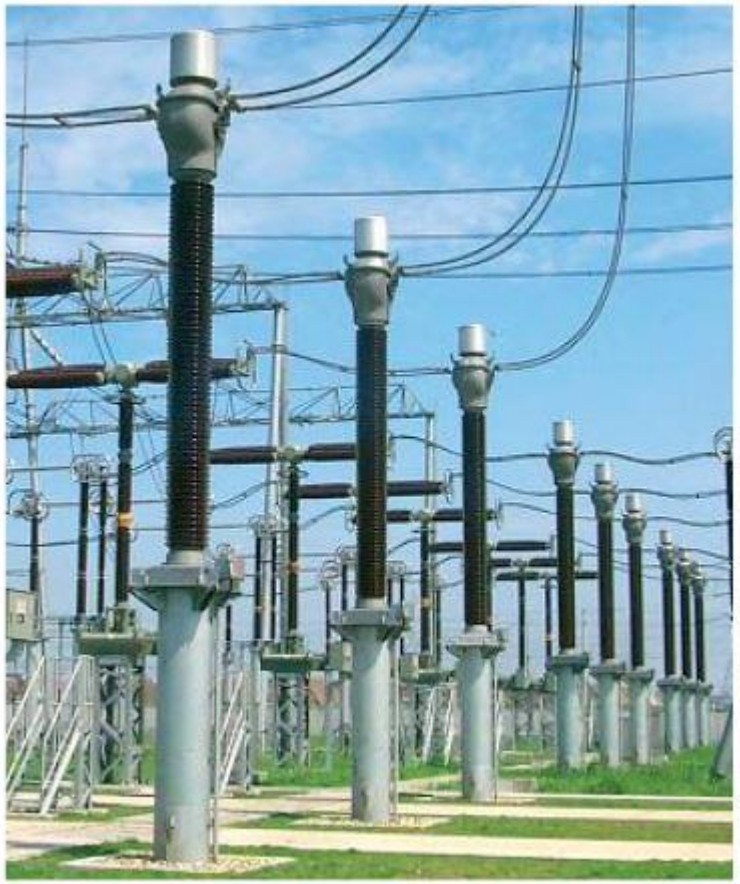
TRANSFORMADOR DE TENSIÓN

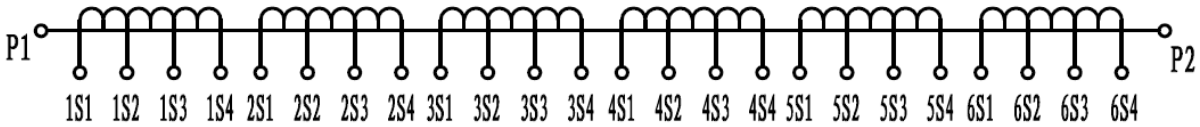


Marca de devanado secundario	1a-1a1	1a-1n	2a-2a2	2a-2n
Tensión secundario nominal, V	115/√3	115	115/√3	115
Clase de precisión	0.2		3P	
Carga nominal, VA	200		200	

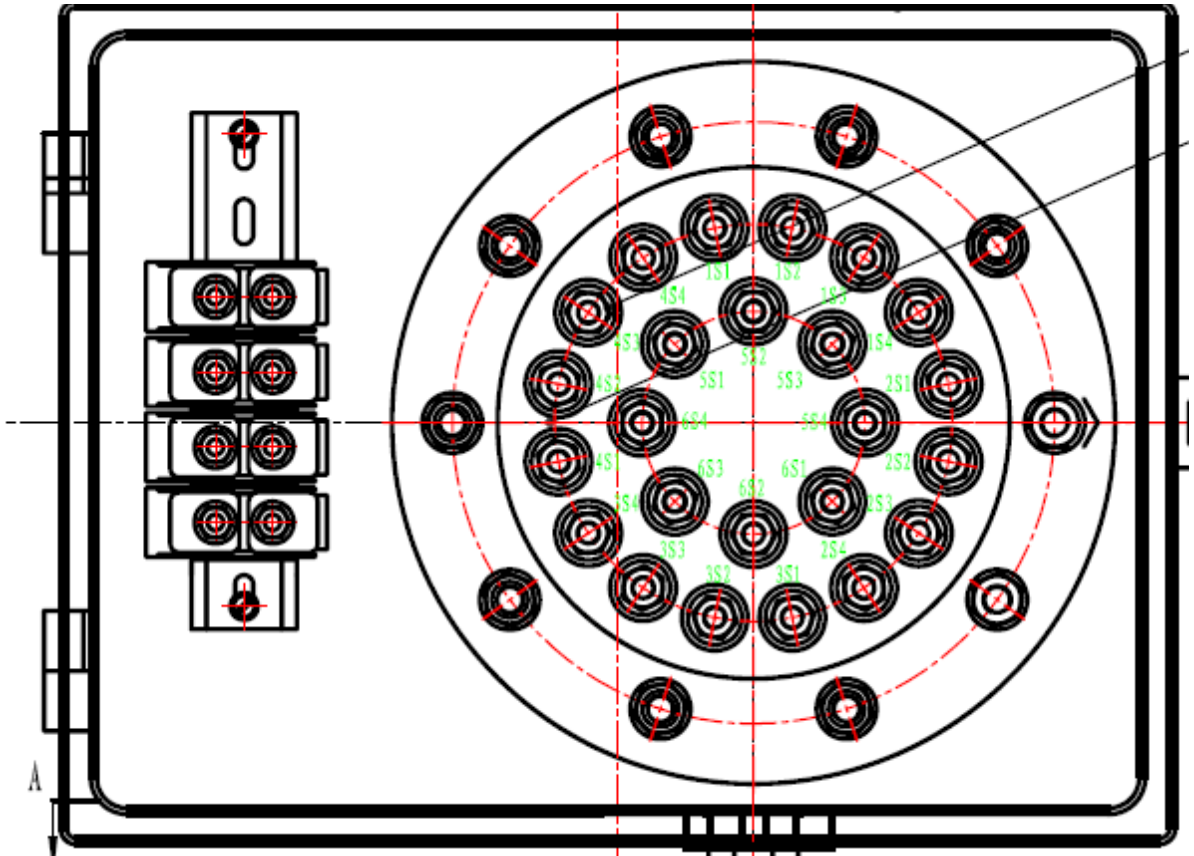


TRANSFORMADOR DE CORRIENTE





Número de arrollamiento	1 ~ 4				5 ~ 6			
Indicación de terminal secundario	S1-S2	S2-S3	S1-S3	S1-S4	S1-S2	S2-S3	S1-S3	S1-S4
Relación de corriente nominal(A/A)	500/1	1000/1	1500/1	2500/1	500/1	1000/1	1500/1	2500/1
clase de presión	5P20	5P20	5P20	5P20	0.2	0.2	0.2	0.2
salida nominal (VA)	25	25	25	25	75	75	75	75



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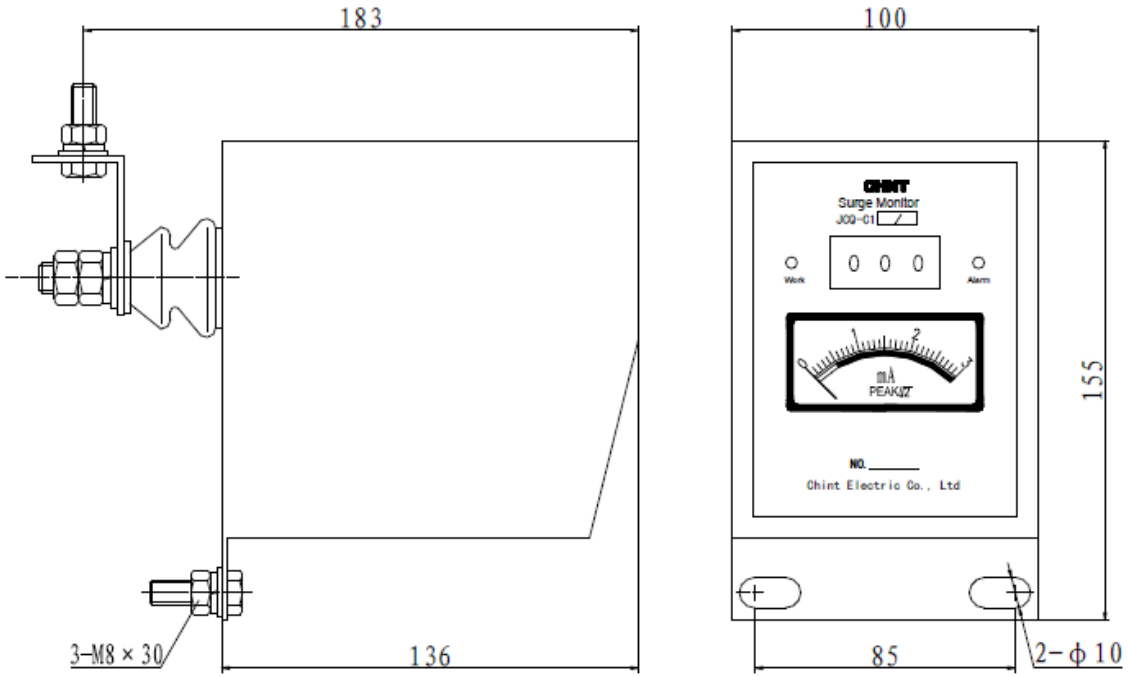
COMPONENTES Y EQUIPOS

DESCARGADOR DE SOBRETENSIONES



Control y Protecciones 230kV

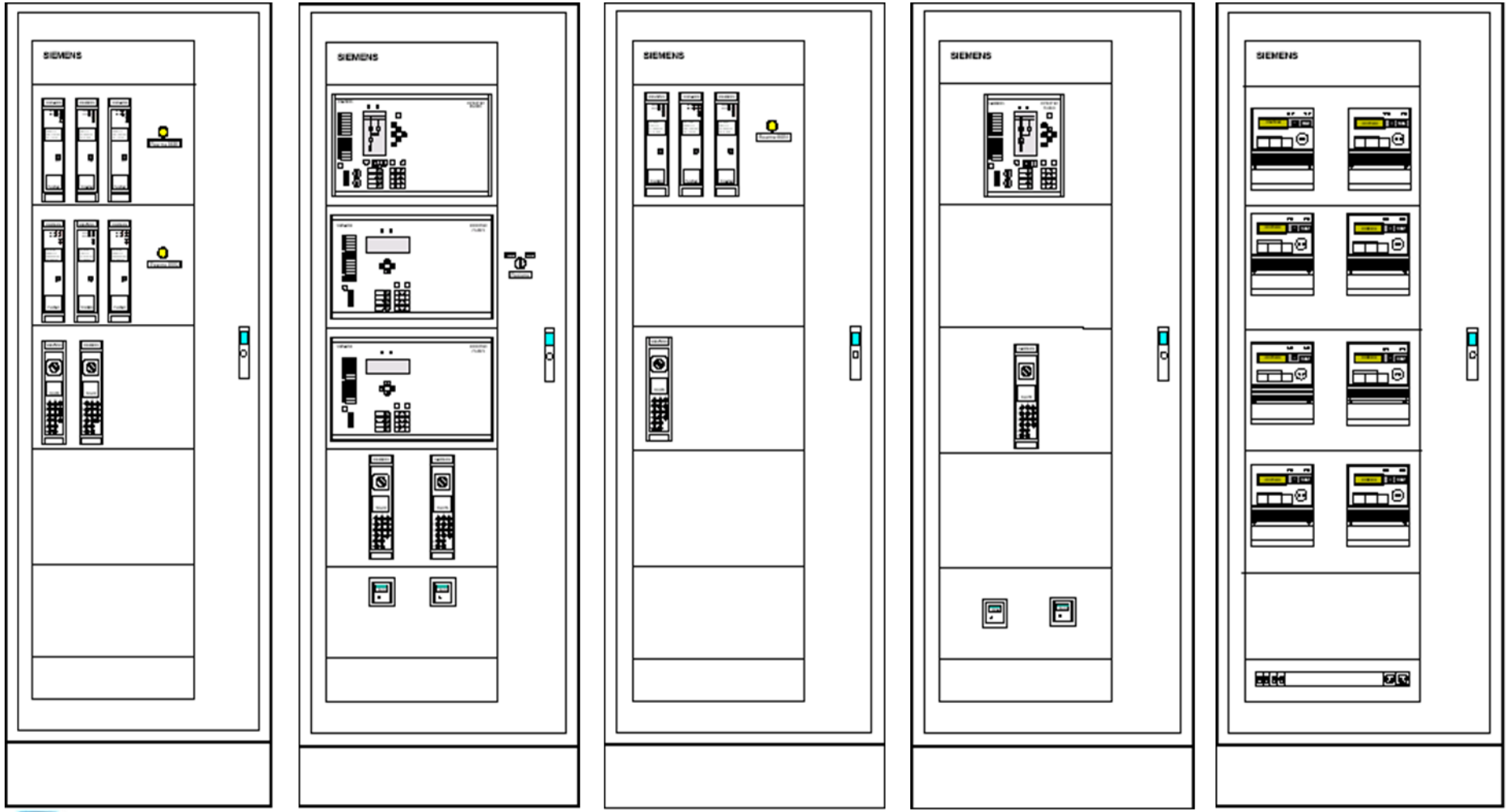
Pos 05-Diferencial de Barras 230kV

Pos 06- Salida de Línea 115 kV

Pos 07-Diferencial de Barras 115kV

Pos 08- Transferencia 115 kV

Pos 09- Contadores

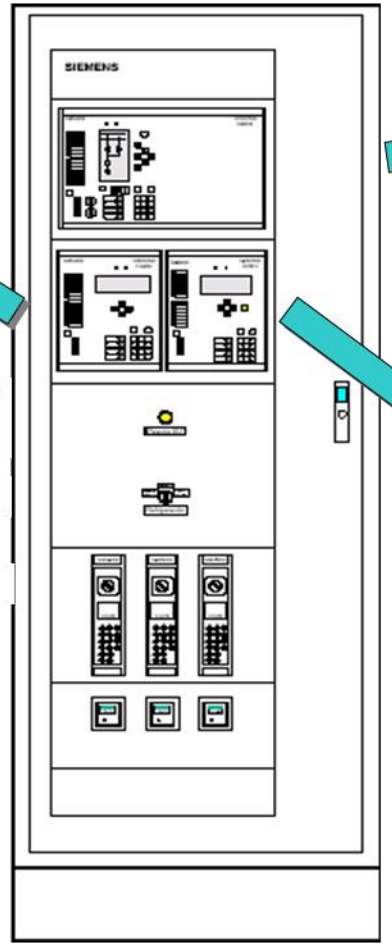


Desarrollo Protecciones 230kV - Pos02

Autotransformador 230/115kV

7SA522

- Protección de distancia, Control y medida.
- 21,21N, 25, 50BF
- Disparo Tri-polar.



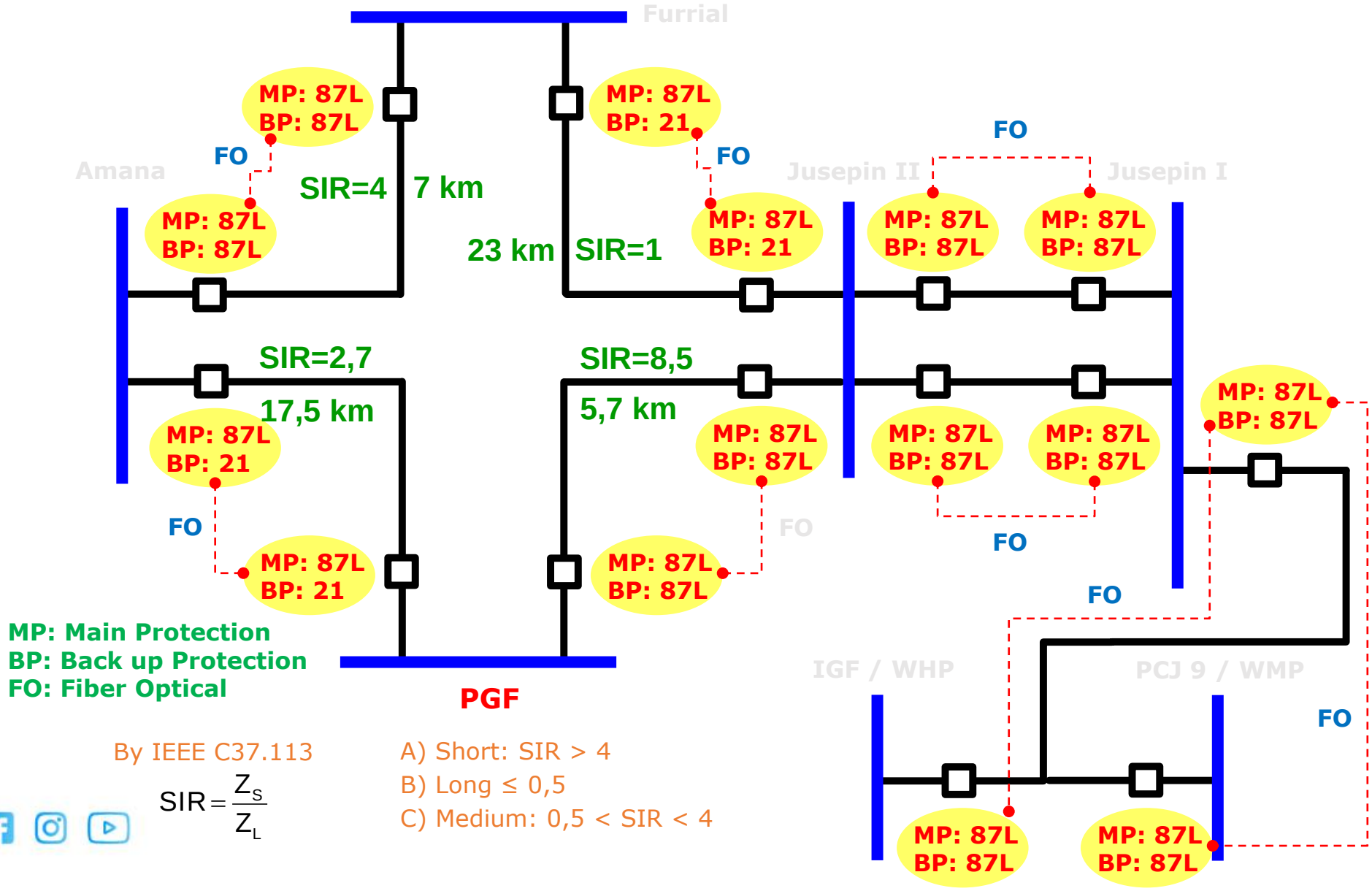
6MD664

- Unidad de Control de posición

7UT613

- Protección diferencial de Transformador (tres devanados)

One Line Diagram of System



By IEEE C37.113

$$SIR = \frac{Z_S}{Z_L}$$

A) Short: SIR > 4
B) Long ≤ 0,5
C) Medium: 0,5 < SIR < 4

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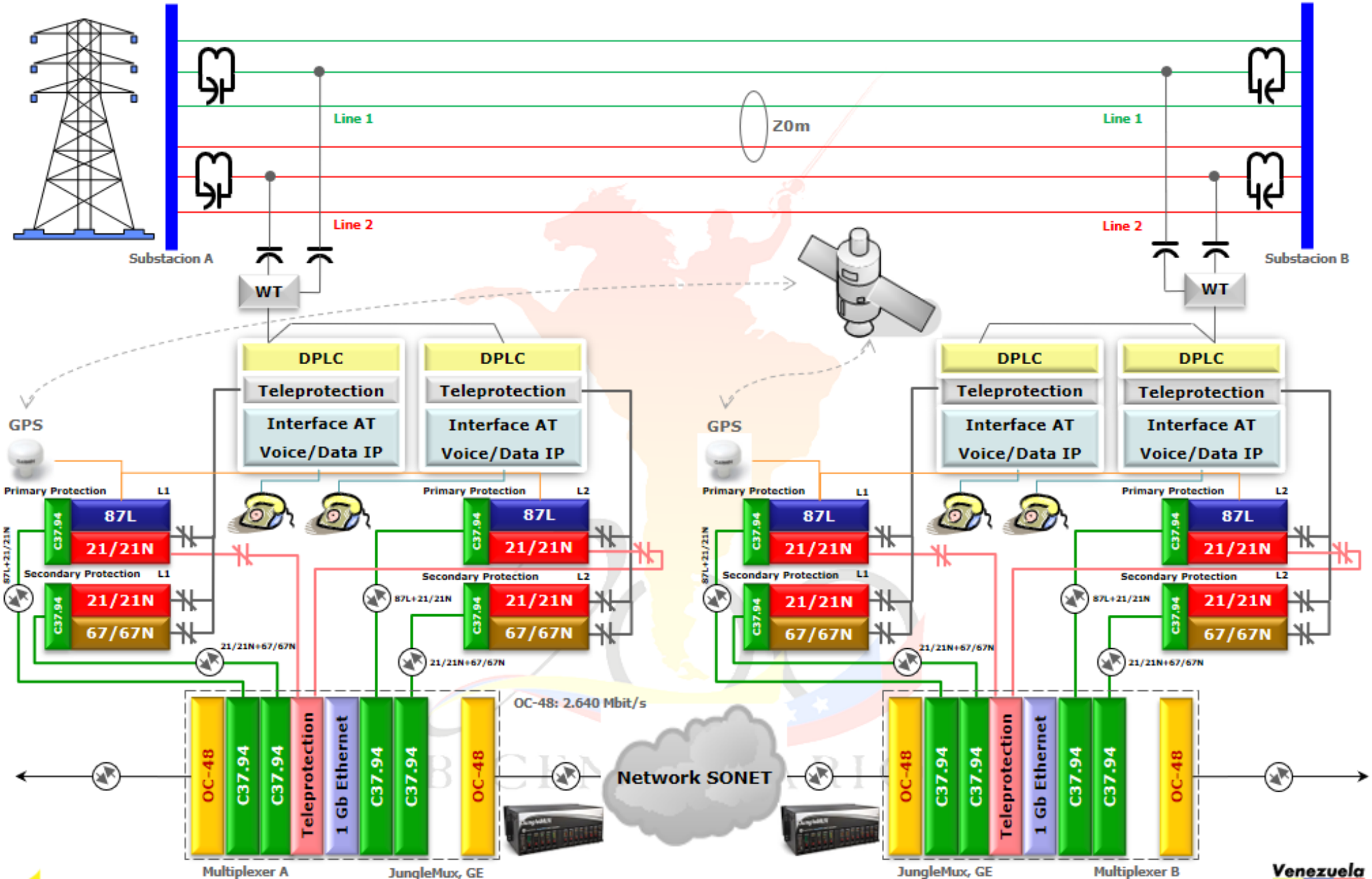
Medium and Long Parallel Transmission Line Protection Scheme



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Venezuela

Short Parallel Transmission Line Protection Scheme

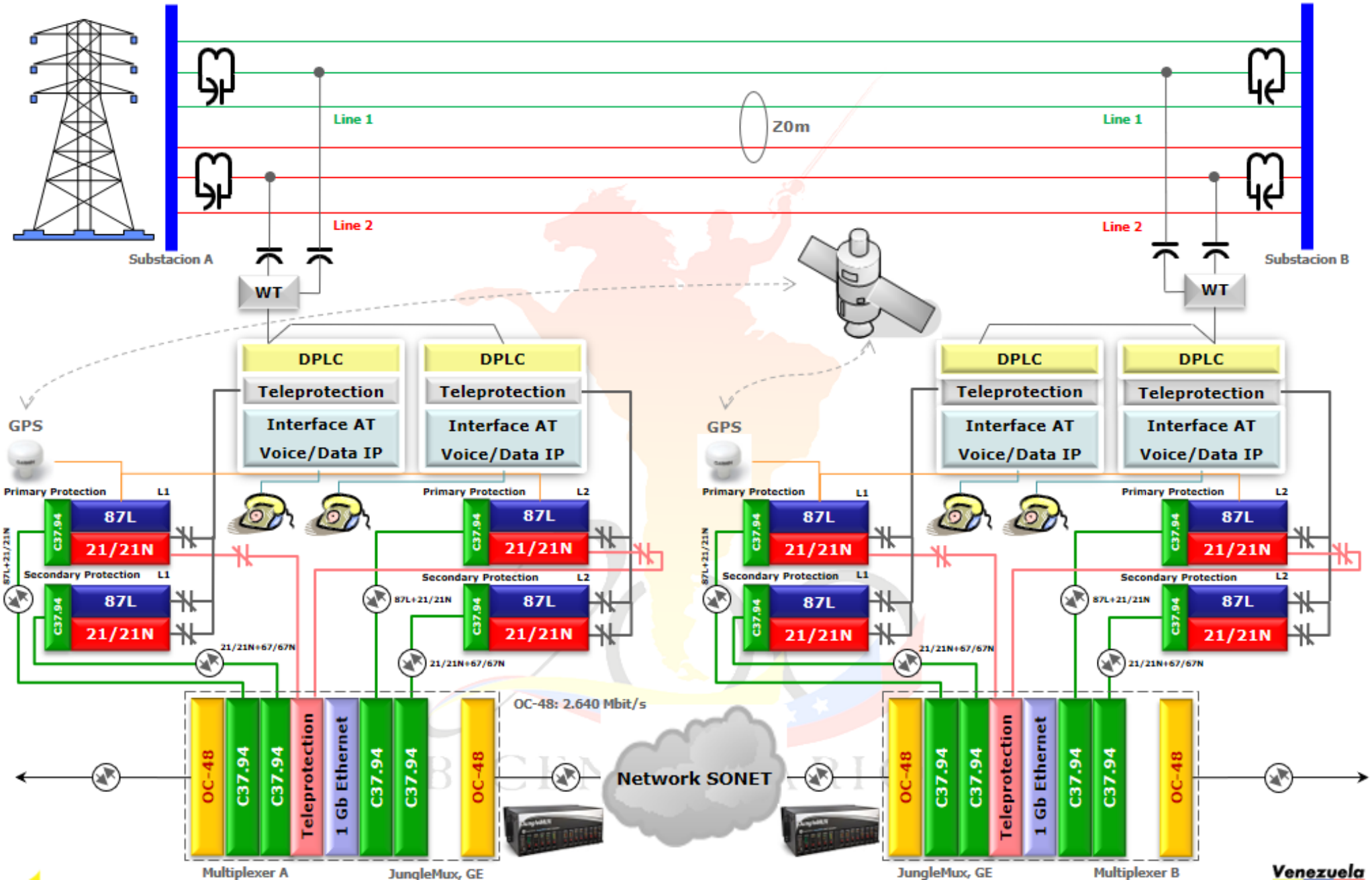

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DIAGRAMA DE PRINCIPIO

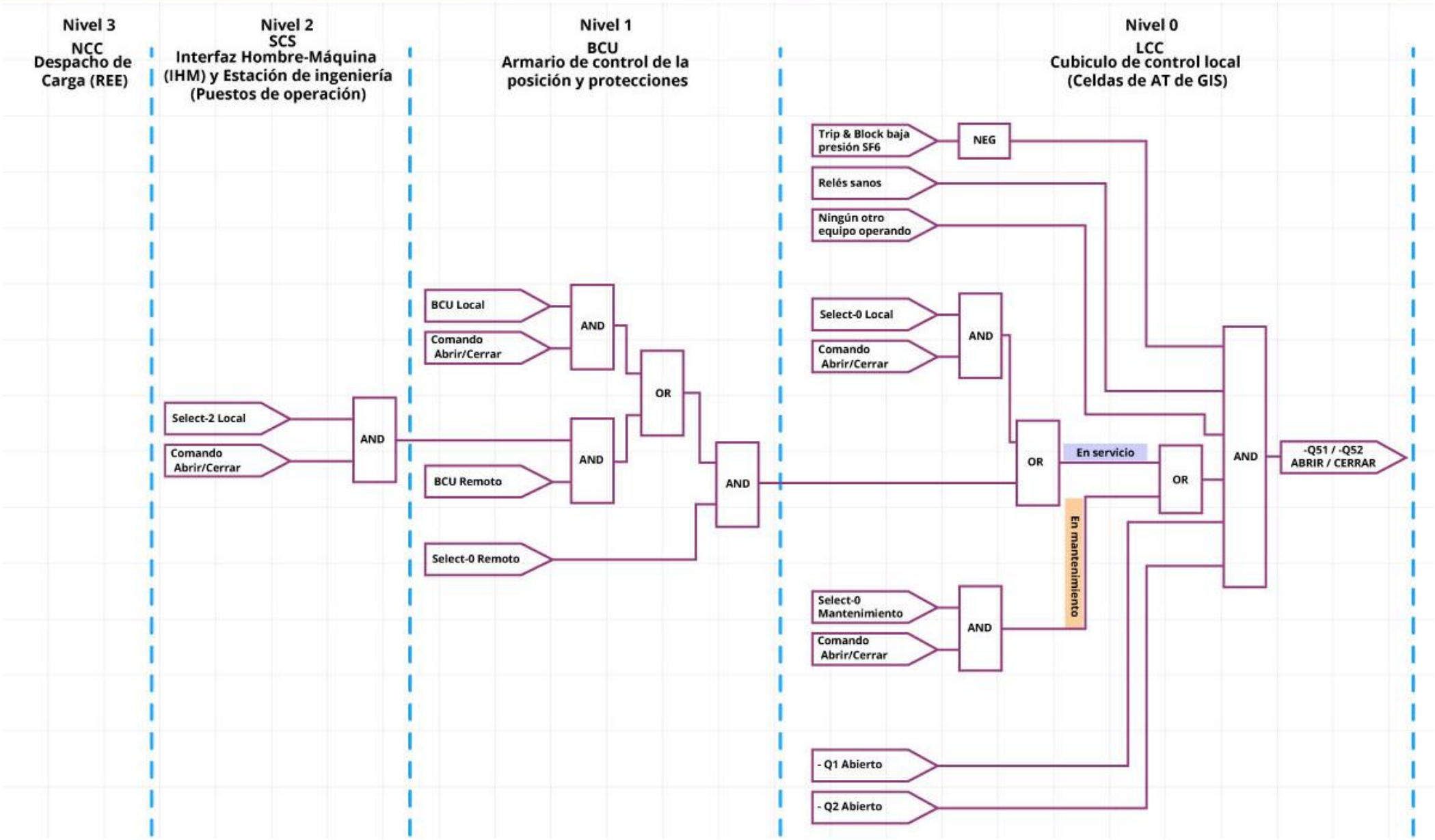

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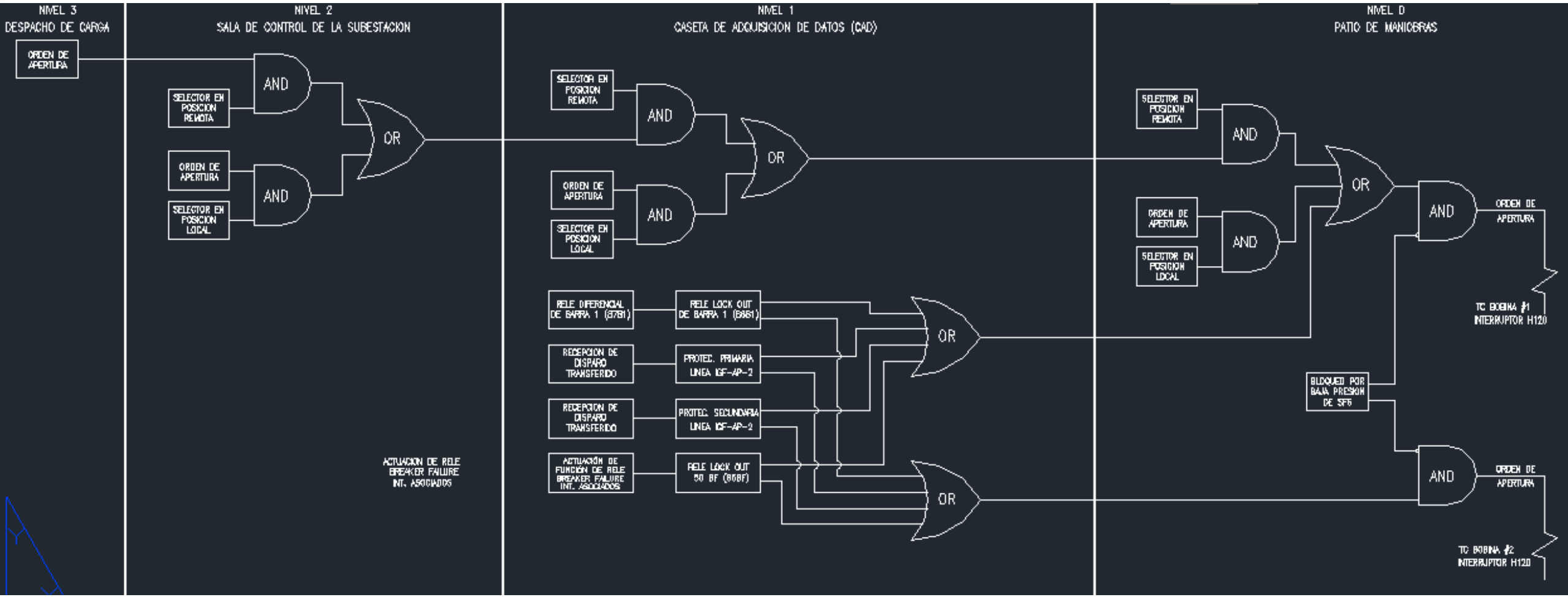
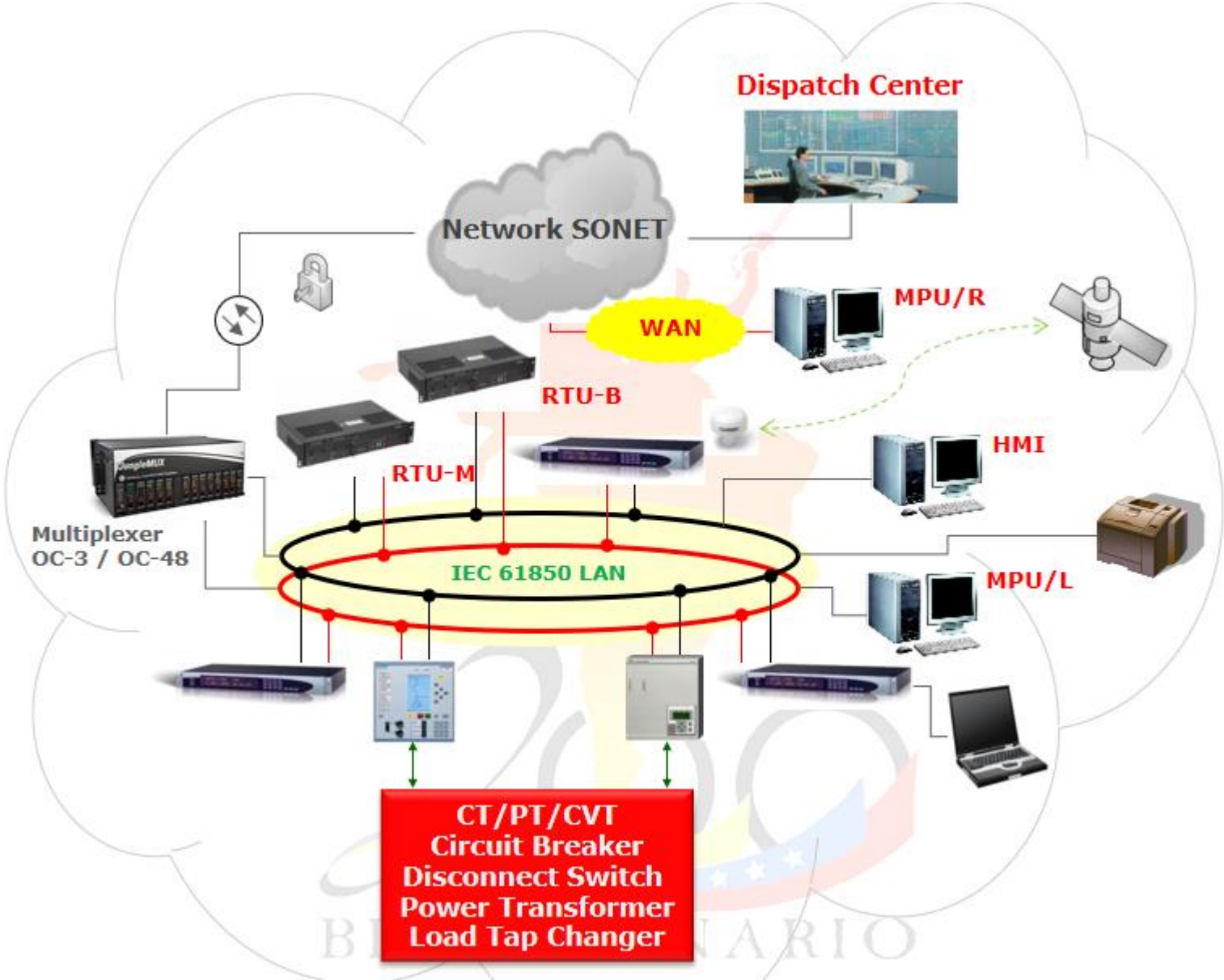
DIAGRAMA DE PRINCIPIO



Substation Automation System

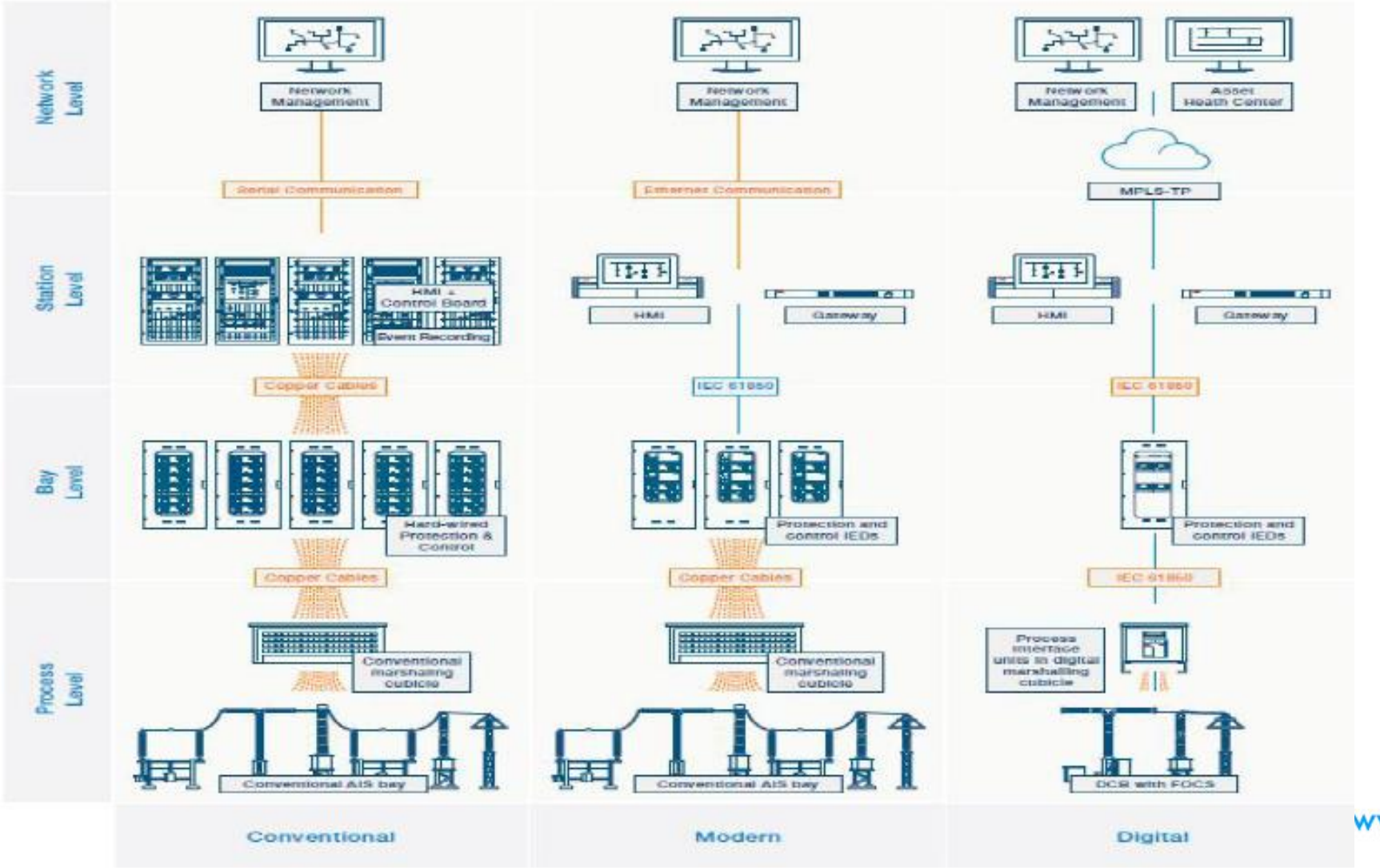


INTEGRACION DEL SISTEMA DE CONTROL

AUTOMATIZACIÓN Y SCADA

COMPONENTES Y EQUIPOS

Evolución de las subestaciones



COMPONENTES Y EQUIPOS

BANCO DE BATERIAS
TABLERO CARGADOR
RECTIFICADOR

COMPONENTES Y EQUIPOS

COMPONENTES Y EQUIPOS

COMPONENTES Y EQUIPOS

COMPONENTES Y EQUIPOS

TABLERO DE SERVICIOS AUXILIARES

DISTRIBUCIÓN DE EQUIPOS EN EL PATIO DE LLAVES

BAHÍA DE TRANSFORMACIÓN

Transformador

Descargador de sobretensión

Transformador de Corriente

Interruptor

Seccionador

Transformador de tensión

Descargador de sobretensión

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BAHÍA DE LÍNEA

Transformador de Corriente

Seccionador de Línea

Seccionador de Barra

Transformador de tensión

Interruptor

Descargador de sobretensión

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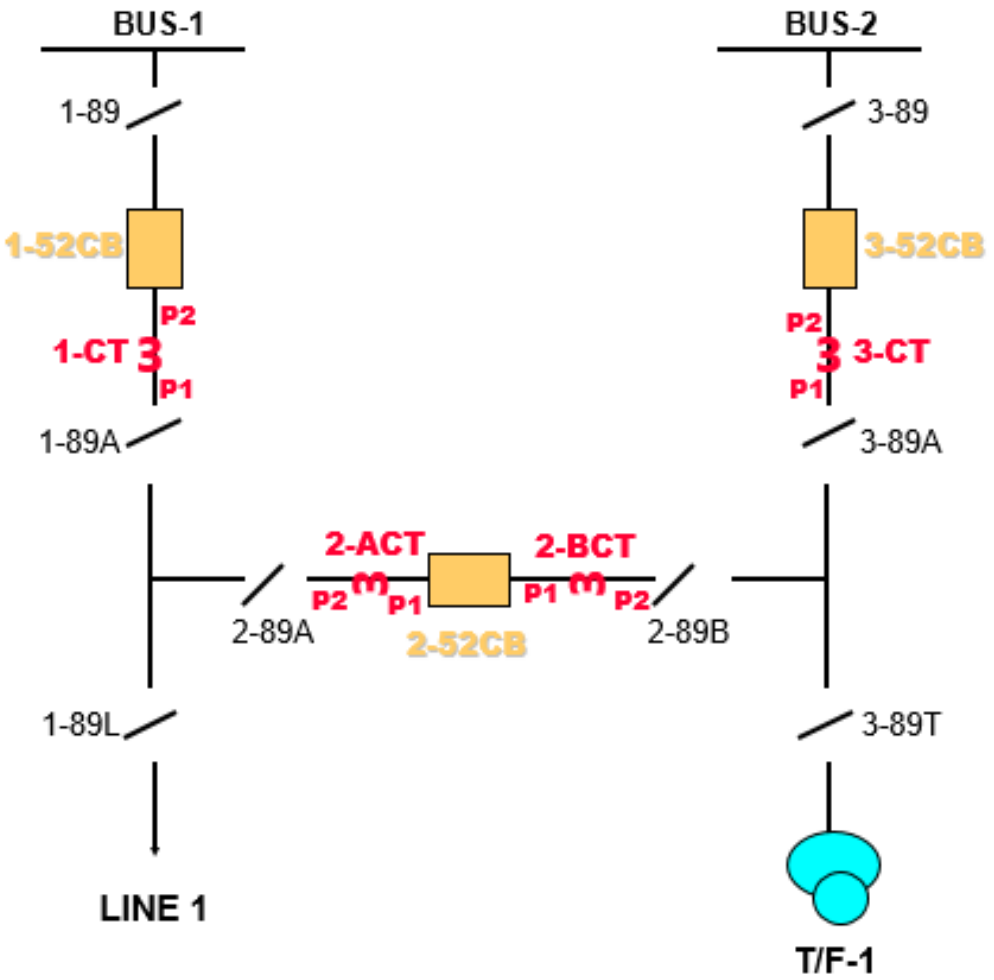
UBICACIÓN Y CANTIDAD DE TC Y TP

ONE & HALF BREAKER SYSTEM

(4CT METHOD)



UBICACIÓN Y CANTIDAD DE TC Y TP

	1- CT	2-BCT	2-ACT	3-CT
CORE-1 (PS)	CT SECONDARY CORE IS CONNECTED TO BUSBAR-1 PROTECTION	SPARE	SPARE	CT SECONDARY CORE IS CONNECTED TO BUSBAR-2 PROTECTION
CORE-2 (PS)	BUSBAR-1 CHECKUP PROTECTION (SPARE)	SPARE	SPARE	BUSBAR-2 CHECKUP PROTECTION (SPARE)
CORE-3 (0.5/0.2)	2CT's SECONDARIES ARE CONNECTED IN PARALLEL AND CONNECTED TO PANEL METERS & ENERGY METER		2CT's SECONDARIES ARE CONNECTED IN PARALLEL AND CONNECTED TO PANEL METERS & ENERGY METER	
CORE-4 (PS)	2CT's SECONDARIES ARE CONNECTED IN PARALLEL AND CONNECTED TO MAIN-2 PROTECTION AFTER LBB/BFR		2CT's SECONDARIES ARE CONNECTED IN PARALLEL AND CONNECTED TO BACKUP PROTECTION AFTER LBB/BFR	
CORE-5 (PS)	2CT's SECONDARIES ARE CONNECTED IN PARALLEL AND CONNECTED TO MAIN-1 PROTECTION		2CT's SECONDARIES ARE CONNECTED IN PARALLEL AND CONNECTED TO MAIN PROTECTION	

EVOLUCION DE LOS IED

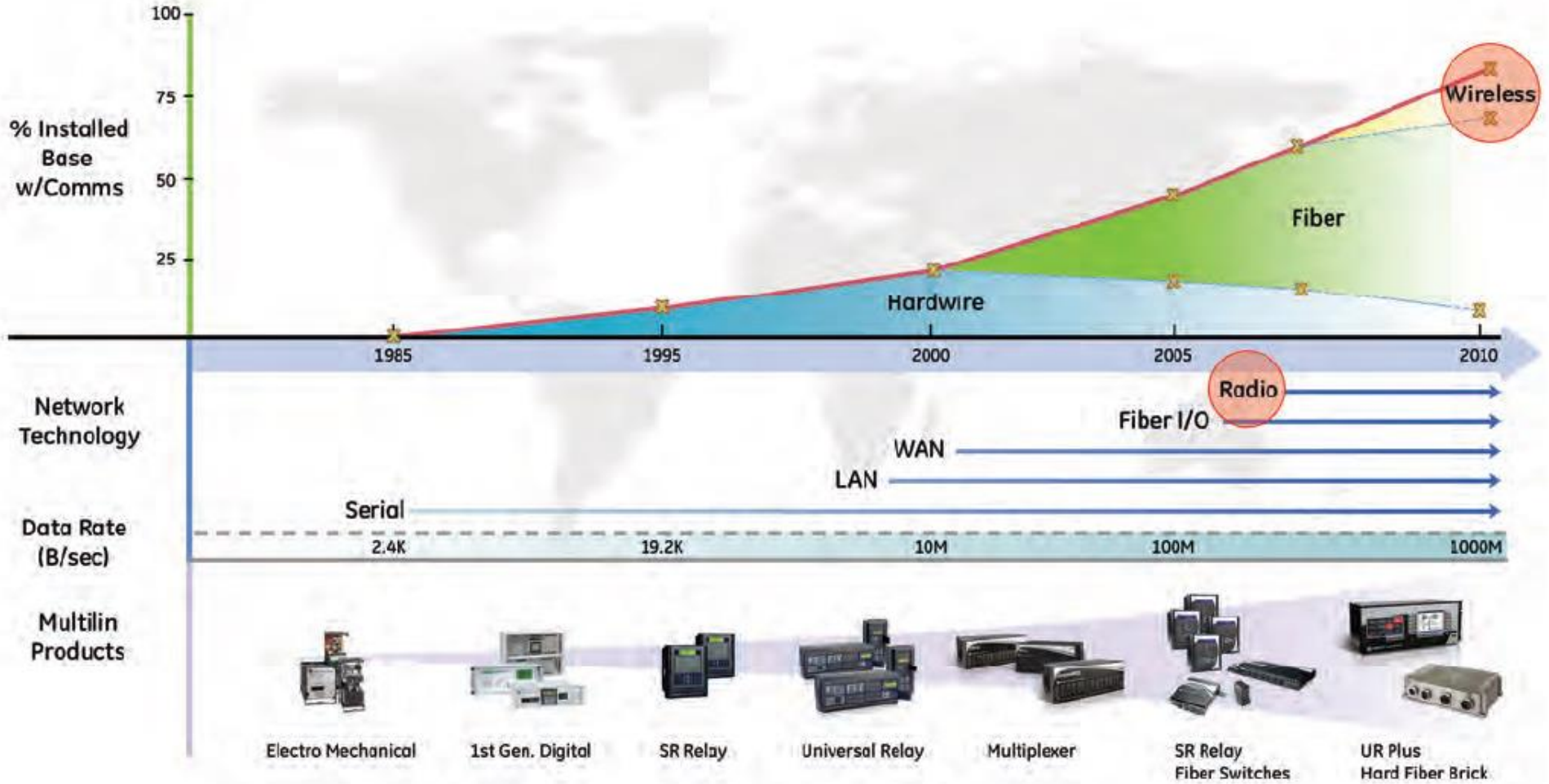


Figure 1.
The Evolution of IED Communications

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EVOLUCION DE LOS IED

On the device side, the IED and its constituent components have undergone an evolutionary convergence of multiple functions and features into a single device (Figure 2). In the past, protection, control, metering, oscillography, sequence of events (SOE), annunciation, and programmable automation logic were all separate functions. Today's IEDs combine these functions and

Figure 2.
Convergence of Functionality in Today's IEDs

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ESQUEMAS DE BARRAS

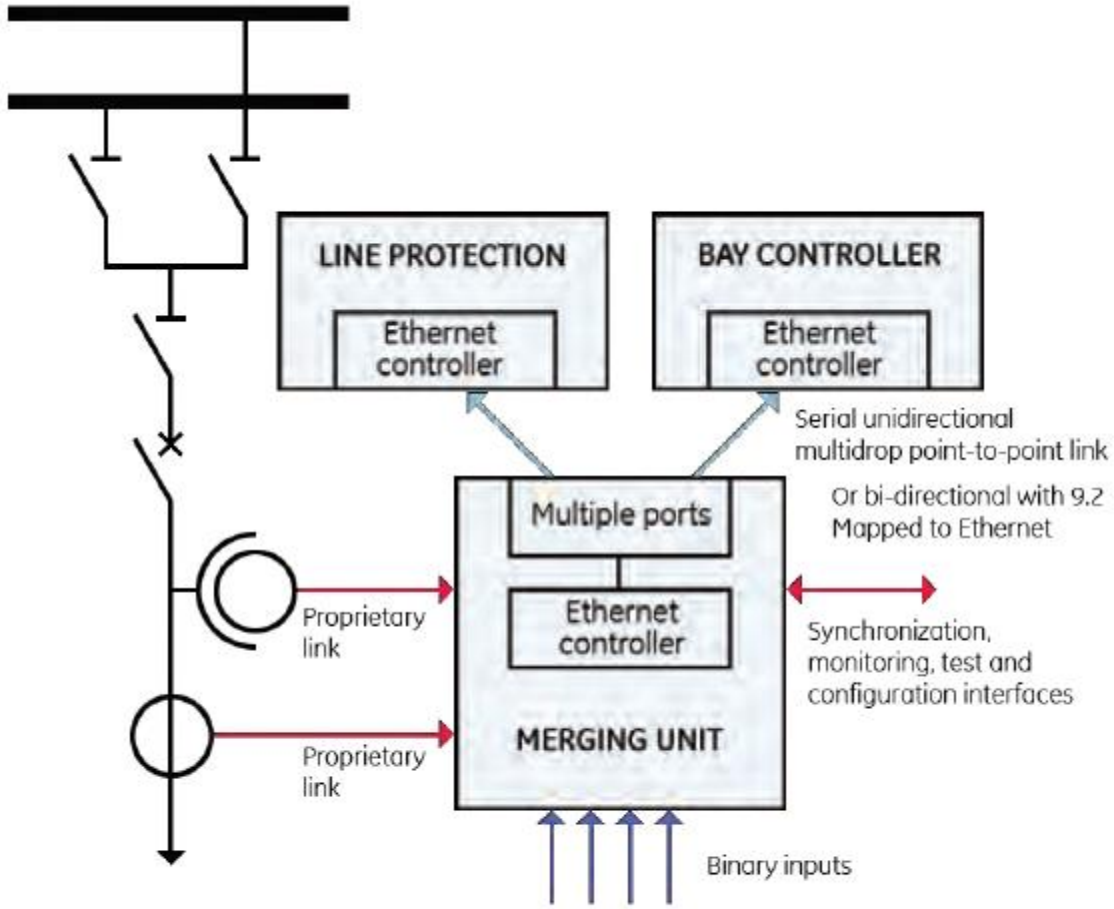

Figure 5.
Sample Measured Value Concept

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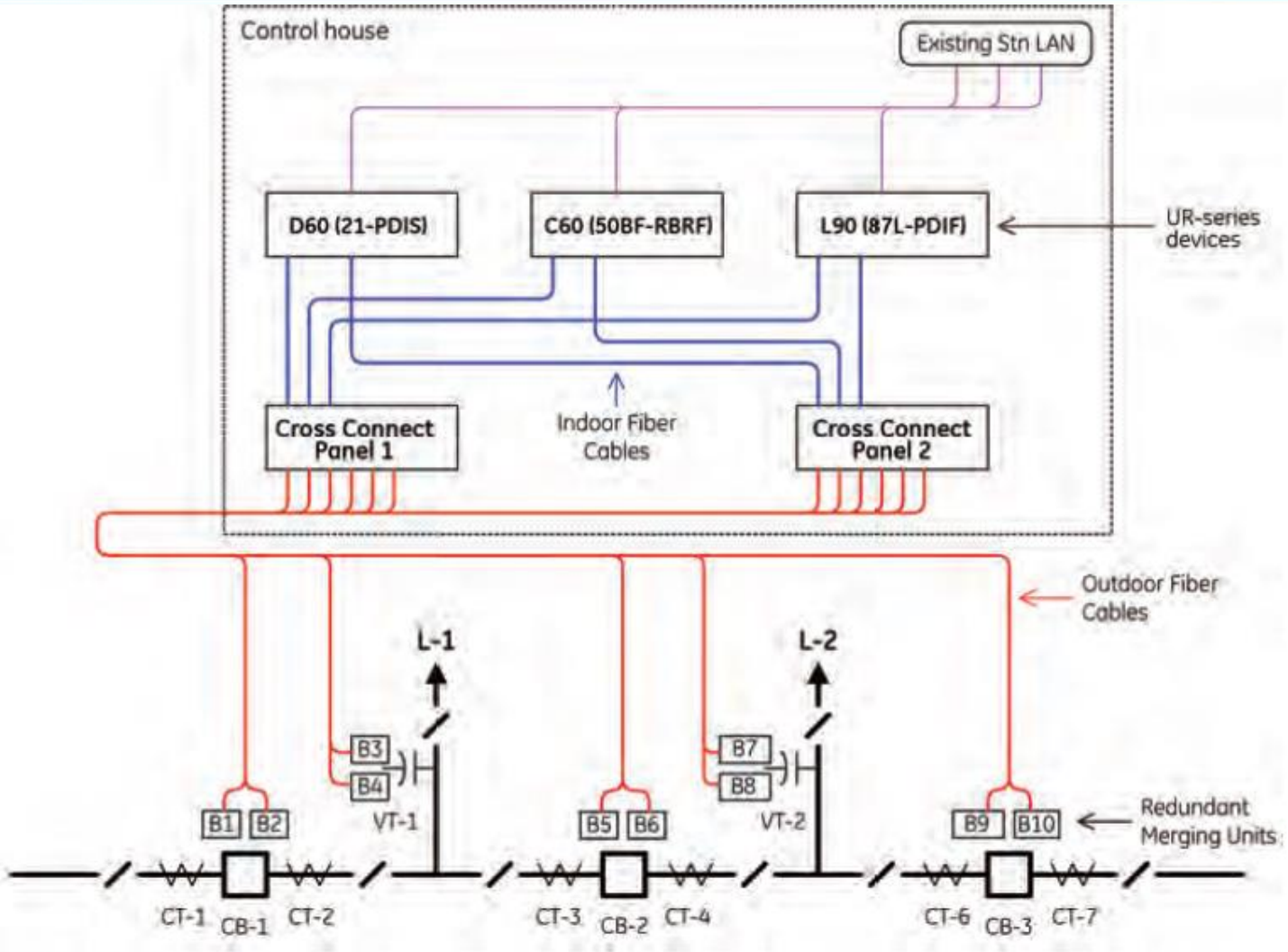

Figure 5.
Example system illustrating the architecture

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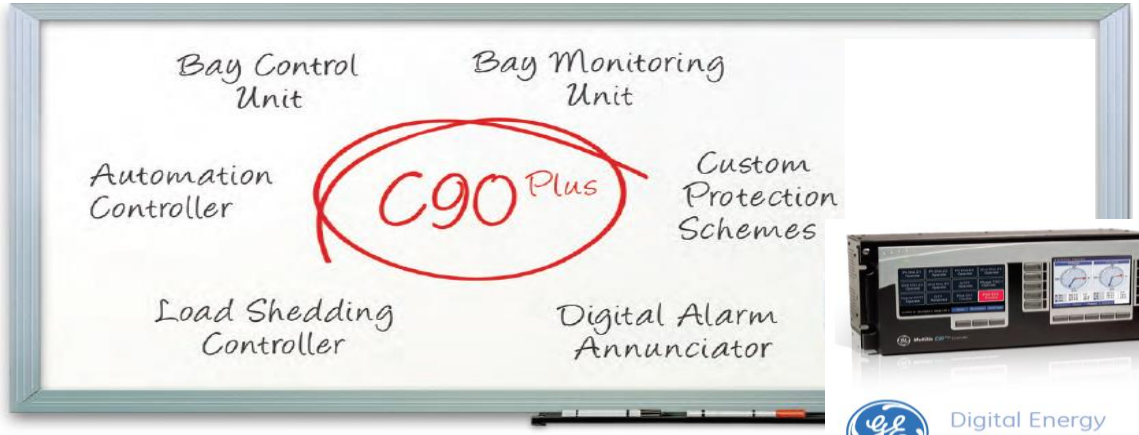
UNIDAD DE CONTROL DE BAHIA (BCU)



Digital Energy Multilin

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Equipment	Manufacturer	Model	Quantity
Line Current Differential Relay	Siemens	7SD52	4
Breaker Failure	Siemens	7VK61	4
Directional Overcurrent	Siemens	7SJ64	4
Distance Relay	General Electric	D90 Plus	4
Bay Control Unit	Siemens	6MD66	4
Energy Meters	Elster	A1882	4

Equipment	Manufacturer	Model	Quantity
Digital Power Line Carrier	PLC Int.	UCC2021D	4
Wave Trap	PLC Int.	PLC 9550	4
Line Tuner	PLC Int.	PLC 9550	4
Coupling Capacitor	ABB	CCA	4

Equipment	Manufacturer	Model	Quantity
Multiplexor	General Electric	Jungle Mux-OC 48	4
RTU	General Electric	D400	6
Switches	Ruggedcom	-	6

DIAGRAMA UNIFILAR GENERAL S/E

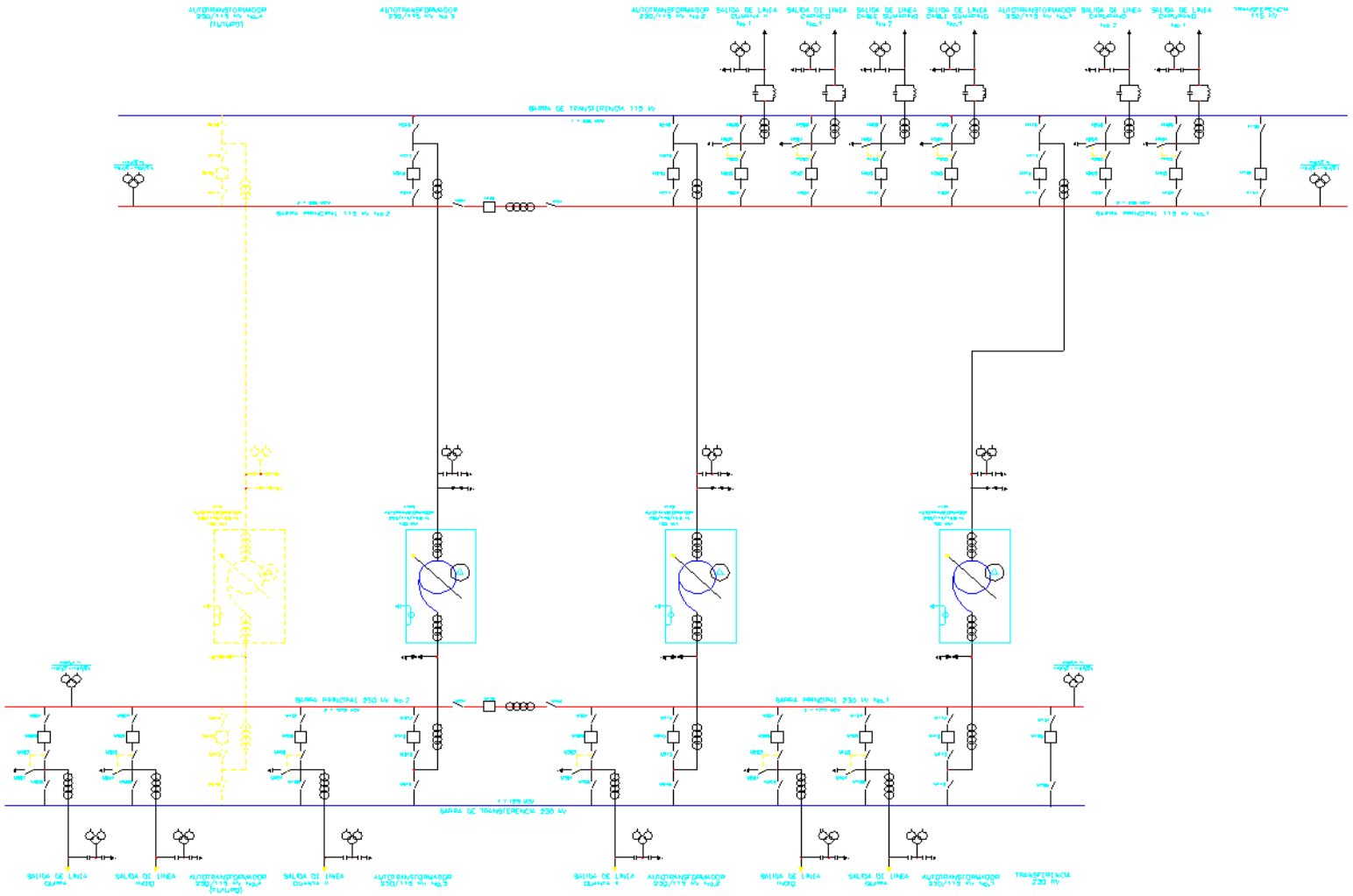


DIAGRAMA UNIFILAR AMPLIADO S/E

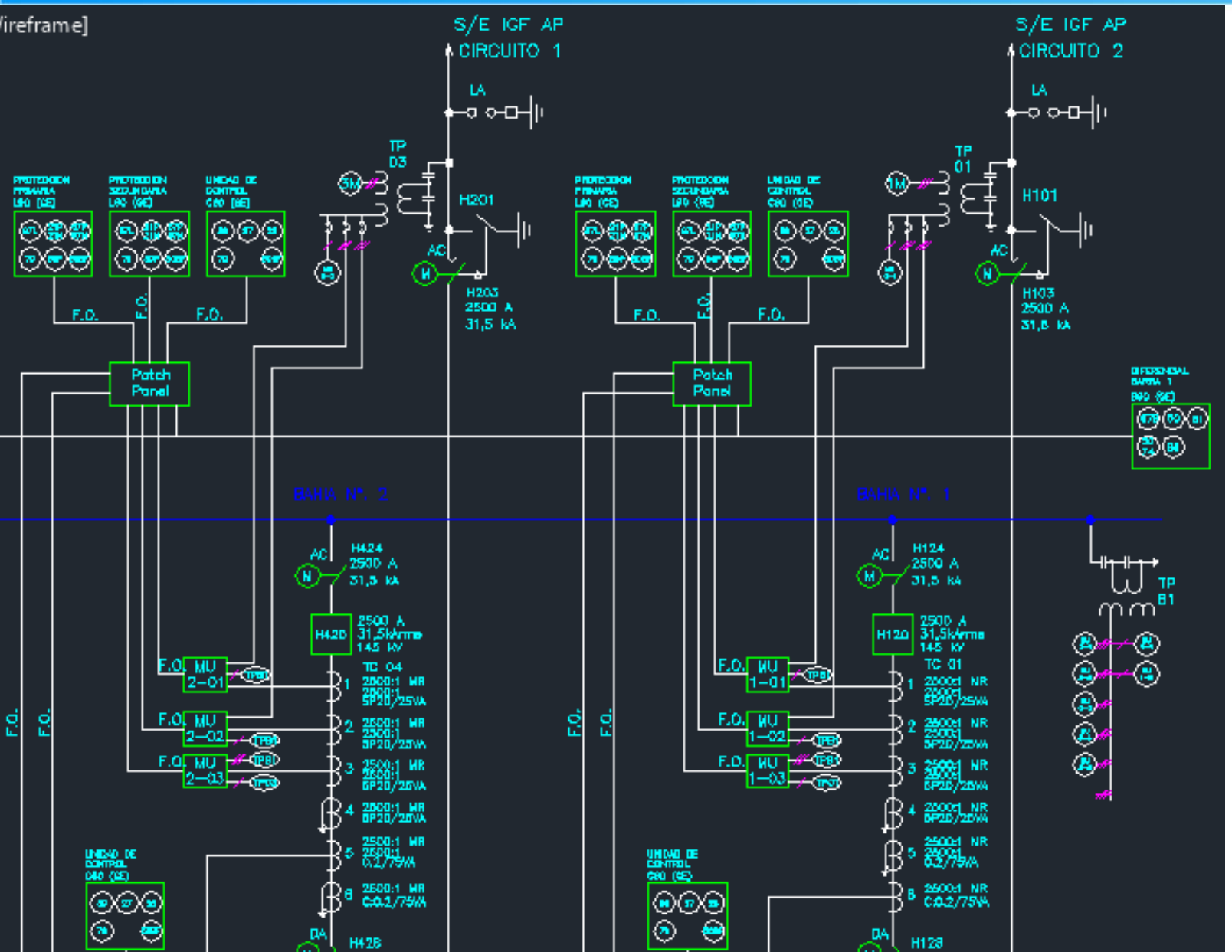
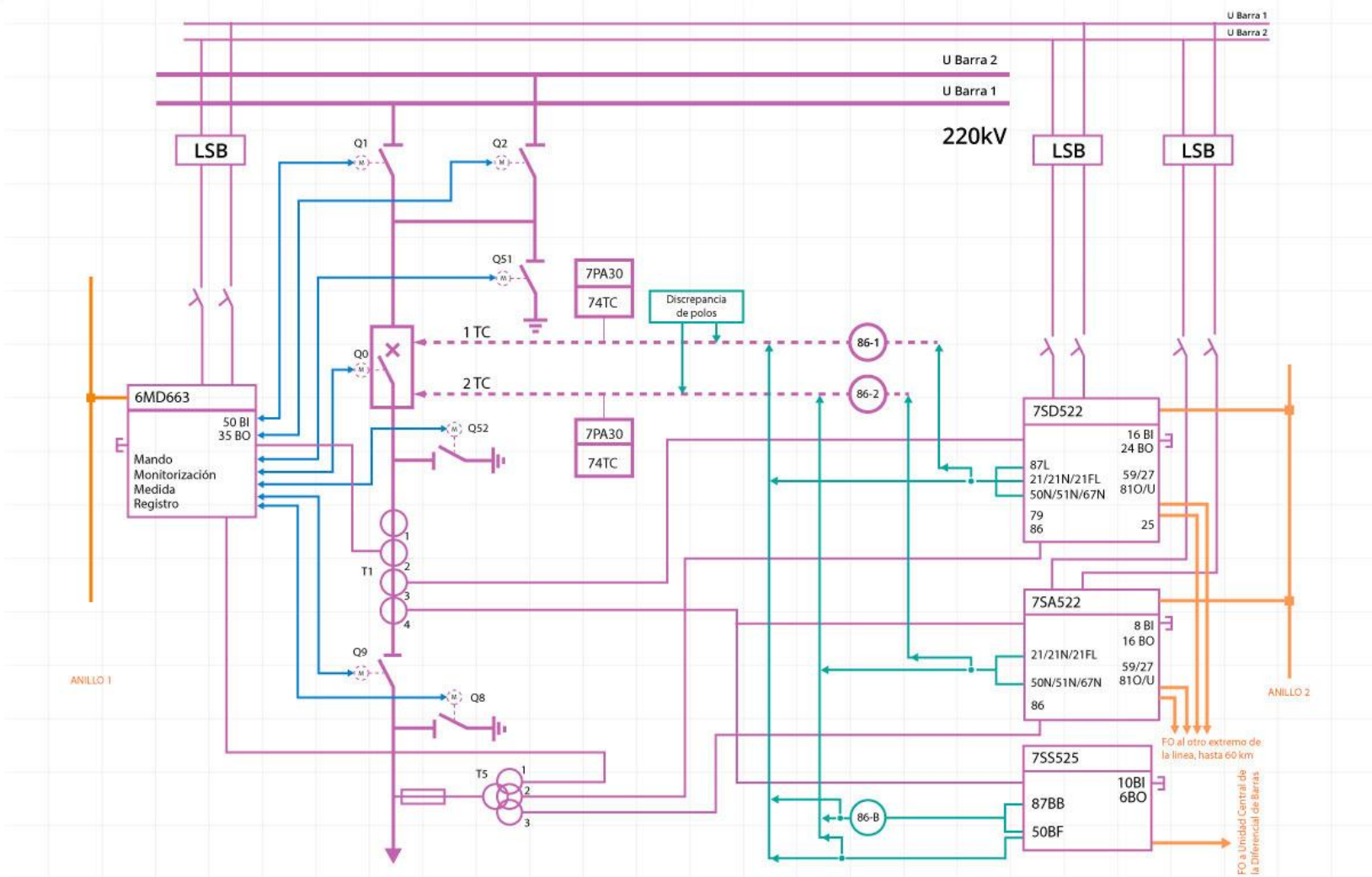


Tabla 1-1: Distribución de núcleos de TCs para nivel de tensión de 115 kV [Elaboración propia]

TCs de 4 núcleos (Nivel de tensión 115 kV)		
Núcleo		Equipos asociados
1	Medida	Medidores, equipos de calidad de la potencia y Controladores de bahía.
2	Protección 1	Protección Principal y esquemas suplementarios (cuando requiera).
3	Protección 2	Protección Respaldo.
4	Protección 3	Diferencial de barras.

DIAGRAMA UNIFILAR AMPLIADO S/E



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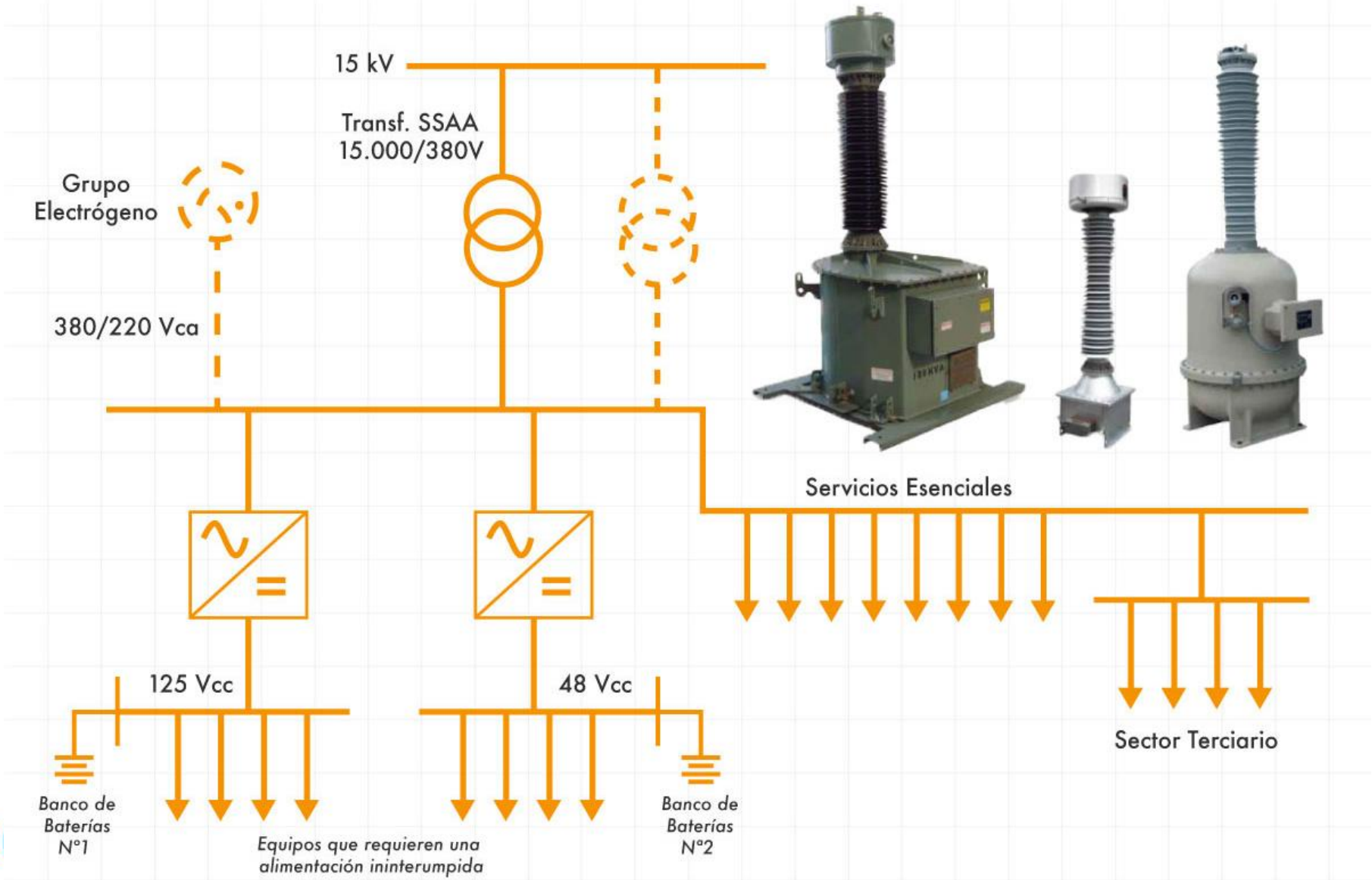
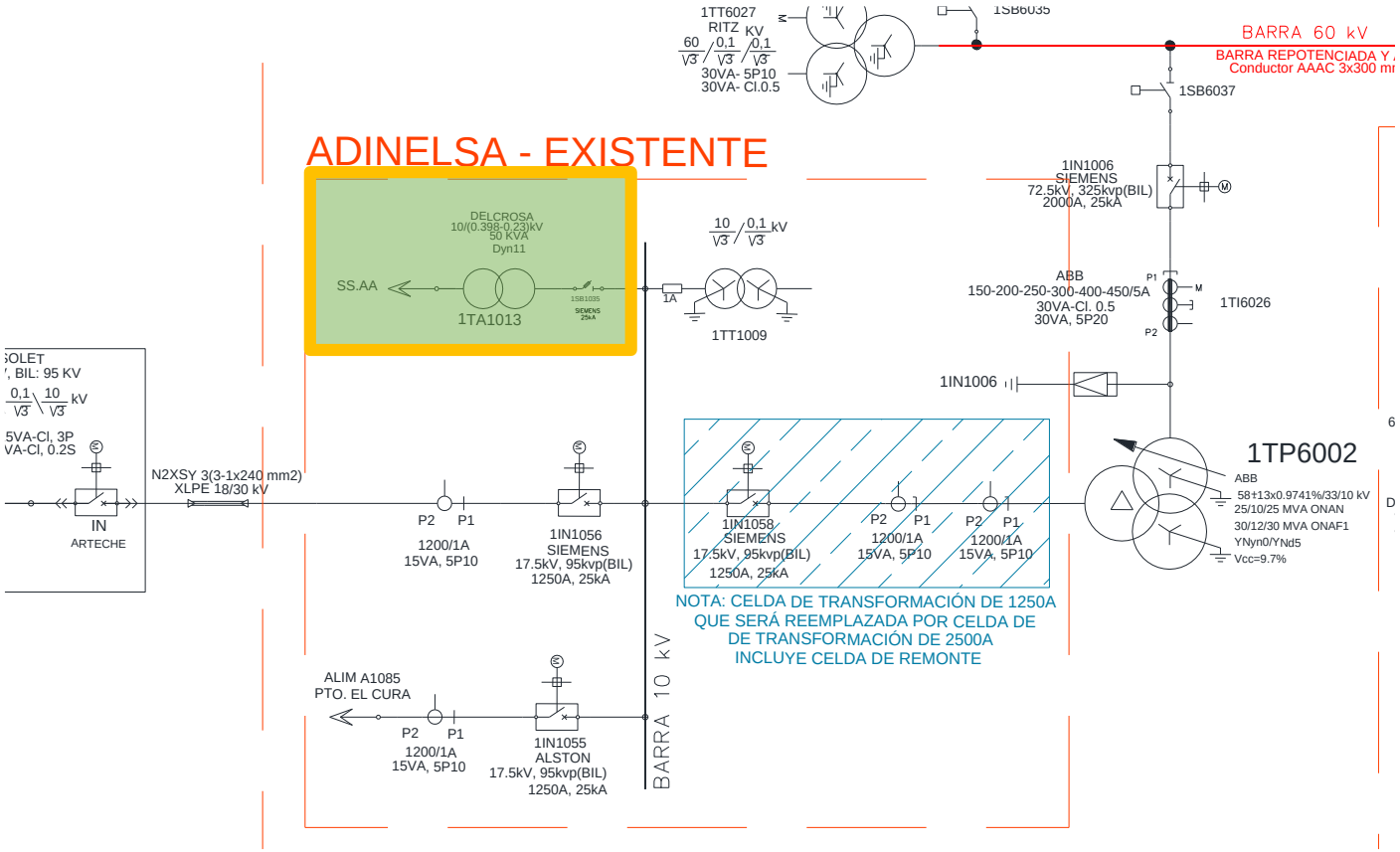
SERVICIOS AUXILIARES



SERVICIOS AUXILIARES EN AC



SERVICIOS AUXILIARES EN DC

CICLO DE TRABAJO

- L1: 40 A durante 3 horas continuas de carga
- L2: 280 A durante 5 s, la corriente de arranque para cargar
- L3: 60 A partir de 5 s por el minuto 120
- L4: 100 A del min 30 hasta el minuto 120
- L5: 80 A minutos del 30 hasta el minuto 60
- L6: Carga al final del ciclo de trabajo, con la secuencia conocida de:

- 40 A durante los primeros 5 s
- 80 A para los próximos 10 s
- 30 A para los próximos 20 s

Por razones de simplicidad, esto puede ser conservadora, considera que una carga de 80 A 35 s.

- L7: 100 A durante 1 minuto aleatoria de la carga.

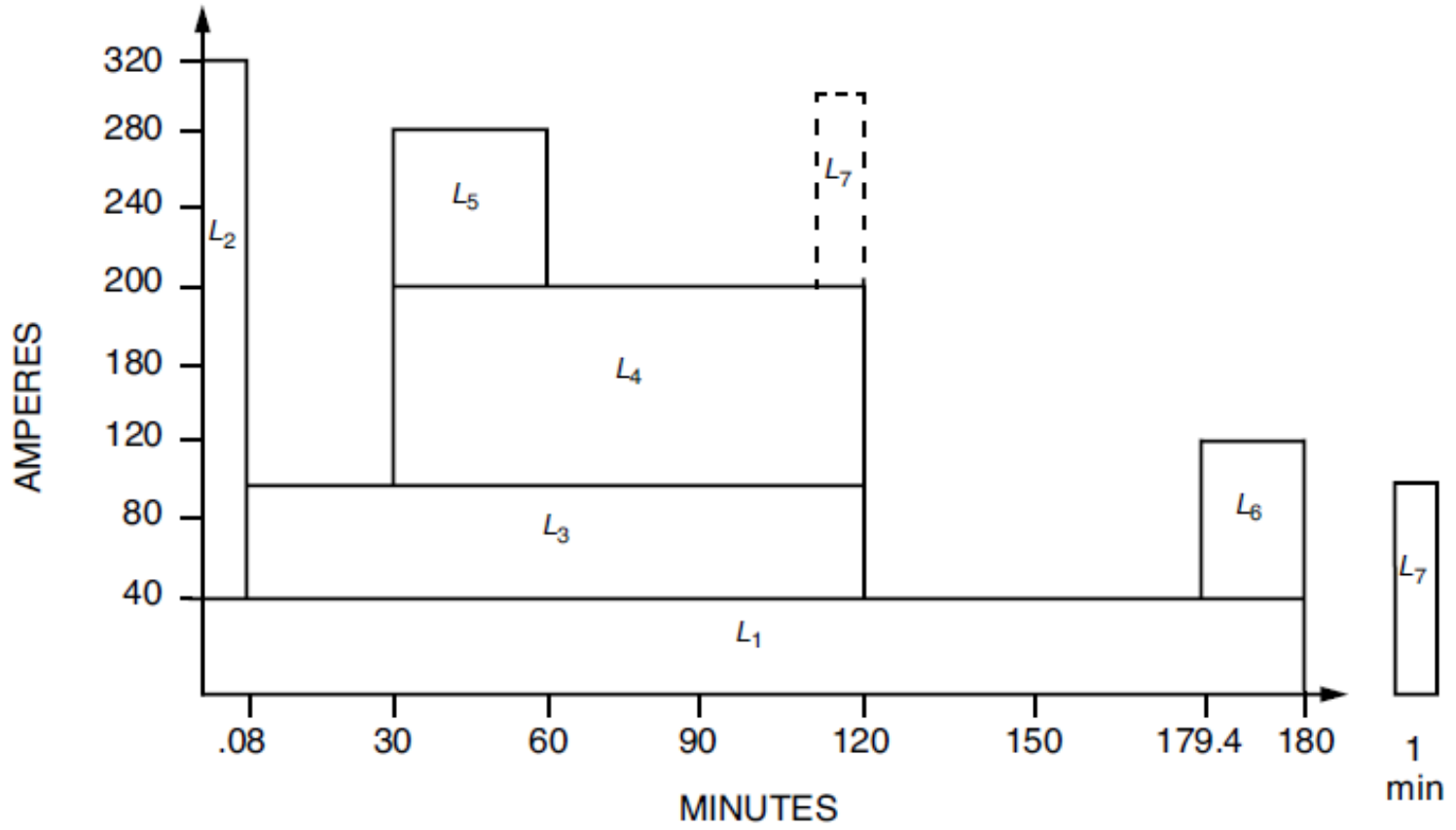


Figure 1—Diagram of a duty cycle

ETAPAS DEL DISEÑO DE SUBESTACIONES DE POTENCIA

NIVELES DE INGENIERÍA

Ingeniería de Detalle

Ingeniería Básica

Ingeniería Conceptual

Pre-inversión