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## **AUDITORÍA DE CURVA PQ PSFV BOSQUE SOLARES DEL BOLIVAR 503, 19.9 MW**

Informe de auditoría de  
curva PQ

Asociados:



Preparado para:



junio de 2024

A 905| R 1171-22

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## REGISTRO DE COMUNICACIONES

Registro de las actividades, comunicaciones y aprobación de informes.

| <b>N°</b> | <b>Fecha</b><br>dd/mm/año | <b>Preparó</b> | <b>Revisó</b> | <b>Aprobó</b> | <b>Observaciones</b> |
|-----------|---------------------------|----------------|---------------|---------------|----------------------|
| 1         | 10/06/2024                | EA             | LP            | FM            | Versión inicial – V1 |

## ABREVIATURAS Y ACRÓNIMOS

|           |                                         |
|-----------|-----------------------------------------|
| CREG      | Comisión de Regulación de Energía y Gas |
| CNO       | Consejo Nacional de Operación           |
| CND       | Centro Nacional de Despacho             |
| ERNC      | Energía Renovables No Convencional      |
| PE        | Parque Eólico                           |
| PSFV      | Parque solar fotovoltaico               |
| SE        | Subestación eléctrica                   |
| AT        | Alta tensión                            |
| MT        | Media tensión                           |
| BT        | Baja tensión                            |
| ONAN      | Oil Natural Air Natural                 |
| ONAF      | Oil Natural Air Forced                  |
| STR       | Sistema de Transmisión Regional         |
| STN       | Sistema de Transmisión Nacional         |
| SDL       | Sistema de Distribución Local           |
| RBC       | Regulador Bajo Carga                    |
| PMU       | Power Management Unit                   |
| P         | Potencia activa                         |
| Q         | Potencia reactiva                       |
| V         | Tensión                                 |
| $X_{REF}$ | Referencia de la variable de control X  |
| POI       | Punto de Interconexión                  |

# SECCIÓN PRINCIPAL

## 1. INTRODUCCIÓN

### 1.1. Objetivo y resultados generales

El presente informe tiene como objetivo presentar para aprobación del CND los puntos de la curva de capacidad de reactiva o Curva PQ en la Planta Solar Bosques de Bolívar 503, de 19,9 MW de potencia nominal, para probar en las pruebas establecidas conforme a la resolución CREG-060 y Acuerdo CNO-1833 de 2024 titulado "Procedimiento para la realización de las pruebas de verificación de la curva de capacidad de las plantas de generación y autogeneradores eólicos y solares fotovoltaicas conectados al STN y STR".

Las pruebas fueron llevadas a cabo entre los días 22 y 23 de mayo del 2024. Las mediciones de estos días fueron complementadas con registros operativos para los puntos de potencia activa superiores a 90% de  $P_n$ . Como resultado de la auditoría se obtiene que la PSFV Bosques del Bolívar **CUMPLE** con la curva de capacidad declarada dentro de las tolerancias establecidas.

### 1.2. Nomenclatura

En el presente documento se empleará la siguiente nomenclatura:

|       |                                                                       |
|-------|-----------------------------------------------------------------------|
| $V_t$ | Tensión en el punto donde se verifica la curva                        |
| P     | Potencia activa de la planta en el punto donde se verifica la curva   |
| Q     | Potencia reactiva de la planta en el punto donde se verifica la curva |
| VREF  | Referencia de Tensión                                                 |

## 2. Datos generales de la auditoría

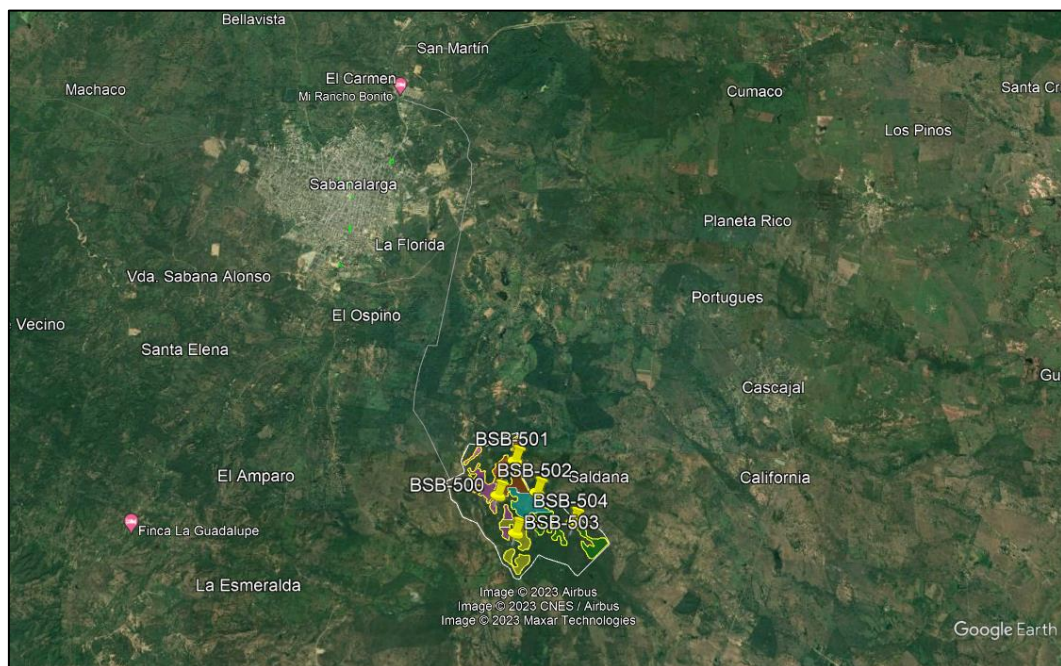
Planta: Bosque Solares del Bolívar 503

Auditor: GME-EEC

Fecha de las pruebas: 22 y 23 de mayo del 2024

## 3. Descripción de las instalaciones

El proyecto del parque solar fotovoltaico Bosque Solares del Bolívar 503, de 19,9 MW de potencia nominal, se encuentra ubicado en el departamento del Atlántico, en las cercanías del municipio de Sabanalarga. El siguiente gráfico muestra la imagen satelital de la zona de influencia del proyecto. Se prevé que el proyecto cuente con 5 módulos (500-504), tres de los cuales se vincularán a las barras de 34.5 kV de la ET Sabanalarga (500-501-502), mientras que los dos restantes se vincularán a las barras de 110 kV (503-504).



**Gráfico 1. Ubicación geográfica del proyecto PSFV Bosques del Bolívar**

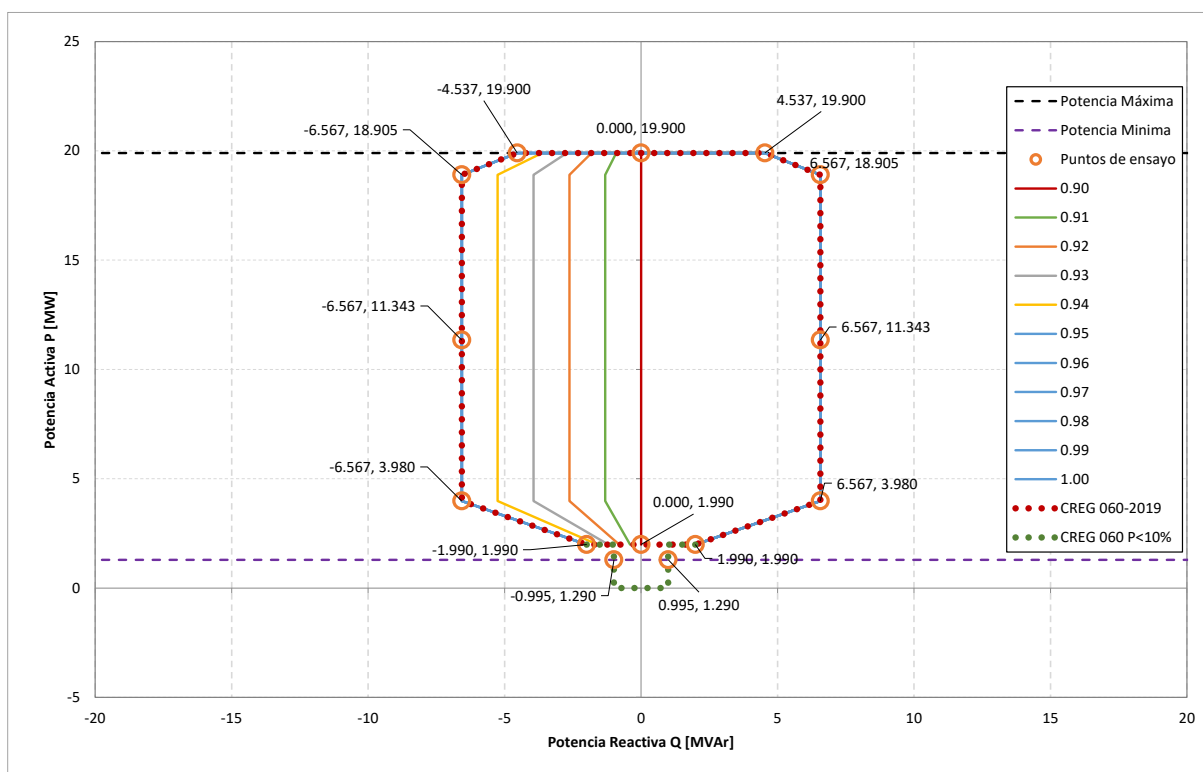
|                                                                       |      |
|-----------------------------------------------------------------------|------|
| Corriente nominal de la planta (kA)                                   | 0.1  |
| Potencia activa nominal (MW)                                          | 19.9 |
| Tensión nominal en bornes de inversor (kV)                            | 0.8  |
| Tensión nominal en punto de conexión (kV)                             | 115  |
| Tensión nominal del lado de alta del transformador de generación (kV) | 115  |

## 4. CURVA DE CAPACIDAD PROPUESTA

### 4.1. Curva PQ para tensiones entre 0,90 y 1,00 pu

En el Gráfico 2 se muestra la curva de capacidad propuesta de la PSFV Bosques del Bolívar, para los distintos niveles de tensión en el POI entre 0,90 y 1,00 pu con pasos de 0,01 pu, según lo requerido por el Anexo 3 del Acuerdo 1833. A modo de referencia, se incluye en

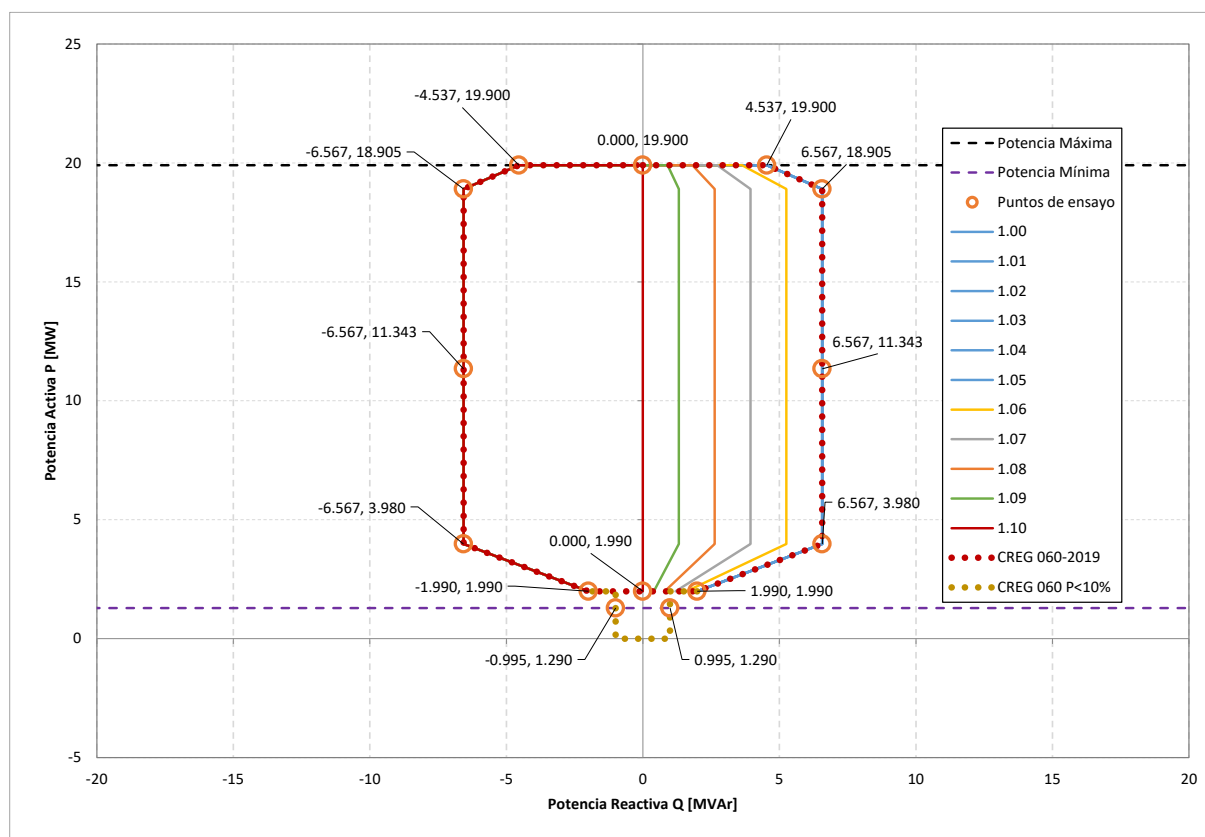
el gráfico la curva de capacidad mínima establecida en la CREG 060-2019.



**Gráfico 2. Curva de capacidad (PQ) propuesta en el POI entre 0,90 y 1,00 pu**

#### 4.2. Curva PQ para tensiones entre 1,00 y 1,10 pu

En el Gráfico 3 se muestra la curva de capacidad propuesta de la PSFV Bosques del Bolívar, para los distintos niveles de tensión en el POI entre 1,00 y 1,10 pu con pasos de 0,01 pu, según lo requerido por el Anexo 3 del Acuerdo 1833. A modo de referencia, se incluye en el gráfico la curva de capacidad mínima establecida en la CREG 060-2019.



**Gráfico 3. Curva de capacidad (PQ) propuesta en el POI entre 1,00 y 1,10 pu**

#### 4.3. Puntos de prueba a verificar

Los puntos operativos a verificar acordados entre el Agente y el CND se detallan en la Tabla 1:

**Tabla 1. Puntos a ensayar**

| Punto | P [MW] | Q [MVar] |
|-------|--------|----------|
| 1     | 1.990  | 0.000    |
| 2     | 1.990  | -1.990   |
| 3     | 3.980  | -6.567   |
| 4     | 11.343 | -6.567   |
| 5     | 18.905 | -6.567   |
| 6     | 19.900 | -4.537   |
| 7     | 1.990  | 1.990    |
| 8     | 3.980  | 6.567    |
| 9     | 11.343 | 6.567    |
| 10    | 18.905 | 6.567    |
| 11    | 19.900 | 4.537    |
| 12    | 19.900 | 0.000    |
| 13    | 1.290  | 0.995    |
| 14    | 1.290  | -0.995   |

La curva de capacidad de la PSFV Bosques del Bolívar será la misma entre 0,95 y 1,05 pu de tensión, y presentará limitación en la región de absorción de potencia reactiva por debajo de 0,95 pu y de entrega de potencia reactiva para tensiones superiores a 1,05 pu, en línea con lo definido en el artículo 1 del Acuerdo CNO 1833. En la Tabla 2 se detallan los puntos de la curva de capacidad para cada valor de tensión en el POI.

**Tabla 2. Tabla de puntos para la definición de la curva de capacidad propuesta**

| 0,90   |       | 0,91   |        | 0,92   |        | 0,93   |        | 0,94   |        | 0,95   |        | 0,96   |        | 0,97   |        | 0,98   |        | 0,99   |        | 1,00   |        |
|--------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| P      | Q     | P      | Q      | P      | Q      | P      | Q      | P      | Q      | P      | Q      | P      | Q      | P      | Q      | P      | Q      | P      | Q      | P      | Q      |
| 1.990  | 0.000 | 1.990  | 0.000  | 1.990  | 0.000  | 1.990  | 0.000  | 1.990  | 0.000  | 1.990  | 0.000  | 1.990  | 0.000  | 1.990  | 0.000  | 1.990  | 0.000  | 1.990  | 0.000  | 1.990  | 0.000  |
| 1.990  | 1.990 | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  | 1.990  |
| 3.980  | 6.567 | 3.980  | 6.567  | 3.980  | 6.567  | 3.980  | 6.567  | 3.980  | 6.567  | 3.980  | 6.567  | 3.980  | 6.567  | 3.980  | 6.567  | 3.980  | 6.567  | 3.980  | 6.567  | 3.980  | 6.567  |
| 11.343 | 6.567 | 11.343 | 6.567  | 11.343 | 6.567  | 11.343 | 6.567  | 11.343 | 6.567  | 11.343 | 6.567  | 11.343 | 6.567  | 11.343 | 6.567  | 11.343 | 6.567  | 11.343 | 6.567  | 11.343 | 6.567  |
| 18.905 | 6.567 | 18.905 | 6.567  | 18.905 | 6.567  | 18.905 | 6.567  | 18.905 | 6.567  | 18.905 | 6.567  | 18.905 | 6.567  | 18.905 | 6.567  | 18.905 | 6.567  | 18.905 | 6.567  | 18.905 | 6.567  |
| 19.900 | 4.537 | 19.900 | 4.537  | 19.900 | 4.537  | 19.900 | 4.537  | 19.900 | 4.537  | 19.900 | 4.537  | 19.900 | 4.537  | 19.900 | 4.537  | 19.900 | 4.537  | 19.900 | 4.537  | 19.900 | 4.537  |
| 19.900 | 0.000 | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  |
| 19.900 | 0.000 | 19.900 | -0.907 | 19.900 | -1.815 | 19.900 | -2.722 | 19.900 | -3.630 | 19.900 | -4.537 | 19.900 | -4.537 | 19.900 | -4.537 | 19.900 | -4.537 | 19.900 | -4.537 | 19.900 | -4.537 |
| 18.905 | 0.000 | 18.905 | -1.313 | 18.905 | -2.627 | 18.905 | -3.940 | 18.905 | -5.254 | 18.905 | -6.567 | 18.905 | -6.567 | 18.905 | -6.567 | 18.905 | -6.567 | 18.905 | -6.567 | 18.905 | -6.567 |
| 11.343 | 0.000 | 11.343 | -1.313 | 11.343 | -2.627 | 11.343 | -3.940 | 11.343 | -5.254 | 11.343 | -6.567 | 11.343 | -6.567 | 11.343 | -6.567 | 11.343 | -6.567 | 11.343 | -6.567 | 11.343 | -6.567 |
| 3.980  | 0.000 | 3.980  | -1.313 | 3.980  | -2.627 | 3.980  | -3.940 | 3.980  | -5.254 | 3.980  | -6.567 | 3.980  | -6.567 | 3.980  | -6.567 | 3.980  | -6.567 | 3.980  | -6.567 | 3.980  | -6.567 |
| 1.990  | 0.000 | 1.990  | -0.398 | 1.990  | -0.796 | 1.990  | -1.194 | 1.990  | -1.592 | 1.990  | -1.990 | 1.990  | -1.990 | 1.990  | -1.990 | 1.990  | -1.990 | 1.990  | -1.990 | 1.990  | -1.990 |
| 1.290  | 0.995 | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  |
| 1.290  | 0.000 | 1.290  | -0.199 | 1.290  | -0.398 | 1.290  | -0.597 | 1.290  | -0.796 | 1.290  | -0.995 | 1.290  | -0.995 | 1.290  | -0.995 | 1.290  | -0.995 | 1.290  | -0.995 | 1.290  | -0.995 |

| 1,01   |       | 1,02   |       | 1,03   |       | 1,04   |       | 1,05   |       | 1,06   |       | 1,07   |       | 1,08   |       | 1,09   |       | 1,10   |       |
|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|--------|-------|
| P      | Q     | P      | Q     | P      | Q     | P      | Q     | P      | Q     | P      | Q     | P      | Q     | P      | Q     | P      | Q     | P      | Q     |
| 1.990  | 0.000 | 1.990  | 0.000 | 1.990  | 0.000 | 1.990  | 0.000 | 1.990  | 0.000 | 1.990  | 0.000 | 1.990  | 0.000 | 1.990  | 0.000 | 1.990  | 0.000 | 1.990  | 0.000 |
| 1.990  | 1.990 | 1.990  | 1.990 | 1.990  | 1.990 | 1.990  | 1.990 | 1.990  | 1.990 | 1.990  | 1.592 | 1.990  | 1.194 | 1.990  | 0.796 | 1.990  | 0.398 | 1.990  | 0.000 |
| 3.980  | 6.567 | 3.980  | 6.567 | 3.980  | 6.567 | 3.980  | 6.567 | 3.980  | 6.567 | 3.980  | 5.254 | 3.980  | 3.940 | 3.980  | 2.627 | 3.980  | 1.313 | 3.980  | 0.000 |
| 11.343 | 6.567 | 11.343 | 6.567 | 11.343 | 6.567 | 11.343 | 6.567 | 11.343 | 6.567 | 11.343 | 5.254 | 11.343 | 3.940 | 11.343 | 2.627 | 11.343 | 1.313 | 11.343 | 0.000 |
| 18.905 | 6.567 | 18.905 | 6.567 | 18.905 | 6.567 | 18.905 | 6.567 | 18.905 | 6.567 | 18.905 | 5.254 | 18.905 | 3.940 | 18.905 | 2.627 | 18.905 | 1.313 | 18.905 | 0.000 |
| 19.900 | 4.537 | 19.900 | 4.537 | 19.900 | 4.537 | 19.900 | 4.537 | 19.900 | 4.537 | 19.900 | 3.630 | 19.900 | 2.722 | 19.900 | 1.815 | 19.900 | 0.907 | 19.900 | 0.000 |

|               | 1,01   | 1,02   | 1,03   | 1,04   | 1,05   | 1,06   | 1,07   | 1,08   | 1,09   | 1,10   |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| <b>19.900</b> | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 | 0.000  | 19.900 |
| <b>19.900</b> | -4.537 | 19.900 | -4.537 | 19.900 | -4.537 | 19.900 | -4.537 | 19.900 | -4.537 | 19.900 |
| <b>18.905</b> | -6.567 | 18.905 | -6.567 | 18.905 | -6.567 | 18.905 | -6.567 | 18.905 | -6.567 | 18.905 |
| <b>11.343</b> | -6.567 | 11.343 | -6.567 | 11.343 | -6.567 | 11.343 | -6.567 | 11.343 | -6.567 | 11.343 |
| <b>3.980</b>  | -6.567 | 3.980  | -6.567 | 3.980  | -6.567 | 3.980  | -6.567 | 3.980  | -6.567 | 3.980  |
| <b>1.990</b>  | -1.990 | 1.990  | -1.990 | 1.990  | -1.990 | 1.990  | -1.990 | 1.990  | -1.990 | 1.990  |
| <b>1.290</b>  | 0.995  | 1.290  | 0.995  | 1.290  | 0.995  | 1.290  | 0.796  | 1.290  | 0.398  | 1.290  |
| <b>1.290</b>  | -0.995 | 1.290  | -0.995 | 1.290  | -0.995 | 1.290  | -0.995 | 1.290  | -0.995 | 1.290  |

## 5. EQUIPOS DE MEDICIÓN

### 5.1. Equipos empleados

Para las mediciones realizadas se emplearon los equipos listados en la Tabla 3.

**Tabla 3. Equipos de medición empleados**

| Equipo                      | Marca  | Modelo | N° de Serie       | Clase/error            |
|-----------------------------|--------|--------|-------------------|------------------------|
| <b>Registrador GME6</b>     | ELSPEC | PureBB | 00_60_35_38_1B_2A | IEC 61000-4-30 Class A |
| <b>Transf. de corriente</b> | -      | -      | -                 | 0,2                    |
| <b>Transf. de tensión</b>   | -      | -      | -                 | 0,2                    |

### 5.2. Puntos de medición

Para las mediciones realizadas se emplearon los puntos de medición y variables listados en la Tabla 4.

**Tabla 4. Puntos de medición y variables registradas**

| Variable                 | Tablero     | Borne | Escala    | Equipo |
|--------------------------|-------------|-------|-----------|--------|
| <b>Tensión</b>           | -           | -     | 110 V     | GME6   |
| <b>Potencia activa</b>   | (calculada) | -     | 0-200 MW  | GME6   |
| <b>Potencia reactiva</b> | (calculada) | -     | ±100 MVar | GME6   |
| <b>Frecuencia</b>        | (calculada) | -     | 40-70 Hz  | GME6   |
| <b>Corriente</b>         | -           | -     | 5 A       | GME6   |

### 5.3. Determinación de errores

De acuerdo con los datos recolectados en planta se realiza el cálculo de los errores de medición según las expresiones detalladas a continuación:

- $E_{CT}$  = Clase 0,2, relación 600/1 A
- $E_{PT}$  = Clase 0,2, relación 110000/110 kV
- $E_R$  = Clase A (IEC61000-4-30)

Siguiendo los lineamientos del Anexo III del Acuerdo CNO 1833 y de la norma ANSI/ASME PTC 19.1, el error relativo de la medición se calcula como la raíz de la suma de los cuadrados de los errores relativos de CT, PT y equipo de medición:

$$Emr = \sqrt{E_{PT}^2 + E_{CT}^2 + E_R^2}$$

La clase de los instrumentos es el error absoluto referido a escala completa. Si se considera

al error relativo de cada instrumento como su clase se lleva a cabo una aproximación conservadora, tal como lo dicta dicha normativa.

Luego, se calcula el error de medición absoluto de potencia reactiva asociado a los transformadores de medida y el registrador con el uso de la siguiente ecuación.

$$Ema = \sqrt{3} Emr CT_{PRIM} PT_{PRIM}$$

Para el caso particular de las pruebas realizadas resulta:

$$Emr = \sqrt{0,002^2 + 0,002^2 + (0,001^2 + 0,01^2)} = 0,0104$$

$$Ema = \sqrt{3} \cdot 0,0104 \cdot \frac{300 \text{ A} \cdot 34500 \text{ V}}{10^6} = 1,19 \text{ MVar}$$

## 6. RESULTADOS DE LAS PRUEBAS

### 6.1. Tabla de resultados

La Tabla 5 detalla los puntos obtenidos de las pruebas realizadas.

- En la columna Región se indica si se trata de entrega de potencia reactiva o absorción de potencia reactiva.
- En la columna modo de control se indica si es tensión, potencia reactiva o factor de potencia.
- En la columna de Hora se indica el momento en el que se alcanza el punto.
- La columna de puntos objetivo ( $P_0$  y  $Q_0$ ) indica los puntos esperados de potencia reactiva.
- La columna de promedio corregido ( $Q_m$ ) presenta el valor promedio de potencia reactiva de la serie de puntos obtenidos para cada condición operativa PQ.
- La columna de  $V_t$ , indica la tensión en el punto donde se verifica la curva.
- La columna Causa de limitación debe indicar qué activó la limitación en la planta o si la limitación obedece al sistema.
- En observaciones se indica la ocurrencia de eventos anormales en la prueba como por ejemplo si se activaron alarmas por condiciones de temperatura. Asimismo, se indica si la prueba a potencia nominal se realizó individualmente o se validó a través de registros de la operación.

**Tabla 5. Tabla de resultados**

| N° | Región    | Modo | Hora                | Punto objetivo<br>Po<br>[MW] | Qo<br>[MVar] | Promedio<br>corregido<br>Qm<br>[MVar] | Vt<br>[pu] | Cumple | Causa de limitación                                            |
|----|-----------|------|---------------------|------------------------------|--------------|---------------------------------------|------------|--------|----------------------------------------------------------------|
| 1  | Q = 0     | VQ   | 16:00               | 1.990                        | 0.000        | 0.000                                 | 0.996      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 2  | Absorción | VQ   | 16:31               | 1.990                        | -1.990       | -1.990                                | 0.997      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 3  | Absorción | VQ   | 9:36                | 3.980                        | -6.567       | -6.567                                | 1.002      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 4  | Absorción | VQ   | 11:47               | 11.343                       | -6.567       | -6.567                                | 1.004      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 5  | Absorción | VQ   |                     | 18.905                       | -6.567       |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 6  | Absorción | VQ   |                     | 19.900                       | -4.537       |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 7  | Entrega   | VQ   | 16:18               | 1.990                        | 1.990        | 1.990                                 | 0.998      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 1  | Q = 0     | Q    | 16:06               | 1.990                        | 0.000        | 0.000                                 | 0.996      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 2  | Absorción | Q    | 16:36               | 1.990                        | -1.990       | -1.990                                | 0.997      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 3  | Absorción | Q    | 9:41                | 3.980                        | -6.567       | -6.567                                | 1.002      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 4  | Absorción | Q    | 11:52               | 11.343                       | -6.567       | -6.567                                | 1.004      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 5  | Absorción | Q    | 23/05/2024<br>11:59 | 18.905                       | -6.567       | -6.567                                | 1.006      | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 6  | Absorción | Q    | 05/06/2024          | 19.900                       | -4.537       | -4.537                                | 1.002      | SI     | Punto alcanzado durante la                                     |

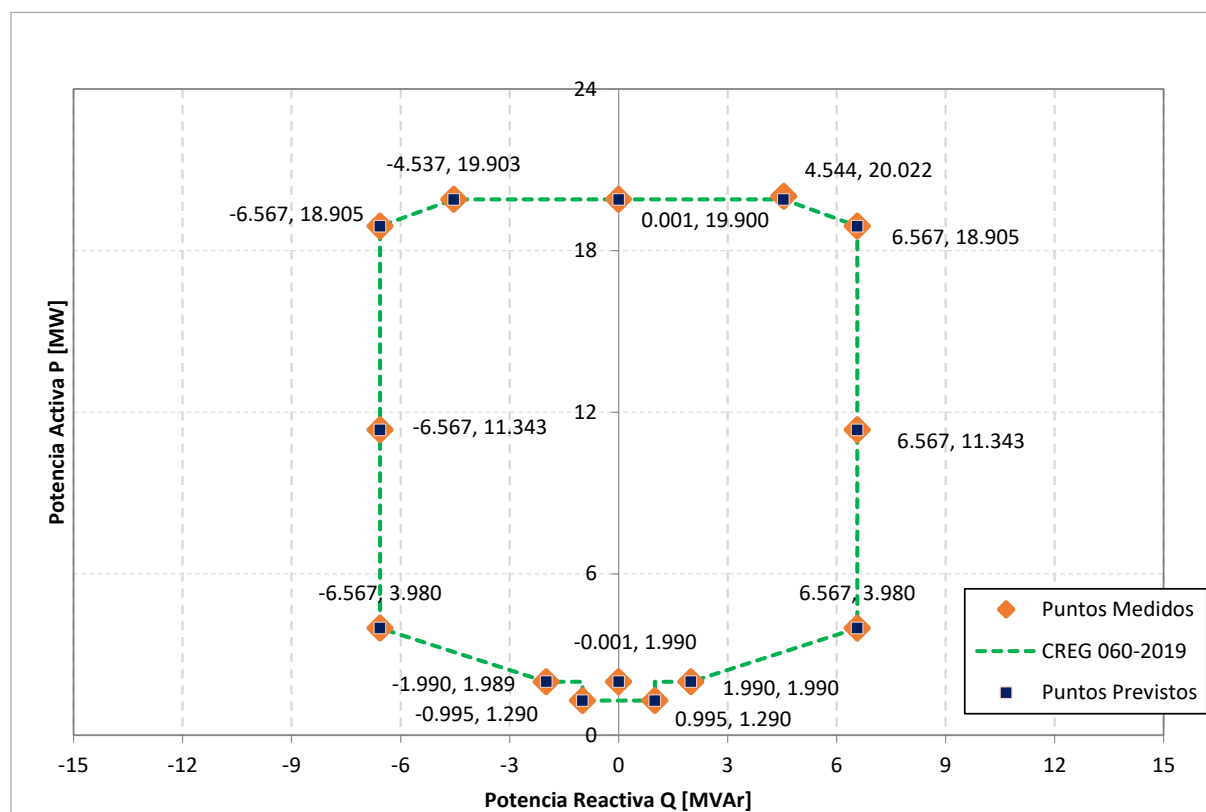
| N° | Región    | Modo | Hora  | Punto objetivo<br>Po<br>[MW] | Qo<br>[MVar] | Promedio<br>corregido<br>Qm<br>[MVar] | Vt<br>[pu] | Cumple | Causa de limitación                                            |
|----|-----------|------|-------|------------------------------|--------------|---------------------------------------|------------|--------|----------------------------------------------------------------|
|    |           |      | 12:24 |                              |              |                                       |            |        | operación de la planta en control Q                            |
| 7  | Entrega   | Q    | 16:23 | 1.990                        | 1.990        | 1.990                                 | 0.998      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 1  | Q = 0     | FP   | 16:07 | 1.990                        | 0.000        | 0.000                                 | 0.996      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 2  | Absorción | FP   | 16:37 | 1.990                        | -1.990       | -1.990                                | 0.997      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 3  | Absorción | FP   | 9:42  | 3.980                        | -6.567       | -6.567                                | 1.002      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 4  | Absorción | FP   | 11:53 | 11.343                       | -6.567       | -6.567                                | 1.004      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 5  | Absorción | FP   |       | 18.905                       | -6.567       |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 6  | Absorción | FP   |       | 19.900                       | -4.537       |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 7  | Entrega   | FP   | 16:24 | 1.990                        | 1.990        | 1.990                                 | 0.998      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 8  | Entrega   | VQ   | 9:56  | 3.980                        | 6.567        | 6.567                                 | 1.007      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 9  | Entrega   | VQ   | 10:12 | 11.343                       | 6.567        | 6.567                                 | 1.007      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 10 | Entrega   | VQ   |       | 18.905                       | 6.567        |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 11 | Entrega   | VQ   |       | 19.900                       | 4.537        |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |

| N° | Región    | Modo | Hora                | Punto objetivo<br>Po<br>[MW] | Qo<br>[MVar] | Promedio<br>corregido<br>Qm<br>[MVar] | Vt<br>[pu] | Cumple | Causa de limitación                                            |
|----|-----------|------|---------------------|------------------------------|--------------|---------------------------------------|------------|--------|----------------------------------------------------------------|
| 12 | Entrega   | VQ   |                     | 19.900                       | 0.000        |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 13 | Entrega   | VQ   | 16:58               | 1.290                        | 0.995        | 0.995                                 | 0.991      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 14 | Absorción | VQ   | 16:43               | 1.290                        | -0.995       | -0.995                                | 0.991      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 8  | Entrega   | Q    | 10:01               | 3.980                        | 6.567        | 6.567                                 | 1.007      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 9  | Entrega   | Q    | 10:17               | 11.343                       | 6.567        | 6.567                                 | 1.007      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 10 | Entrega   | Q    | 26/05/2024<br>12:40 | 18.905                       | 6.567        | 6.567                                 | 1.010      | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 11 | Entrega   | Q    | 05/06/2024<br>12:27 | 19.900                       | 4.537        | 4.537                                 | 1.002      | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 12 | Entrega   | Q    | 05/06/2024<br>12:28 | 19.900                       | 0.000        | 0.000                                 | 1.002      | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 13 | Entrega   | Q    | 17:03               | 1.290                        | 0.995        | 0.995                                 | 0.991      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 14 | Absorción | Q    | 16:48               | 1.290                        | -0.995       | -0.995                                | 0.991      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 8  | Entrega   | FP   | 10:02               | 3.980                        | 6.567        | 6.567                                 | 1.007      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 9  | Entrega   | FP   | 10:18               | 11.343                       | 6.567        | 6.567                                 | 1.007      | SI     | Se alcanzó el punto sin un límite o                            |

| N°               | Región    | Modo | Hora  | Punto objetivo |              | Promedio<br>corregido<br>Qm<br>[MVar] | Vt<br>[pu] | Cumple | Causa de limitación                                            |
|------------------|-----------|------|-------|----------------|--------------|---------------------------------------|------------|--------|----------------------------------------------------------------|
|                  |           |      |       | Po<br>[MW]     | Qo<br>[MVar] |                                       |            |        |                                                                |
| alarma explícito |           |      |       |                |              |                                       |            |        |                                                                |
| 10               | Entrega   | FP   |       | 18.905         | 6.567        |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 11               | Entrega   | FP   |       | 19.900         | 4.537        |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 12               | Entrega   | FP   |       | 19.900         | 0.000        |                                       |            | SI     | Punto alcanzado durante la operación de la planta en control Q |
| 13               | Entrega   | FP   | 17:04 | 1.290          | 0.995        | 0.995                                 | 0.991      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |
| 14               | Absorción | FP   | 16:49 | 1.290          | -0.995       | -0.995                                | 0.991      | SI     | Se alcanzó el punto sin un límite o alarma explícito           |

## 6.2. Curva de capacidad registrada

En la Gráfico 4 se presenta la curva de capacidad verificada en campo. Se muestran los puntos operativos obtenidos y la curva de carga mínima definida por la regulación.

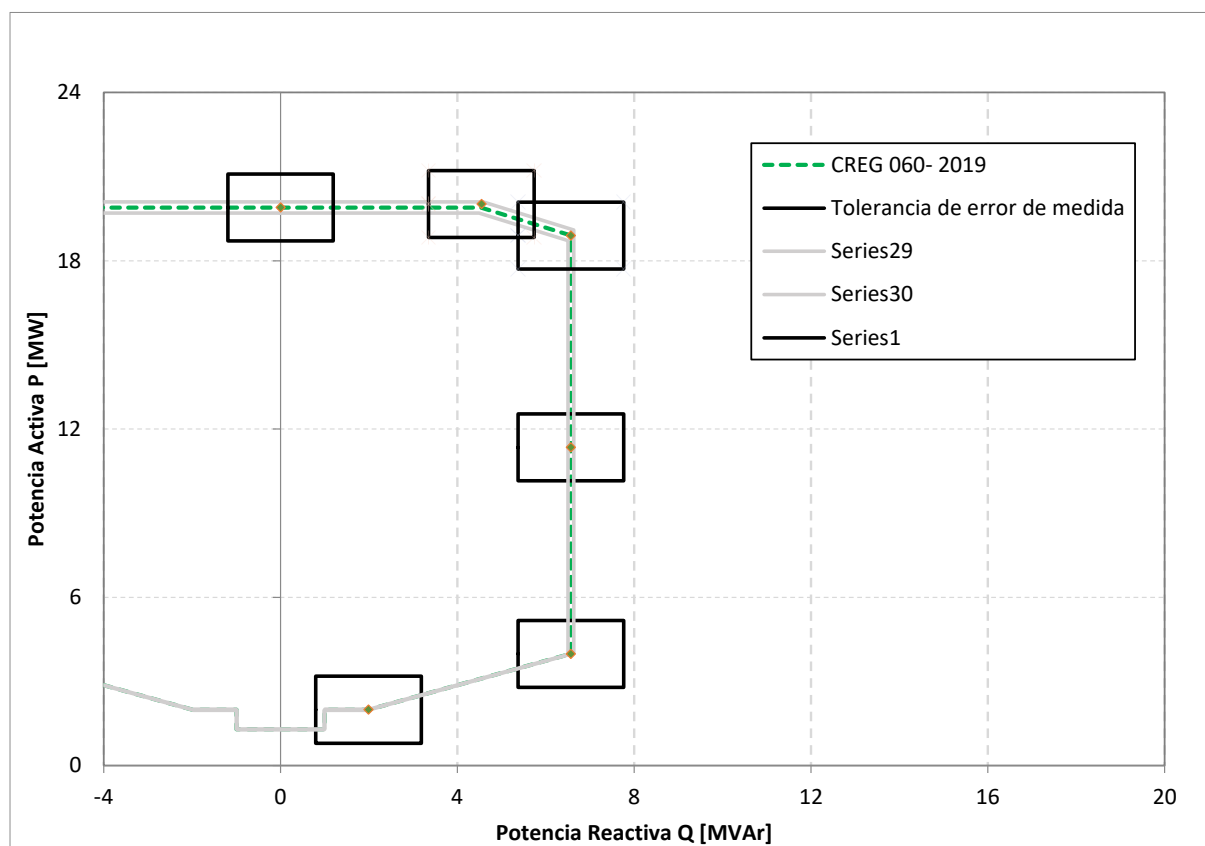


**Gráfico 4. Curva de capacidad relevada de la PSFV BSB 503**

## 6.3. Detalle de evaluación de en la región de entrega de potencia reactiva

En el Gráfico 5 se presenta el detalle de los puntos correspondientes a la región de entrega de potencia reactiva.

Como se aprecia, al menos uno de los puntos obtenidos en los rectángulos de tolerancia de error de cada una de las medidas toca o supera los límites de la curva PQ de referencia CREG 060-2019, cumpliendo con el Anexo 1 del Acuerdo CNO 1833 en la zona de entrega de potencia reactiva.

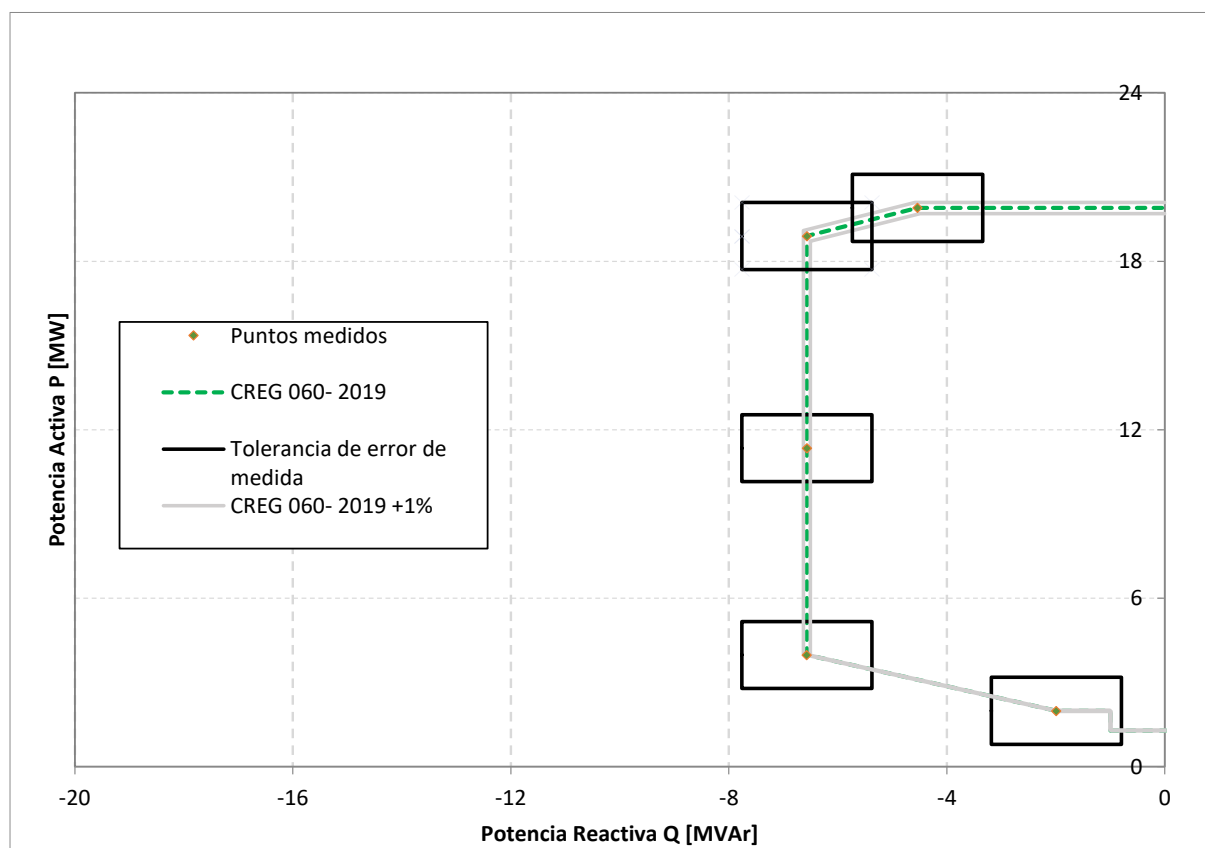


**Gráfico 5. Detalle de región de entrega de potencia reactiva y  $Q = 0$**

#### 6.4. Detalle de evaluación de en la región de absorción de potencia reactiva

En el Gráfico 6 se presenta el detalle de los puntos correspondientes a la región de absorción de potencia reactiva.

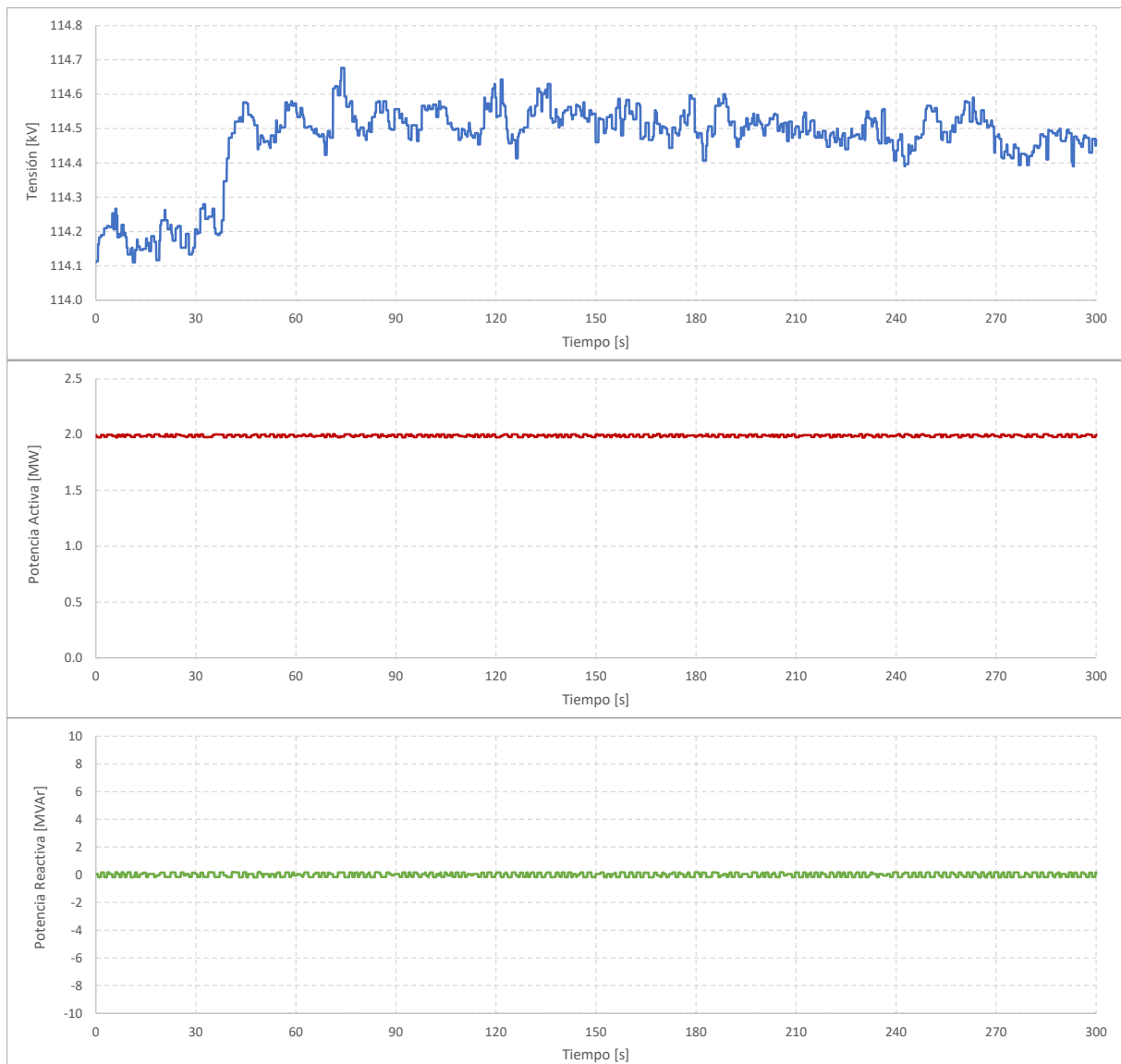
Como se aprecia, al menos uno de los puntos obtenidos en los rectángulos de tolerancia de error de cada una de las medidas toca o supera los límites de la curva PQ de referencia CREG 060-2019, cumpliendo con el Anexo 1 del Acuerdo CNO 1833 en la zona de absorción de potencia reactiva.



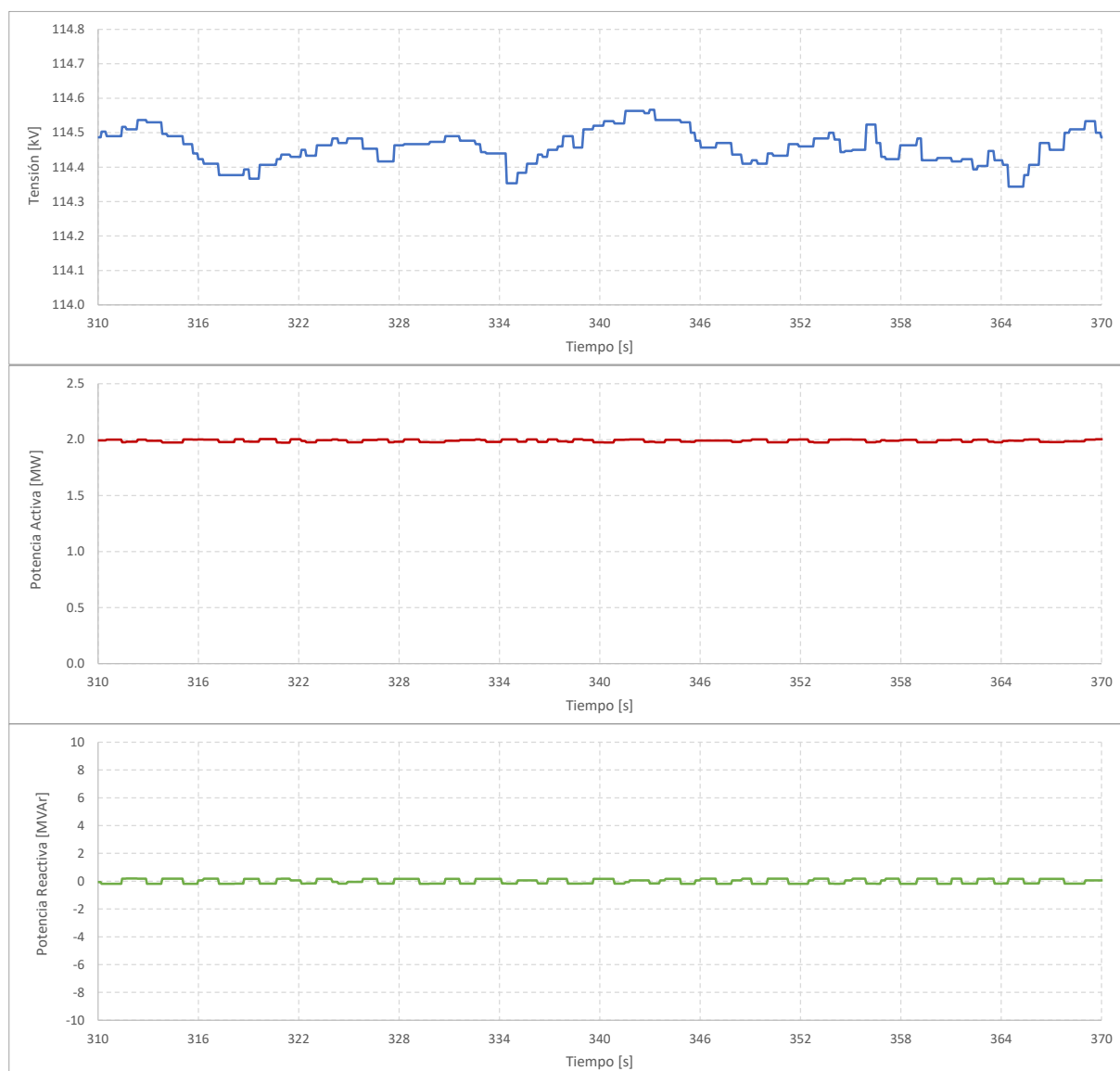
**Gráfico 6. Detalle de región de absorción de potencia reactiva**

### 6.5. Gráficos de tendencia

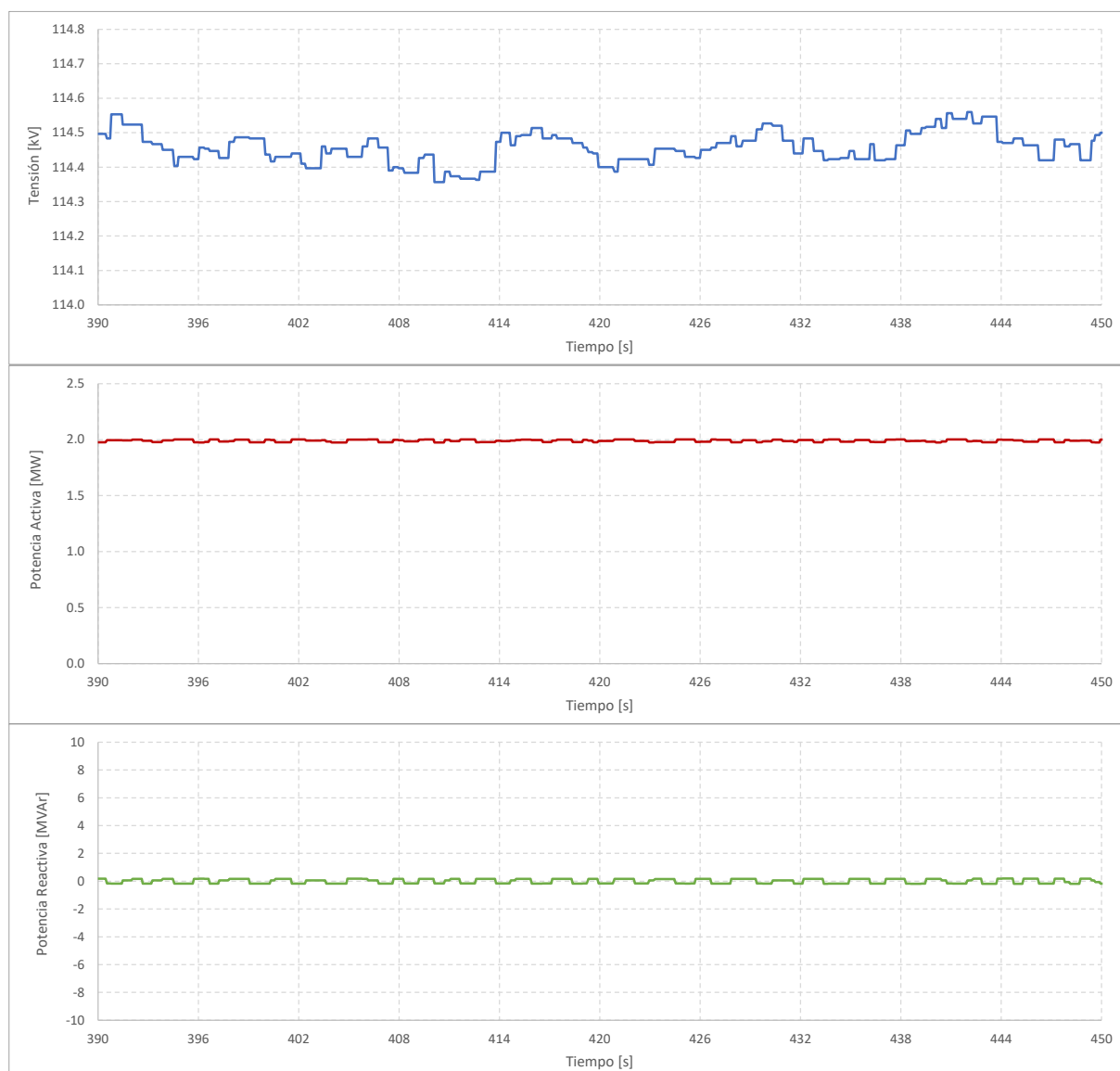
Se muestran a continuación los registros de potencia activa, reactiva y tensión para cada uno de los niveles de carga, tanto para la región de entrega de potencia reactiva como de absorción de potencia reactiva. Puede observarse en cada prueba que se mantiene el punto operativo durante al menos 1 minutos en control de voltaje, 1 minuto en control de potencia reactiva y 1 minuto adicional en control de factor de potencia. Los puntos superiores al 90% de potencia activa nominal fueron registrador durante la operación de la planta, y sólo se capturaron en modo control de reactivo.



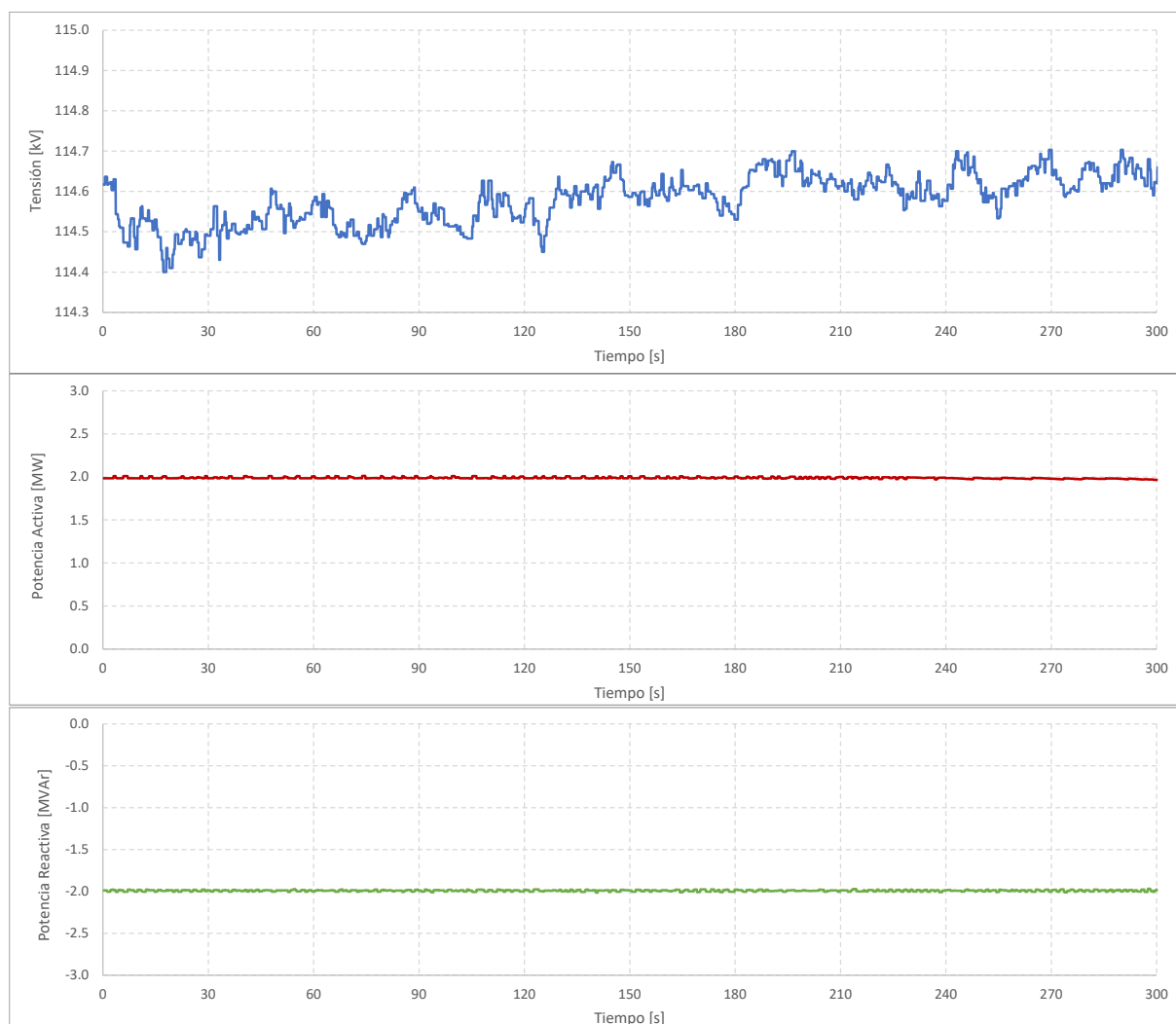
**Gráfico 7. Punto PQ 1 – Control VQ**



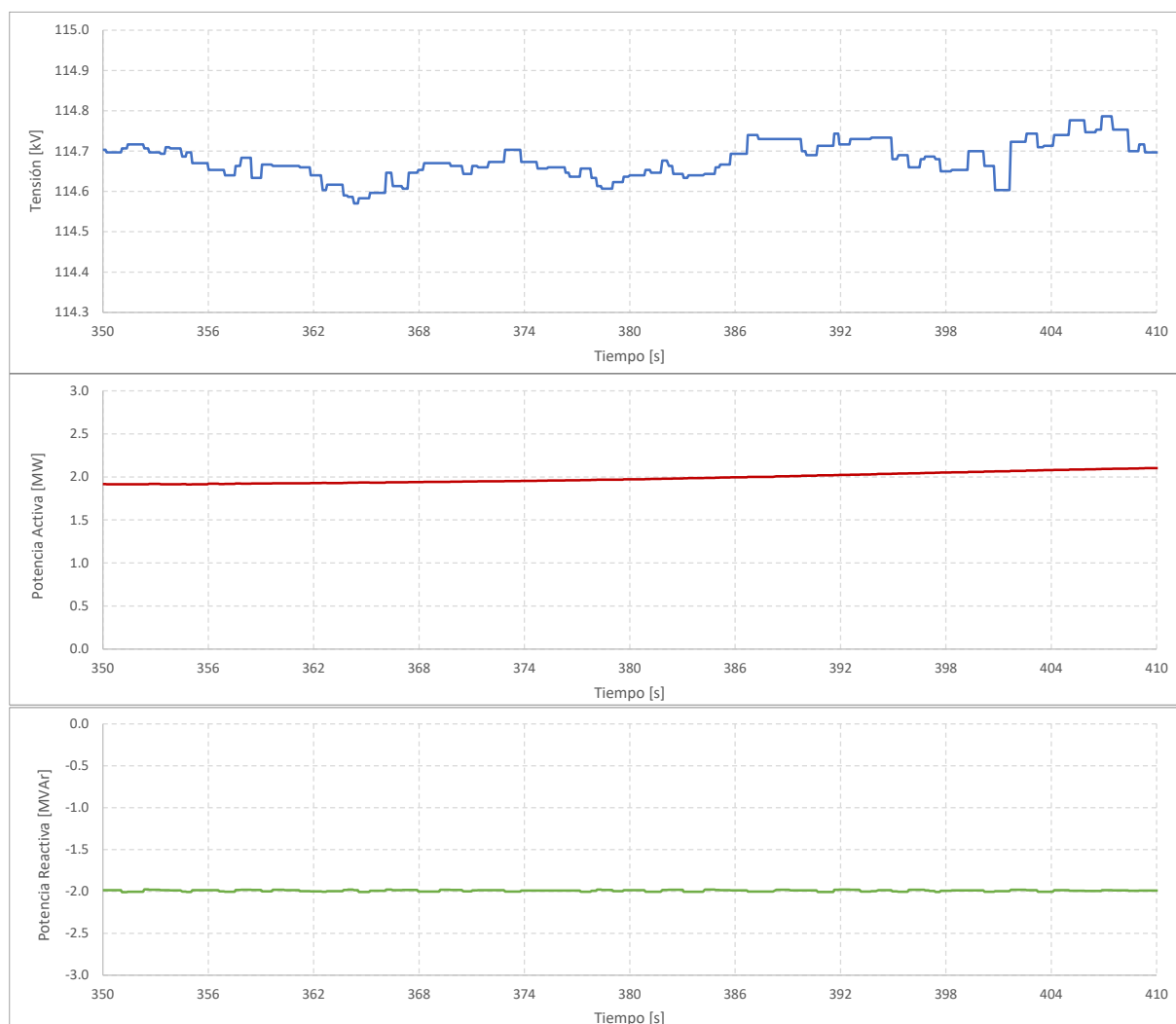
**Gráfico 8. Punto PQ 1 – Control Q**



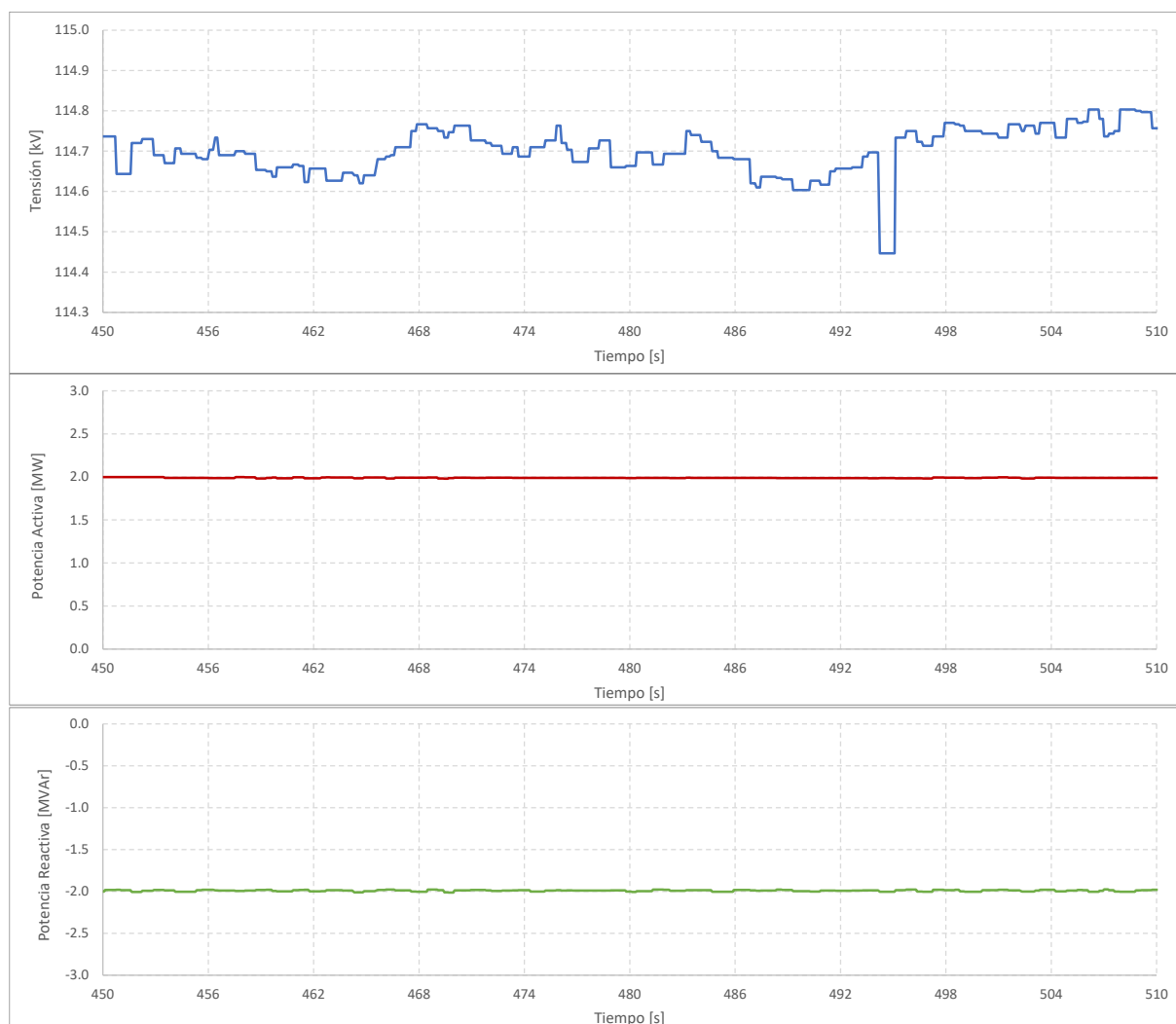
**Gráfico 9. Punto PQ 1 – Control FP**



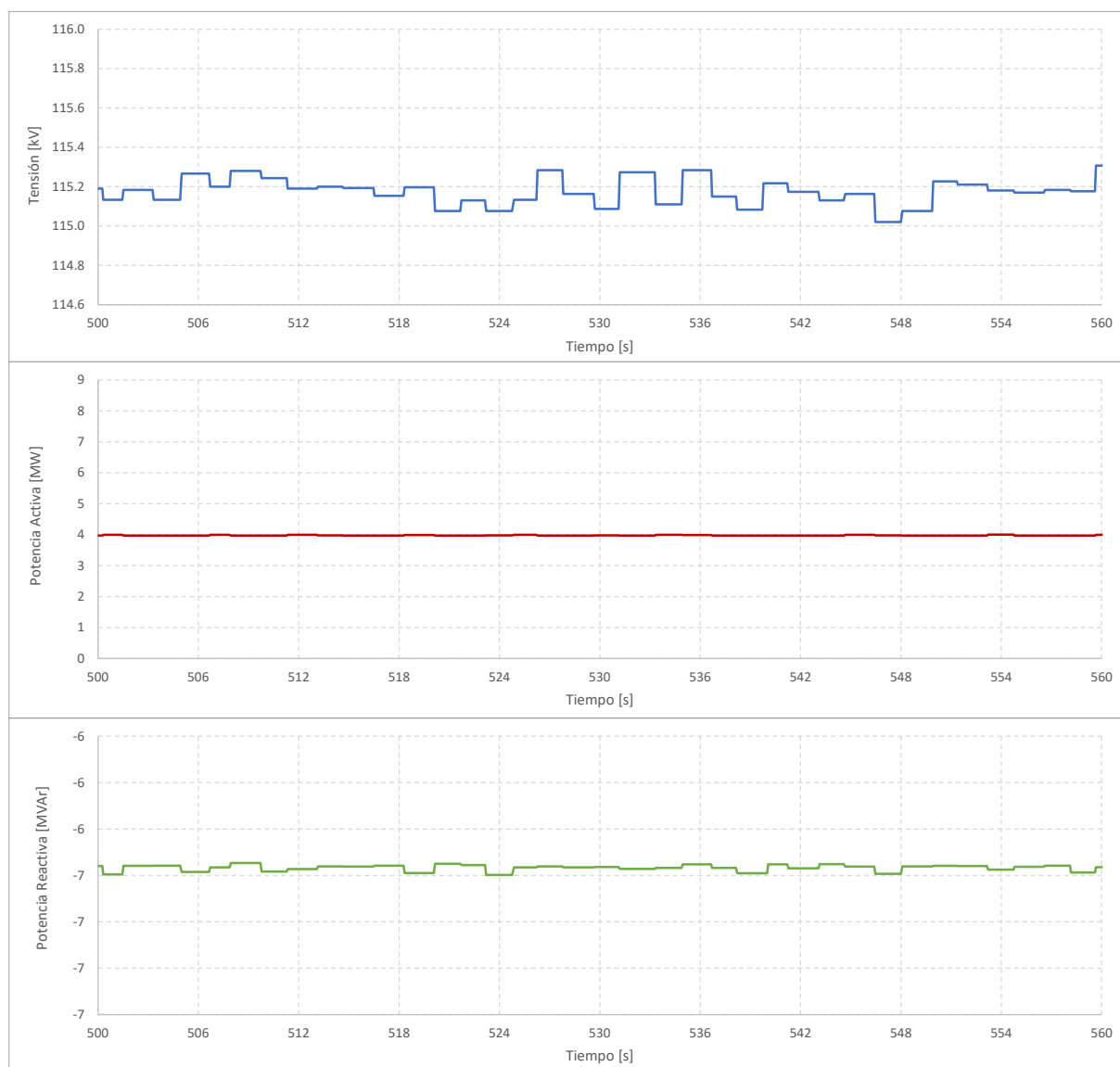
**Gráfico 10. Punto PQ 2 – Control VQ**



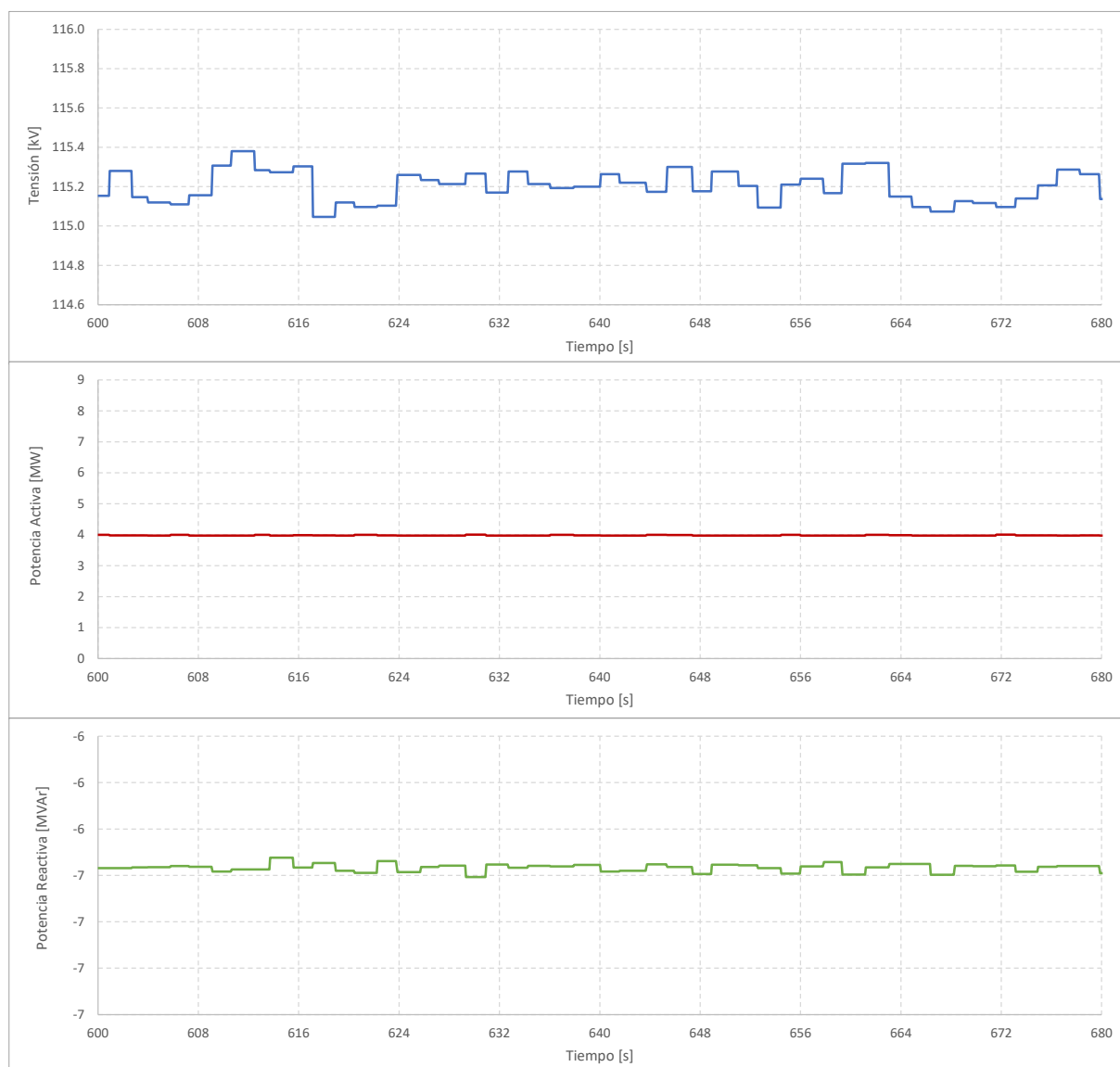
**Gráfico 11. Punto PQ 2 – Control Q**



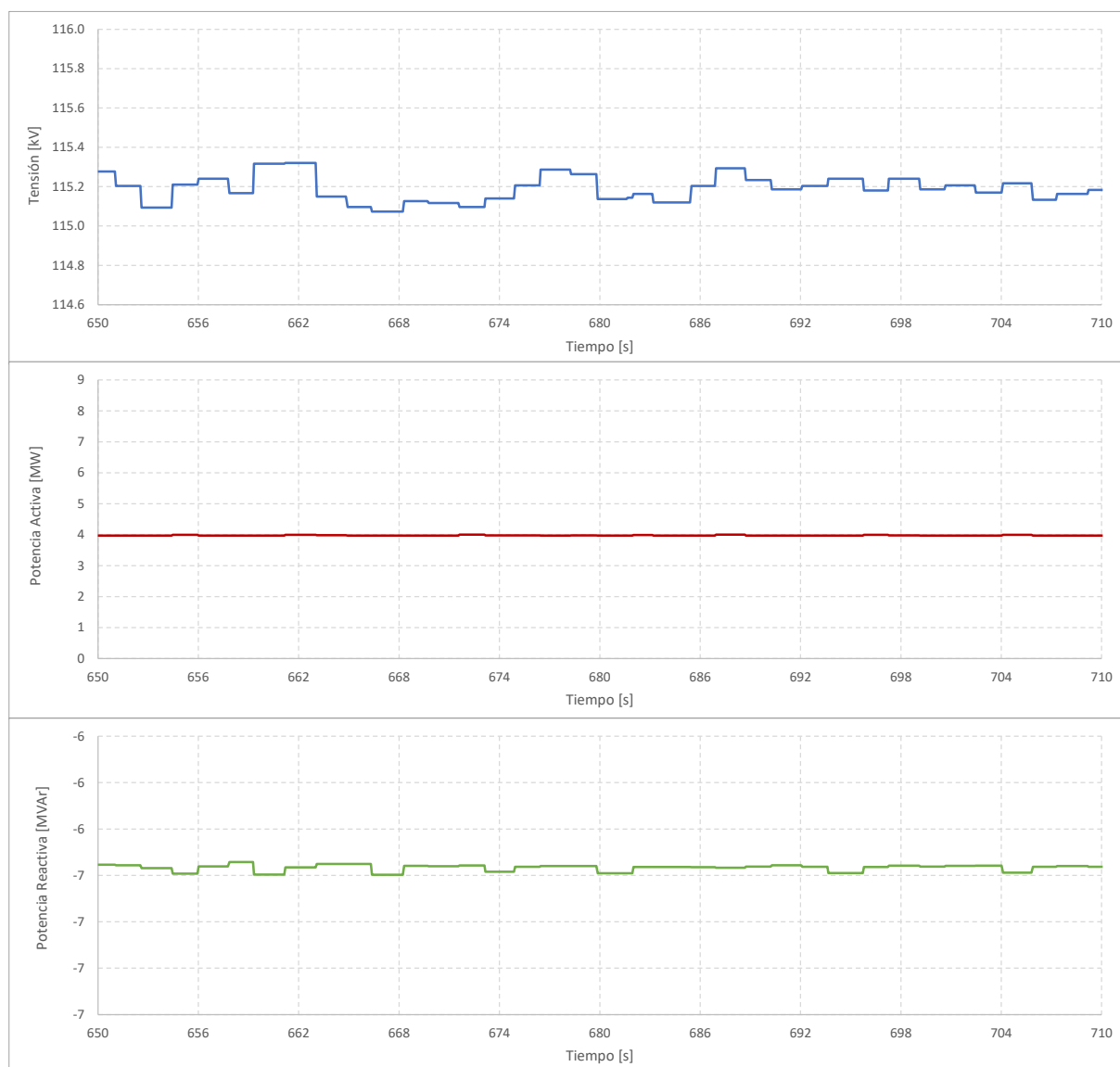
**Gráfico 12. Punto PQ 2 – Control FP**



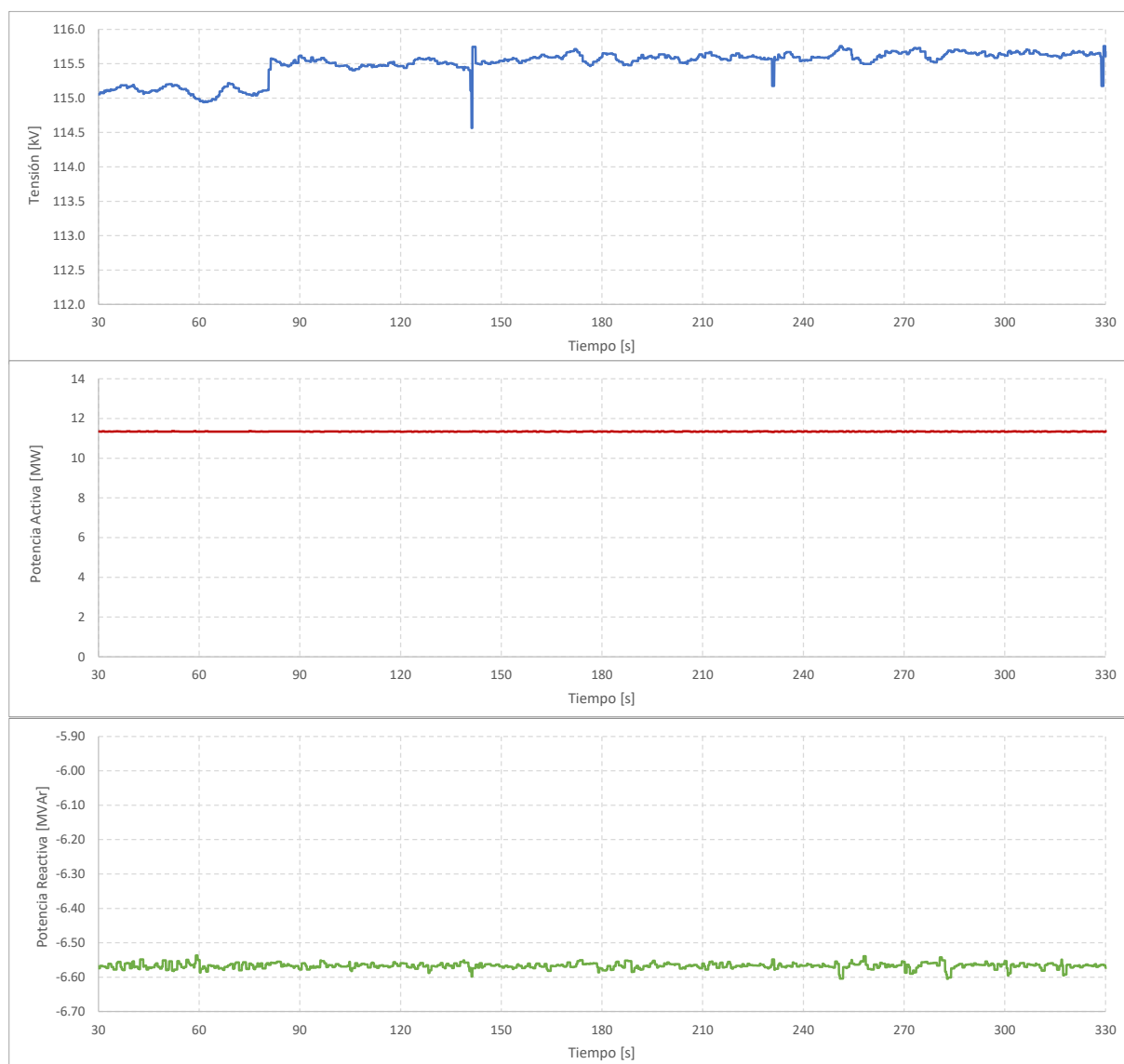
**Gráfico 13. Punto PQ 3 – Control VQ**



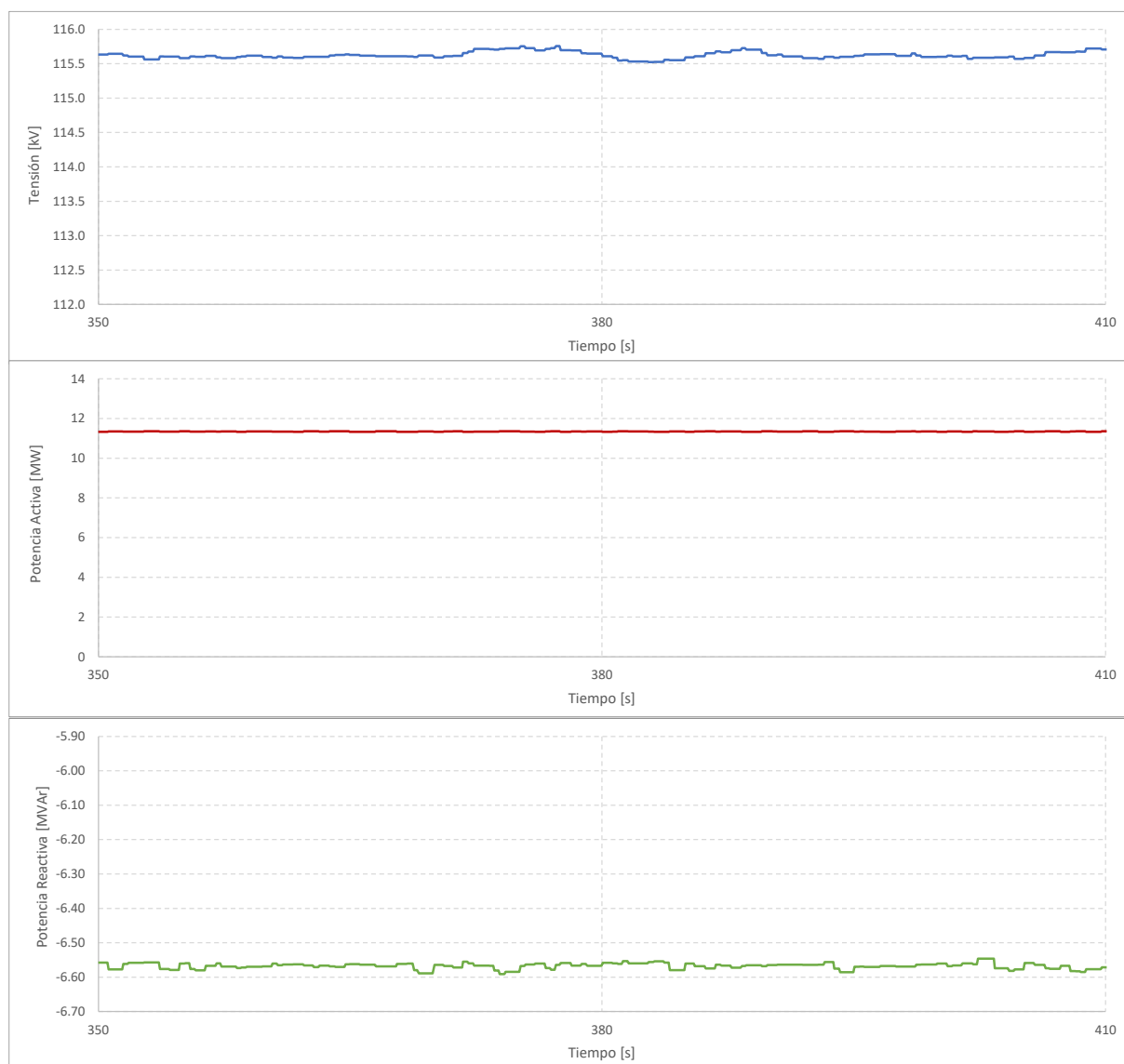
**Gráfico 14. Punto PQ 3 – Control Q**



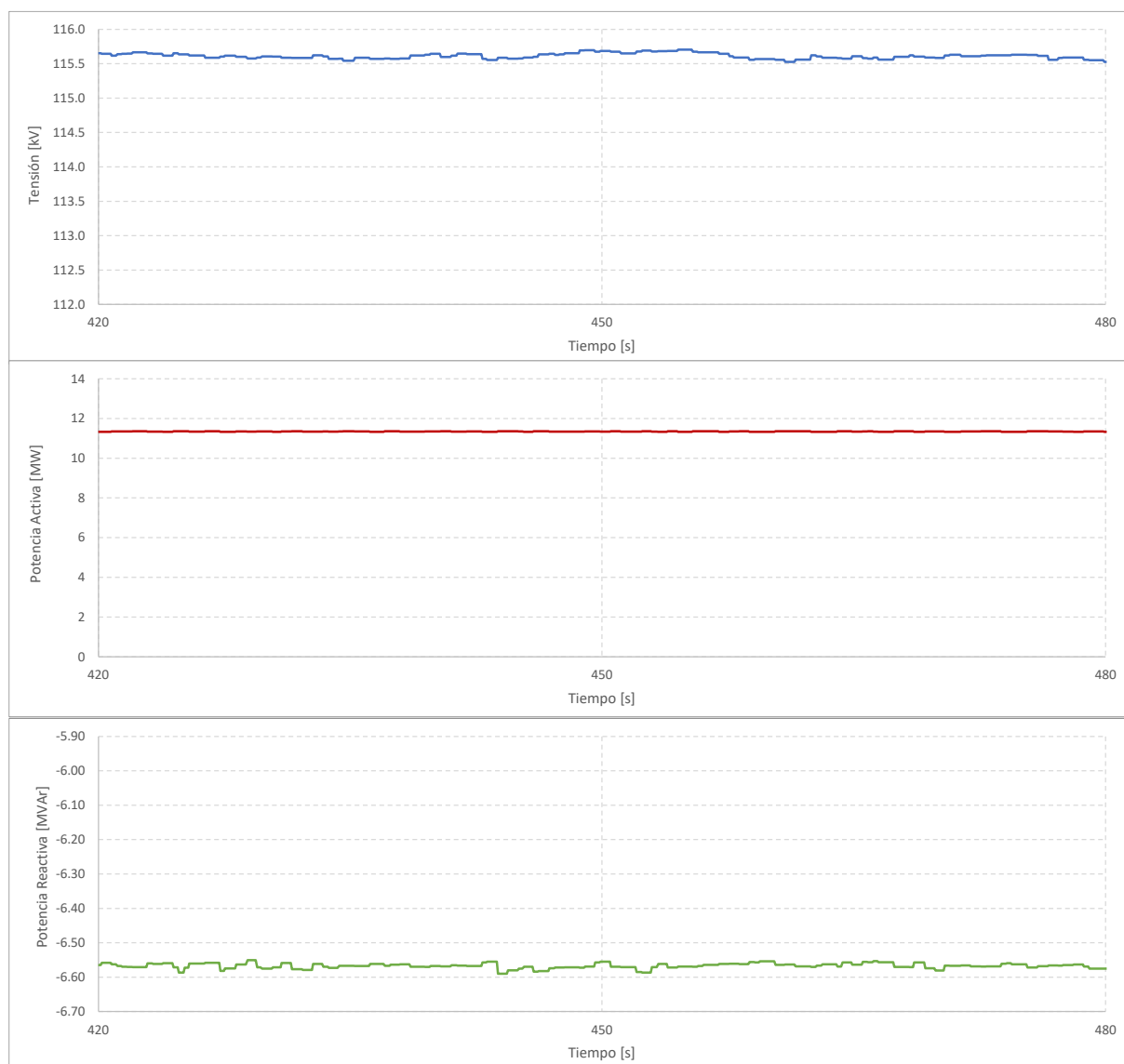
**Gráfico 15. Punto PQ 3 – Control FP**



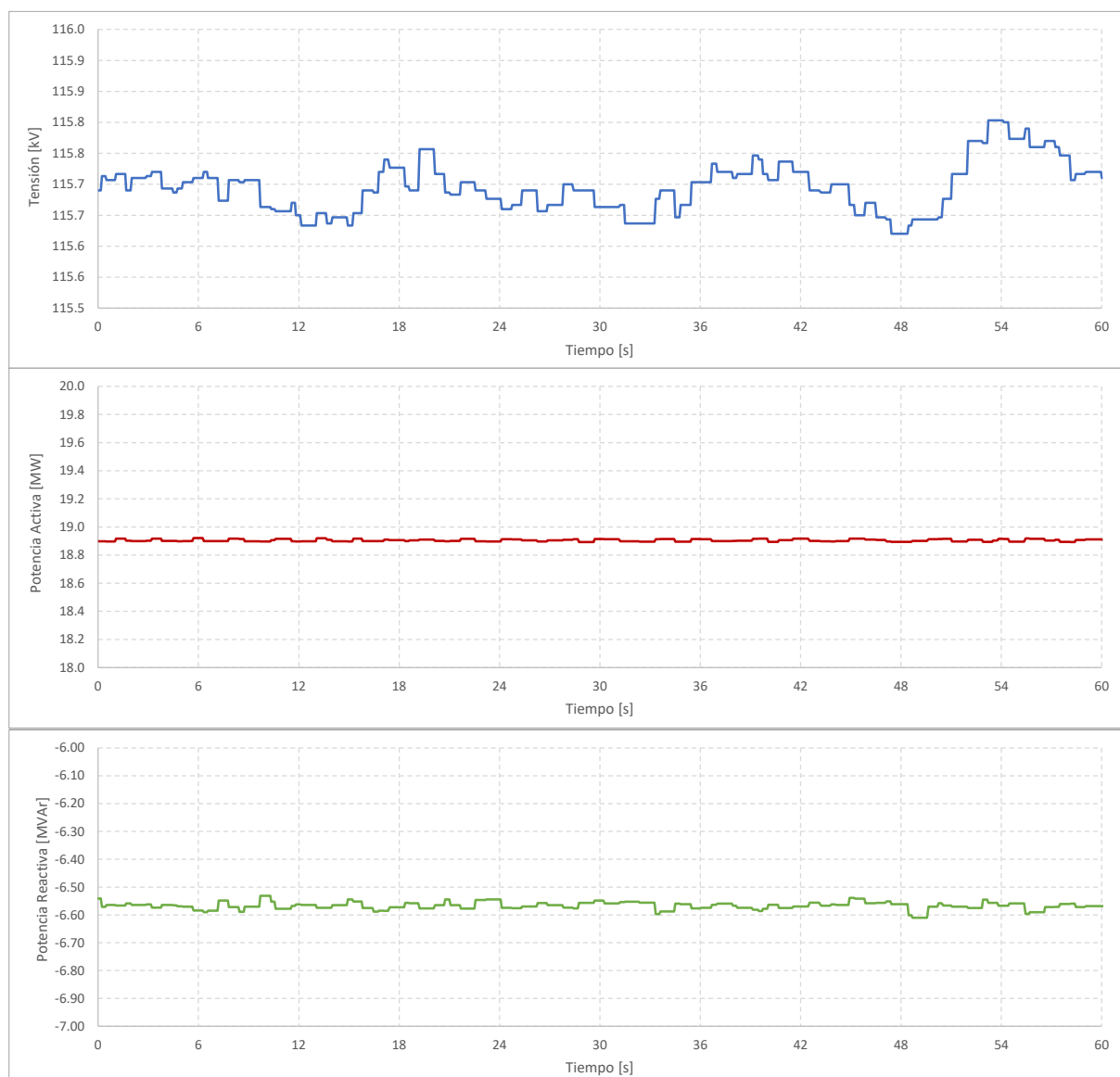
**Gráfico 16. Punto PQ 4 – Control VQ**



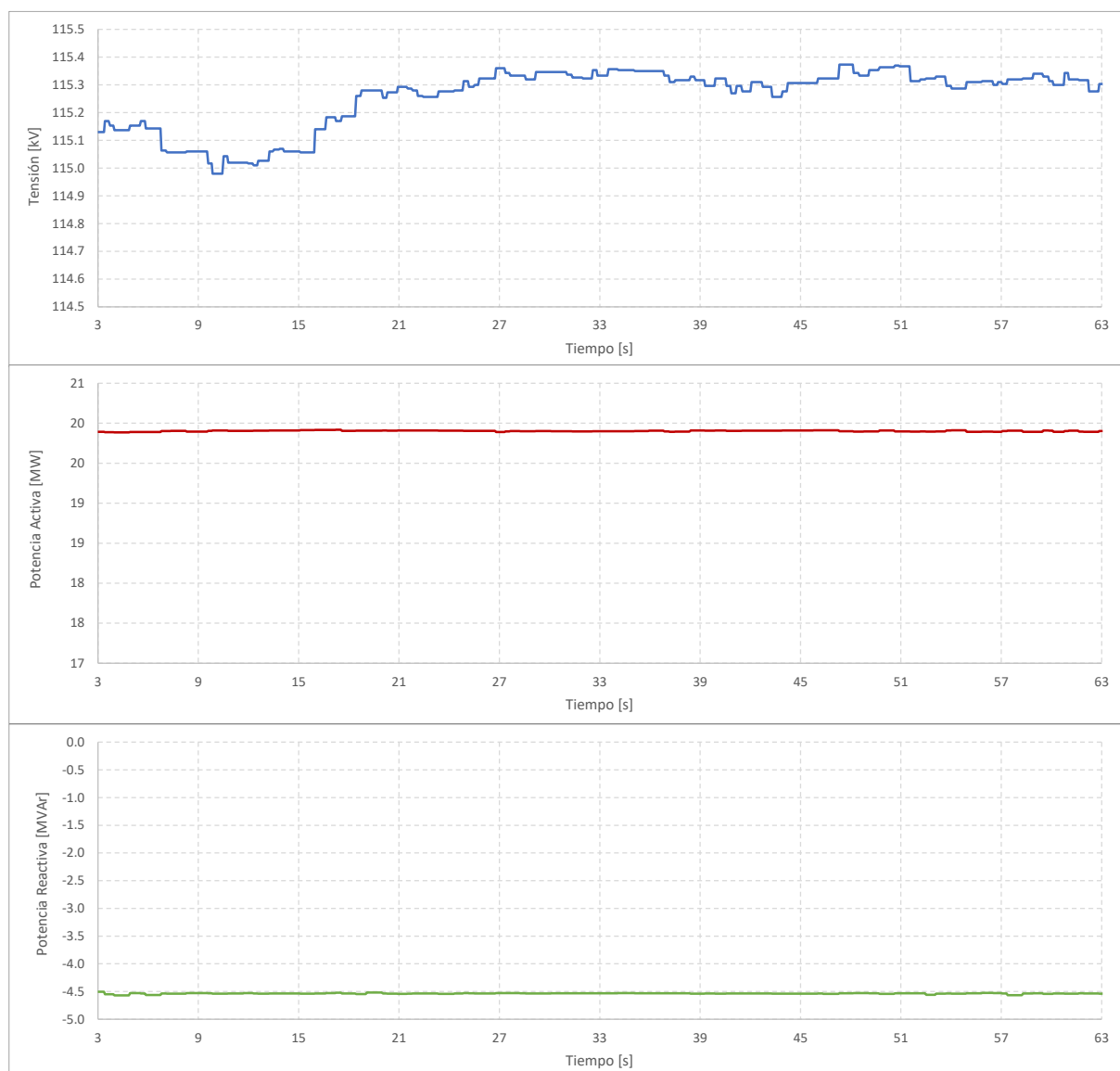
**Gráfico 17. Punto PQ 4 – Control Q**



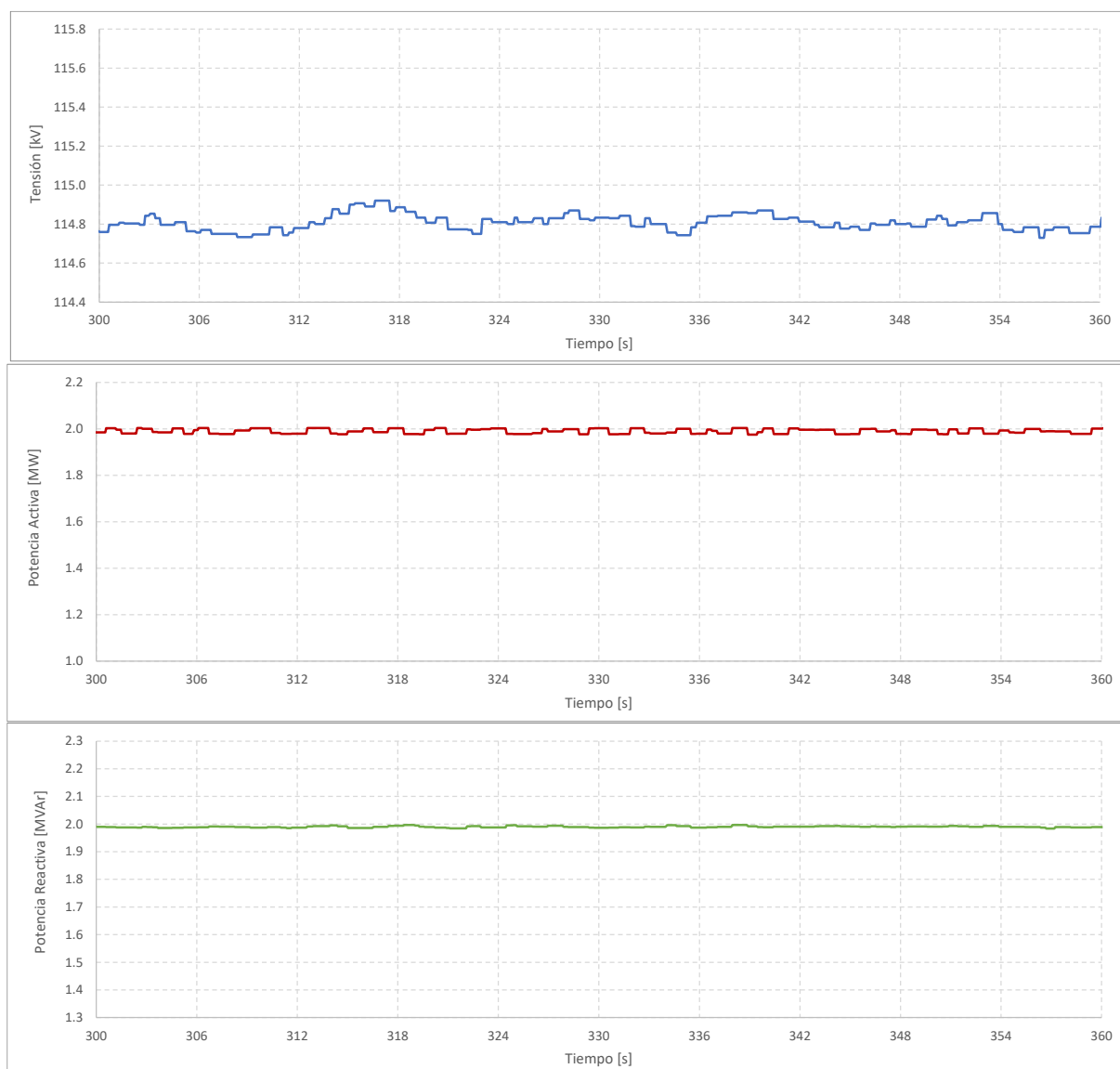
**Gráfico 18. Punto PQ 4 – Control FP**



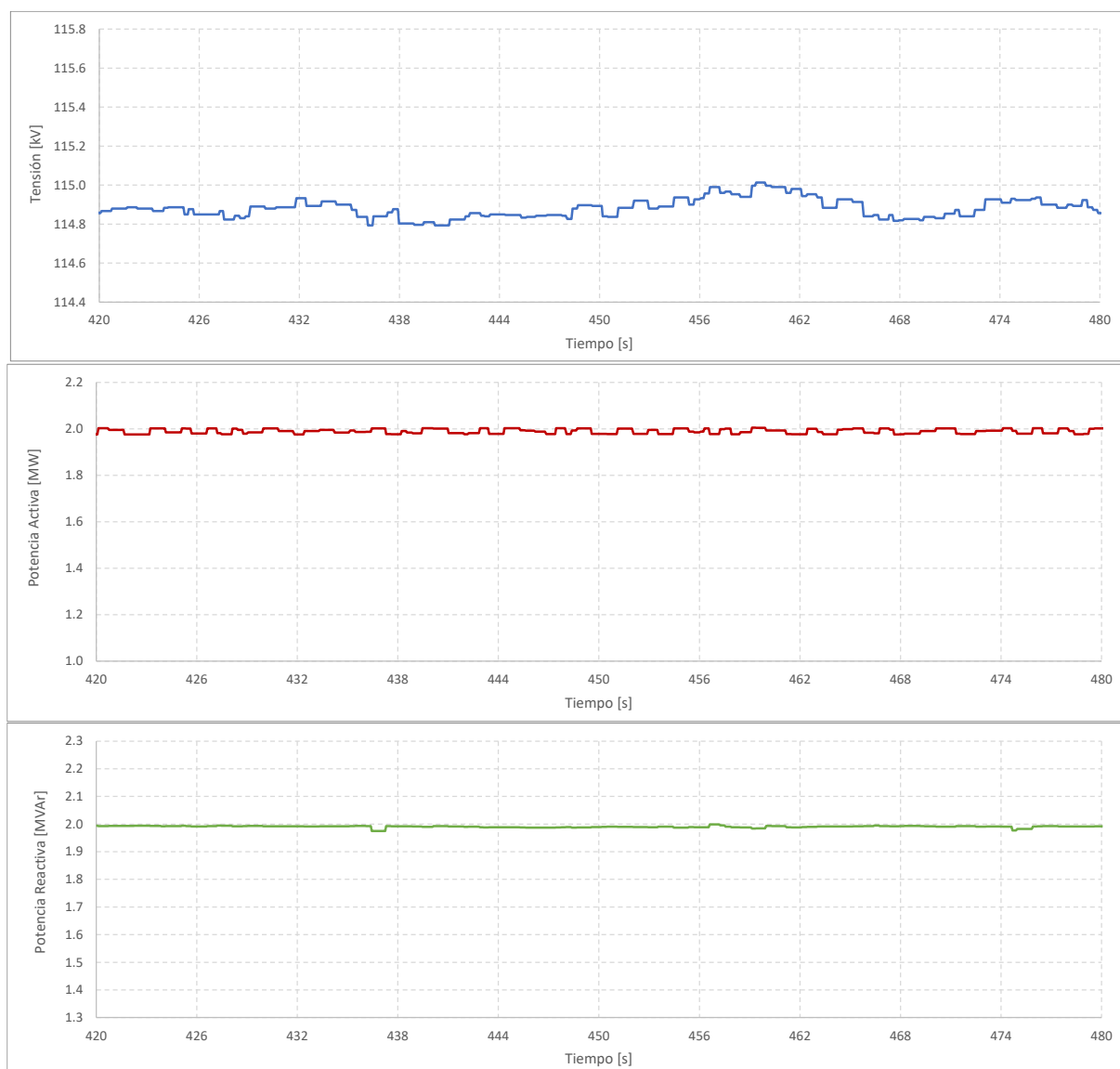
**Gráfico 19. Punto PQ 5 – Control Q**



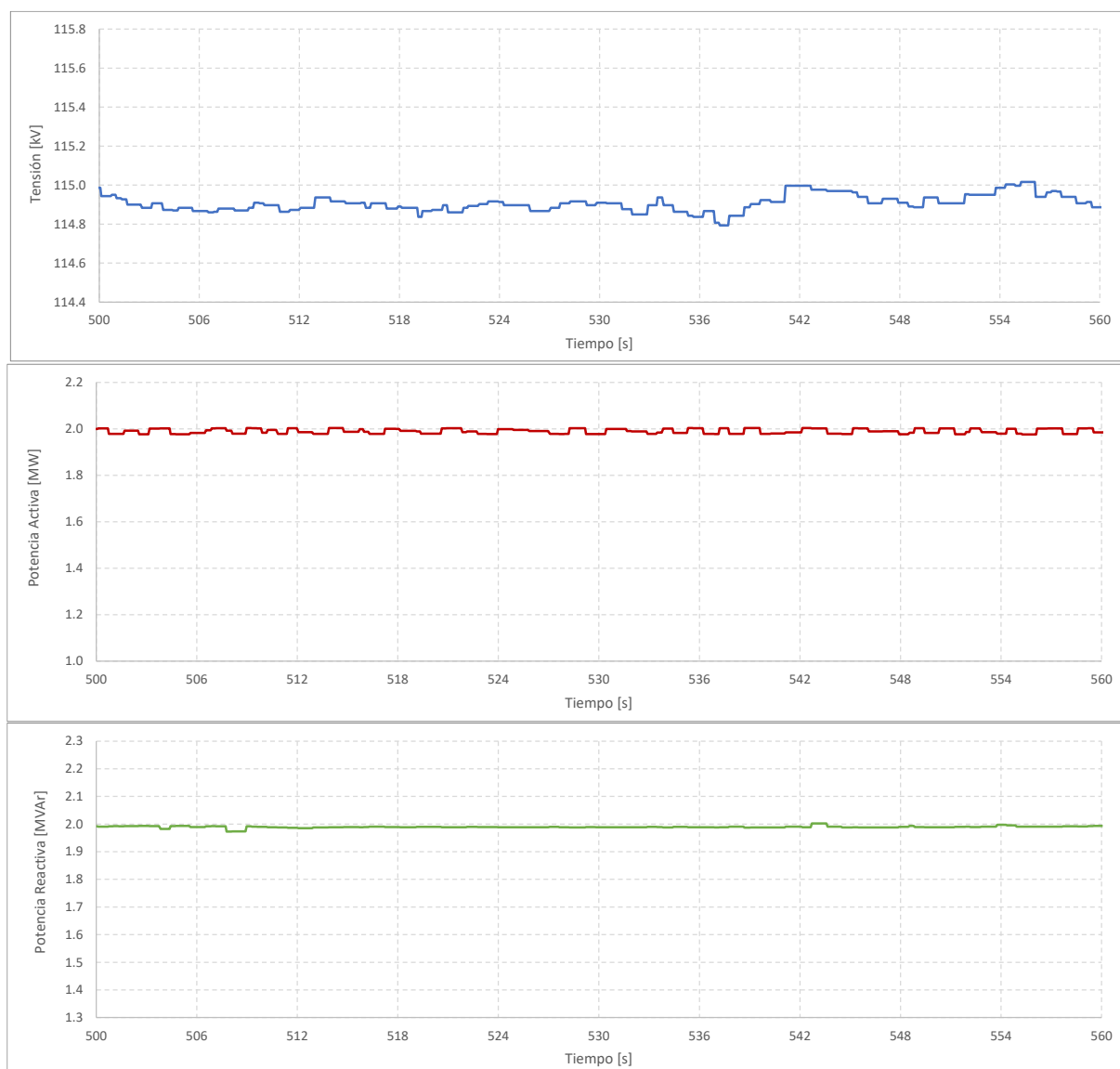
**Gráfico 20. Punto PQ 6 – Control Q**



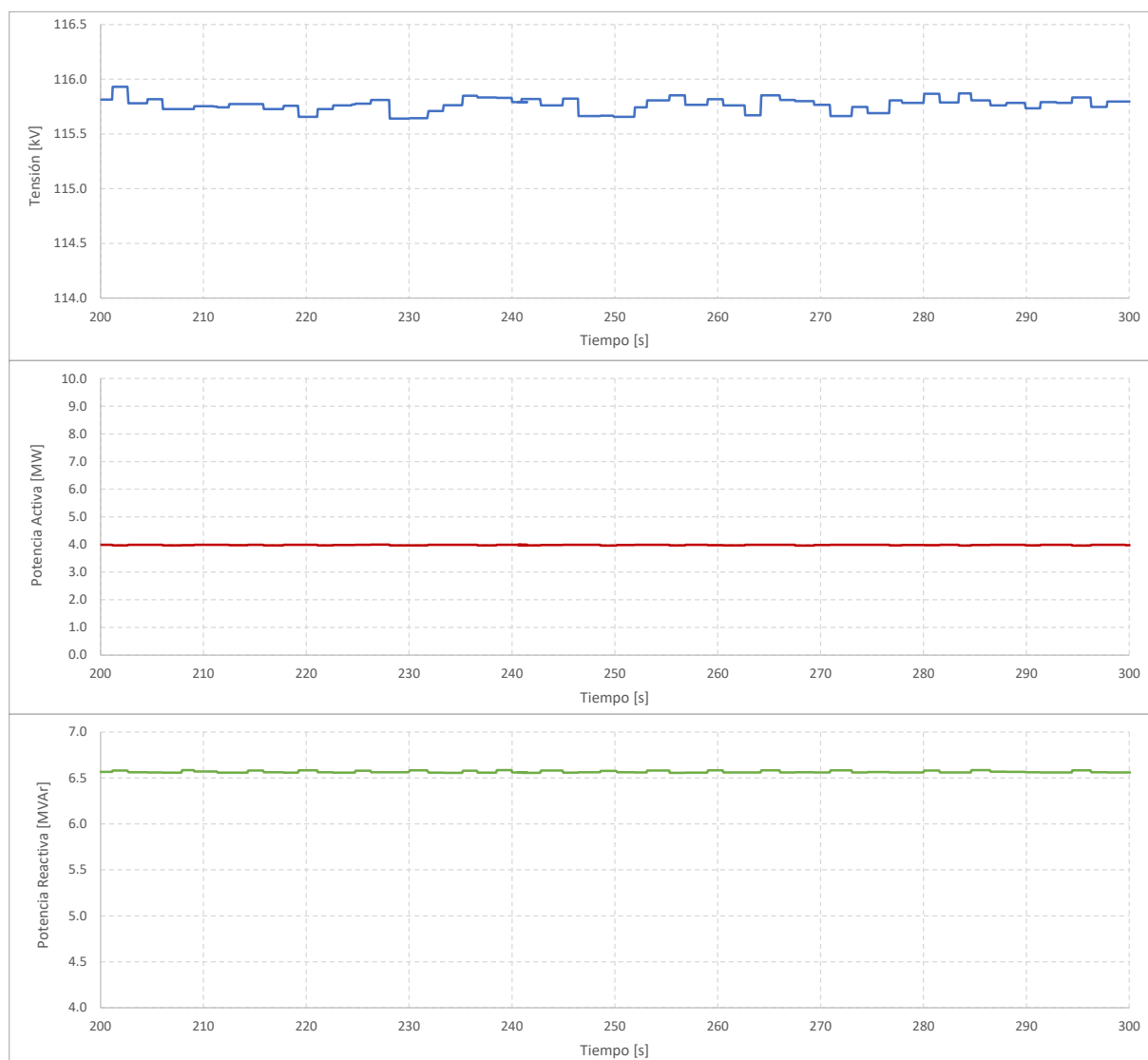
**Gráfico 21. Punto PQ 7 – Control VQ**



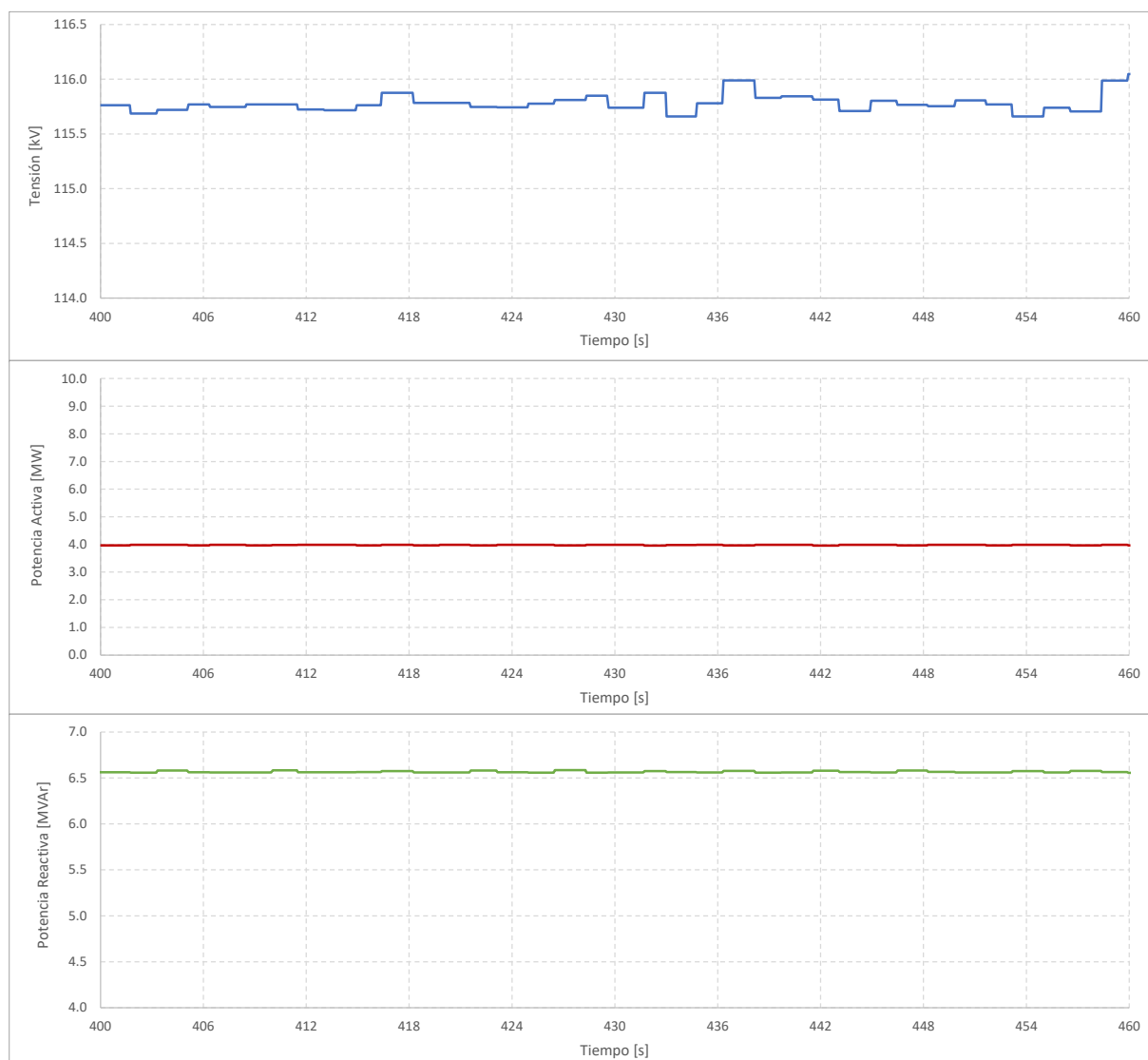
**Gráfico 22. Punto PQ 7 – Control Q**



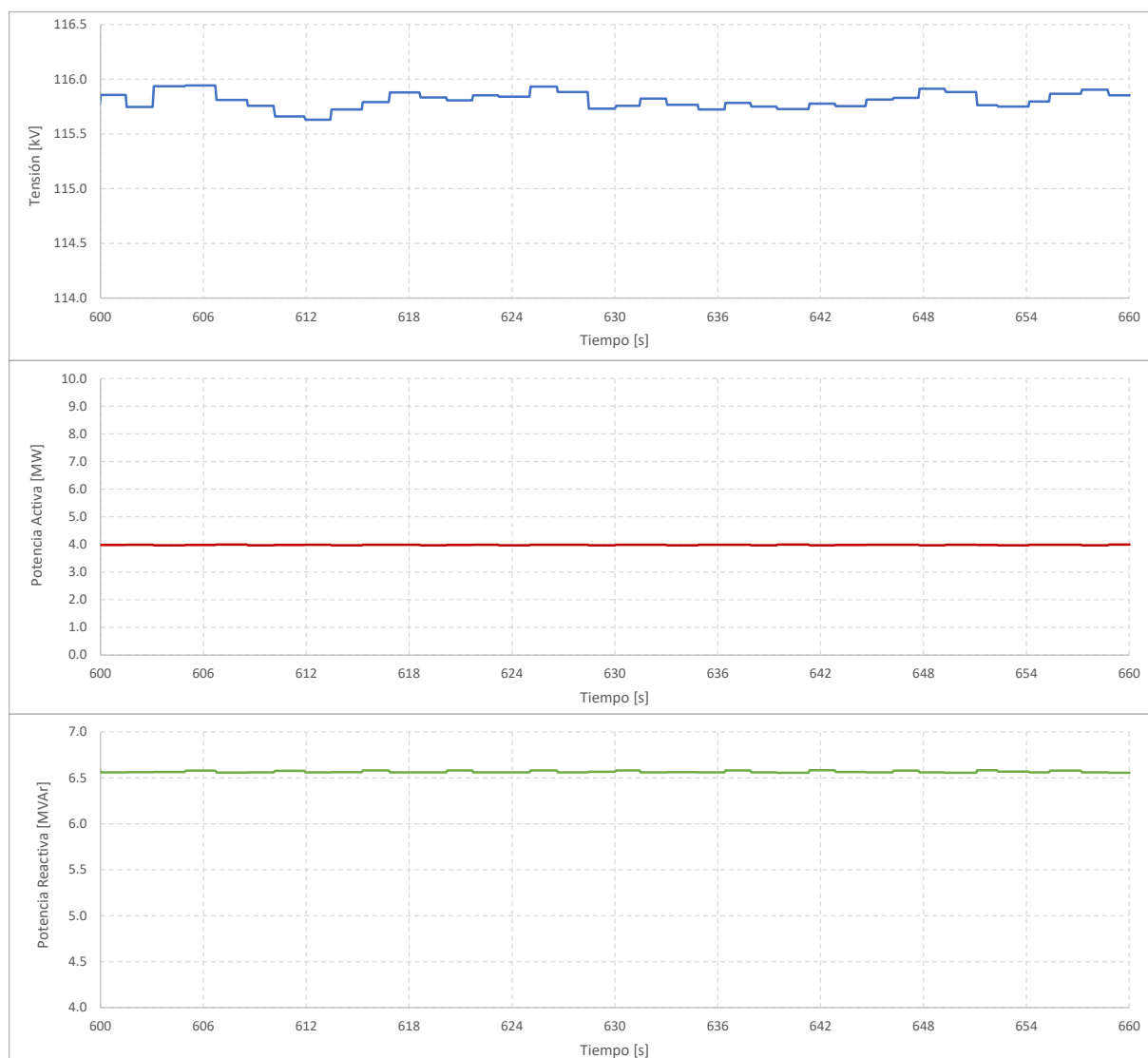
**Gráfico 23. Punto PQ 7 – Control FP**



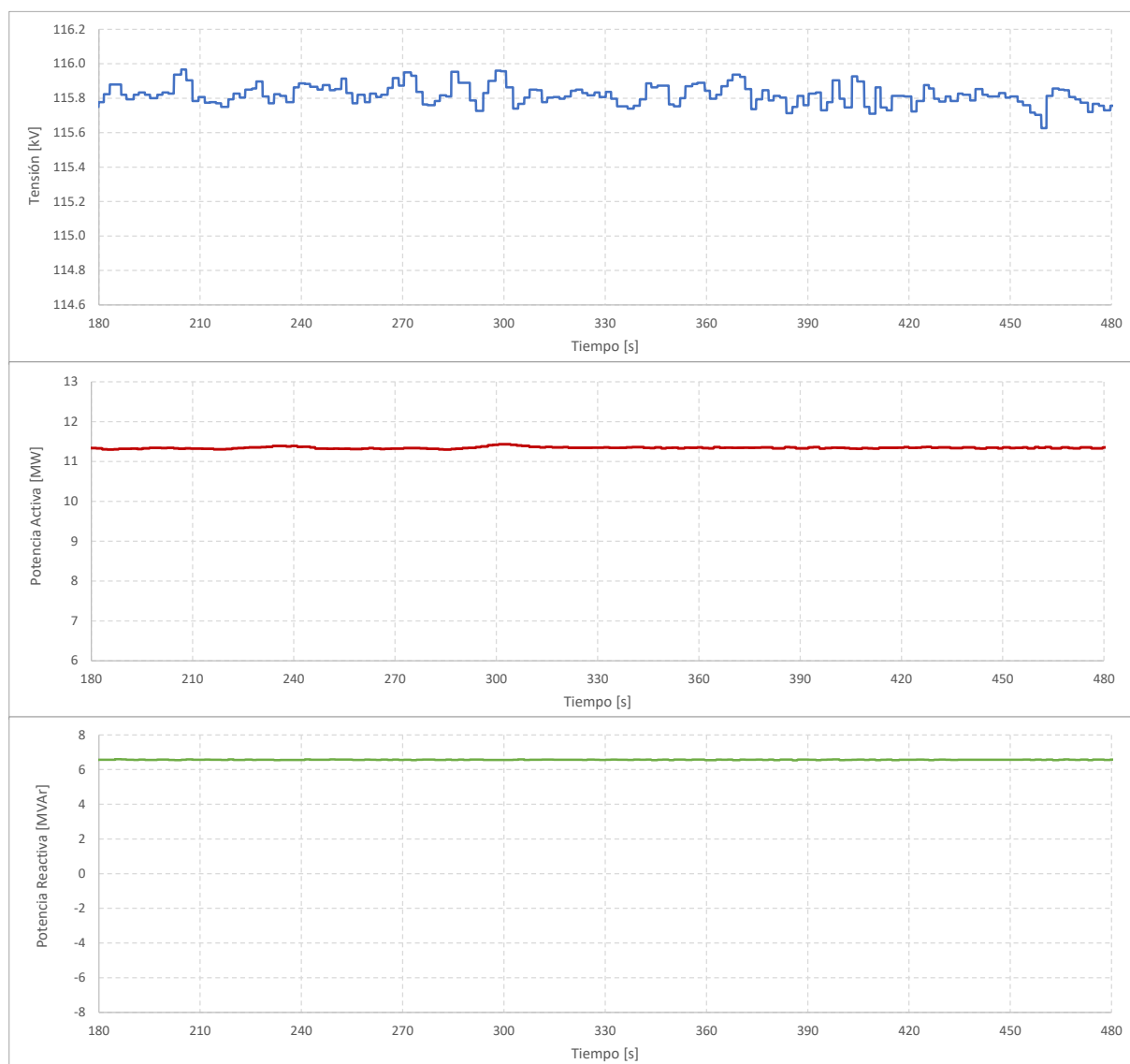
**Gráfico 24. Punto PQ 8 – Control VQ**



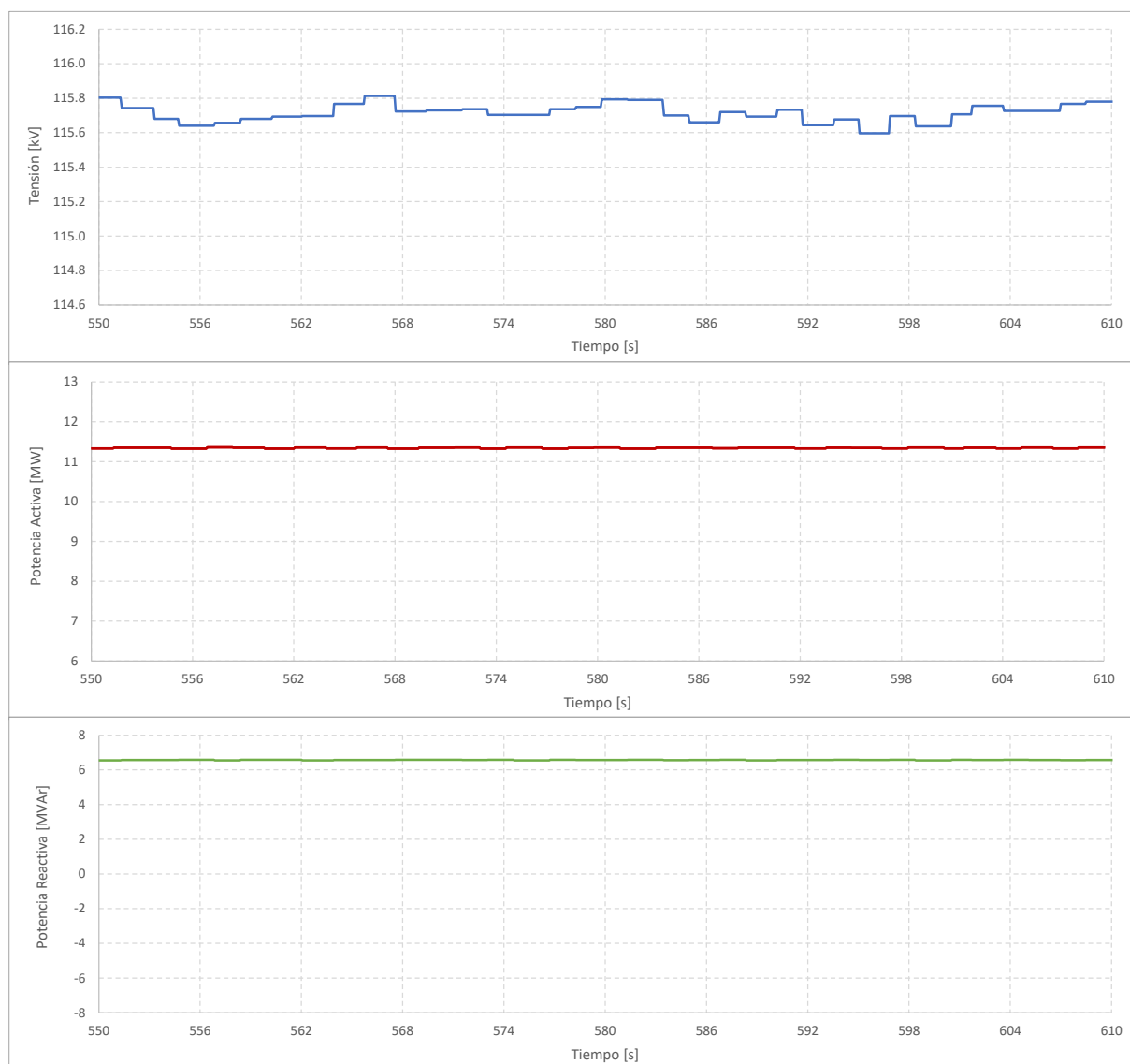
**Gráfico 25. Punto PQ 8 – Control Q**



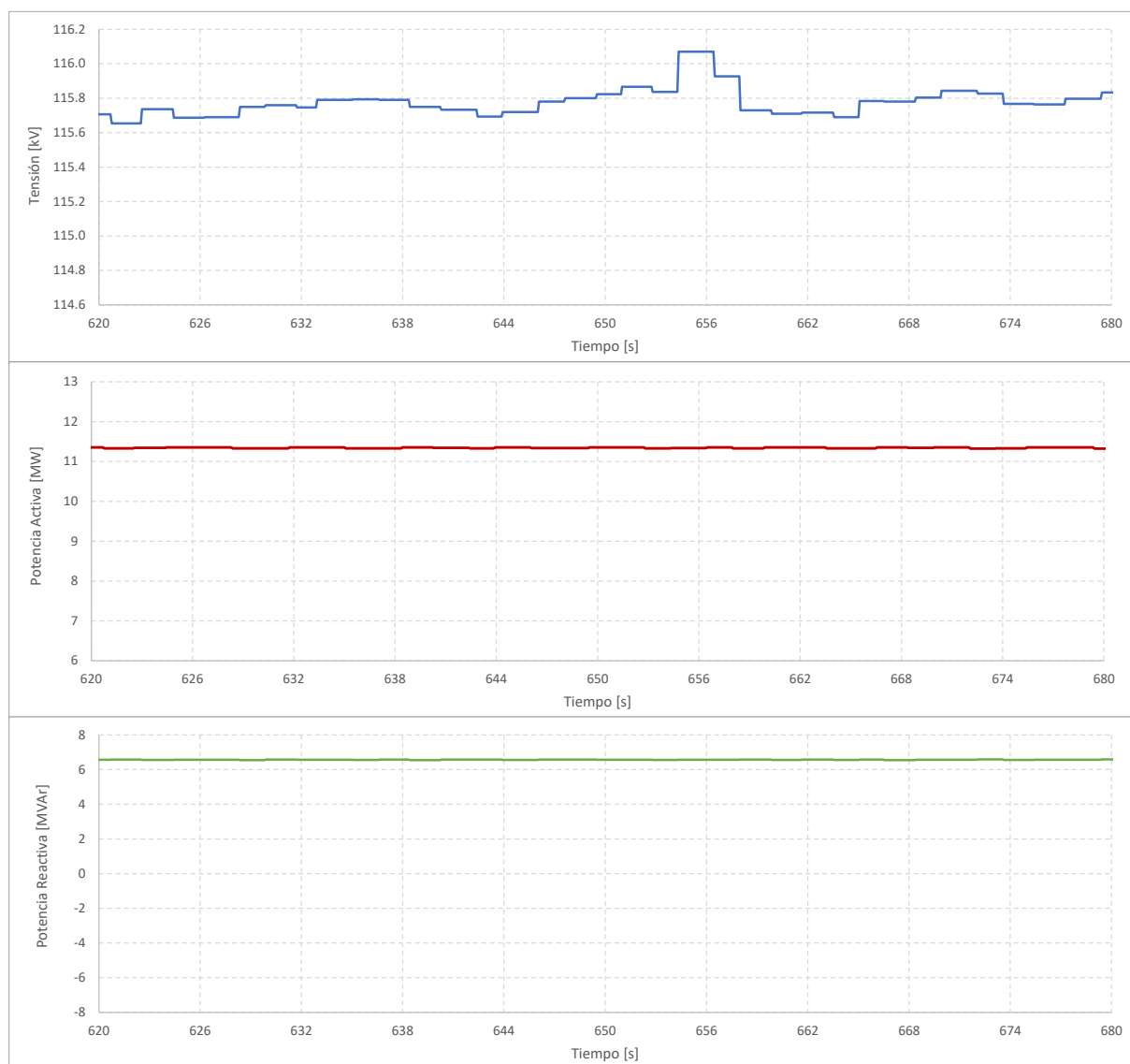
**Gráfico 26. Punto PQ 8 – Control FP**



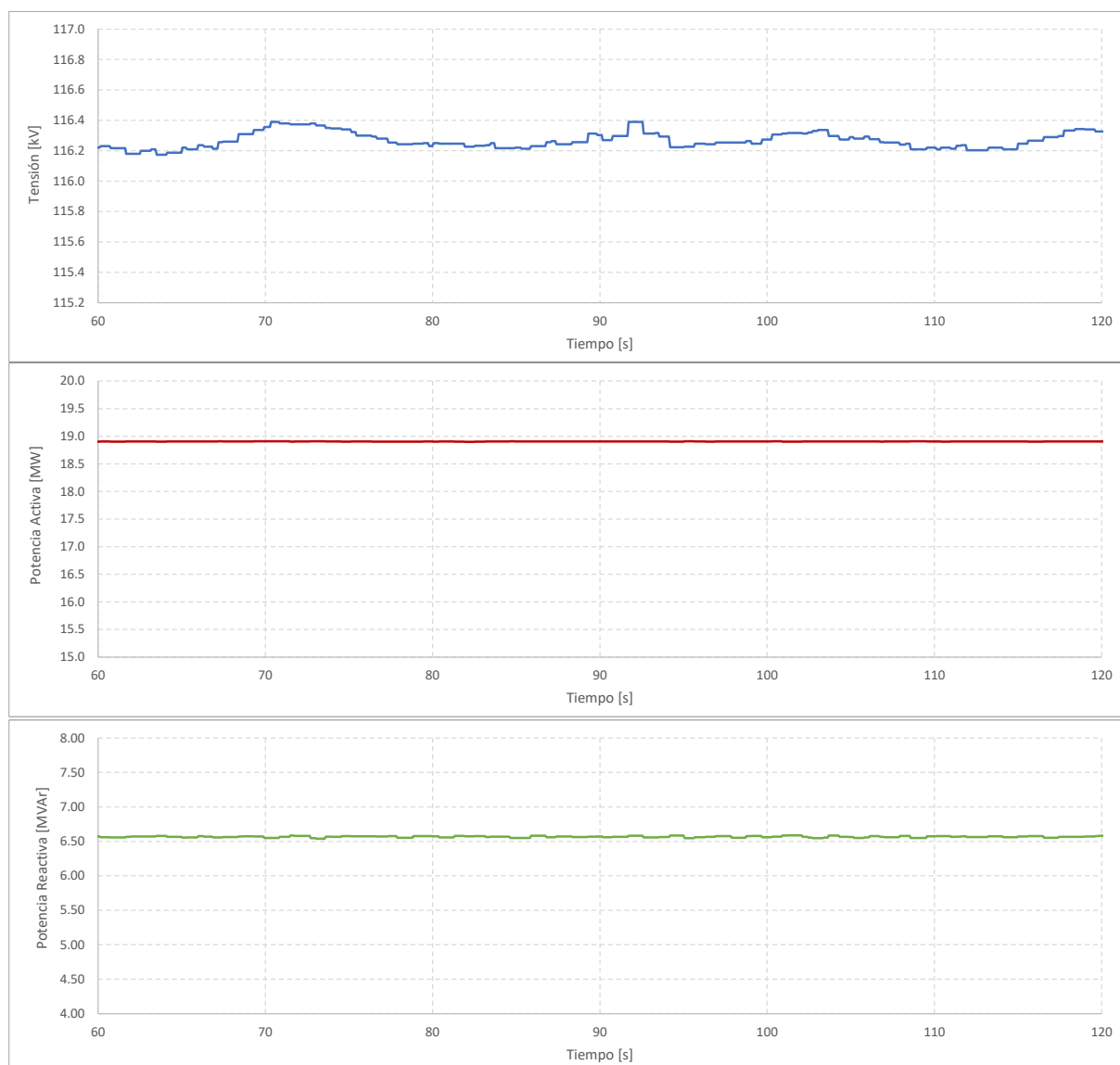
**Gráfico 27. Punto PQ 9 – Control VQ**



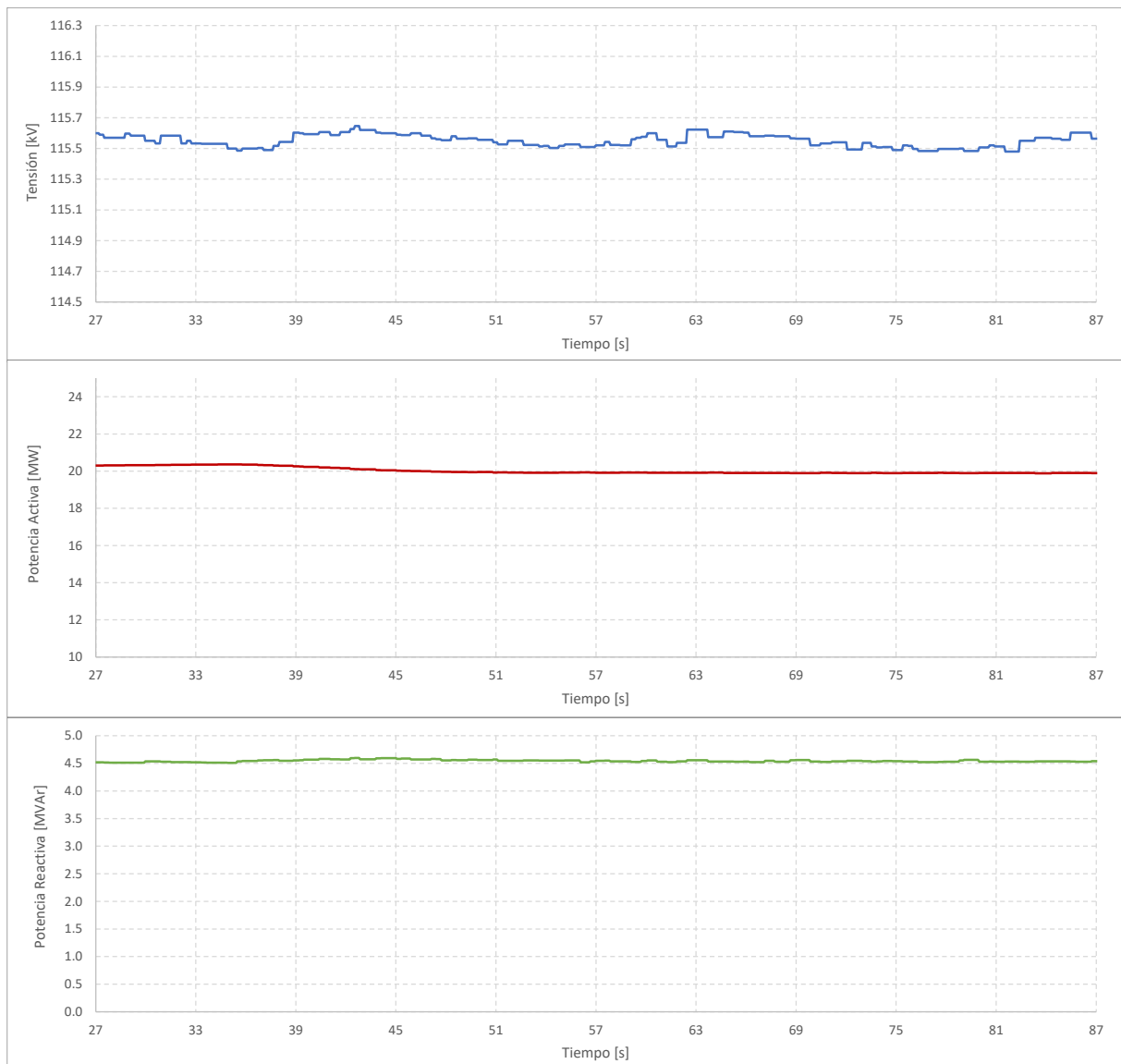
**Gráfico 28. Punto PQ 9 – Control Q**



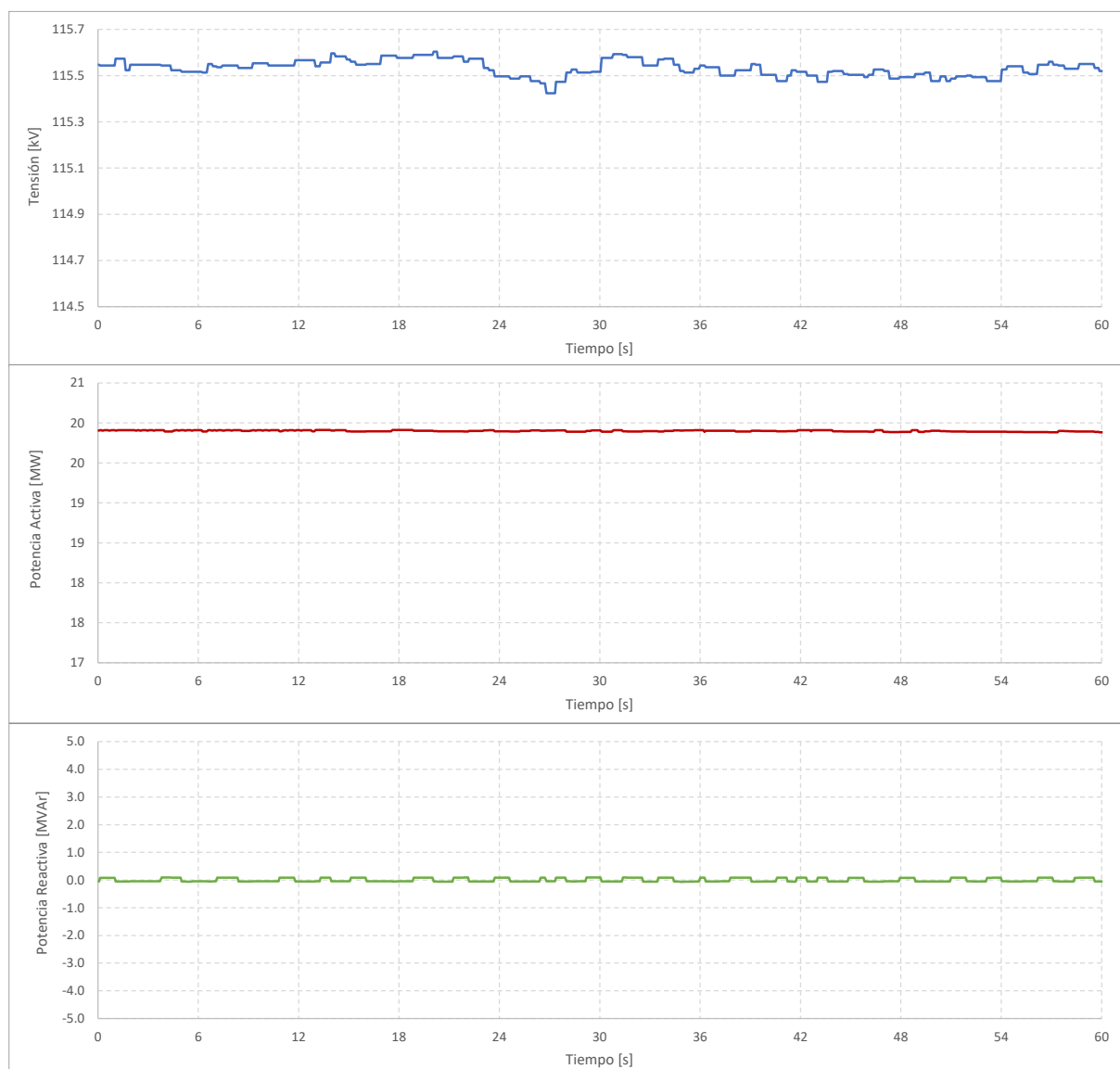
**Gráfico 29. Punto PQ 9 – Control FP**



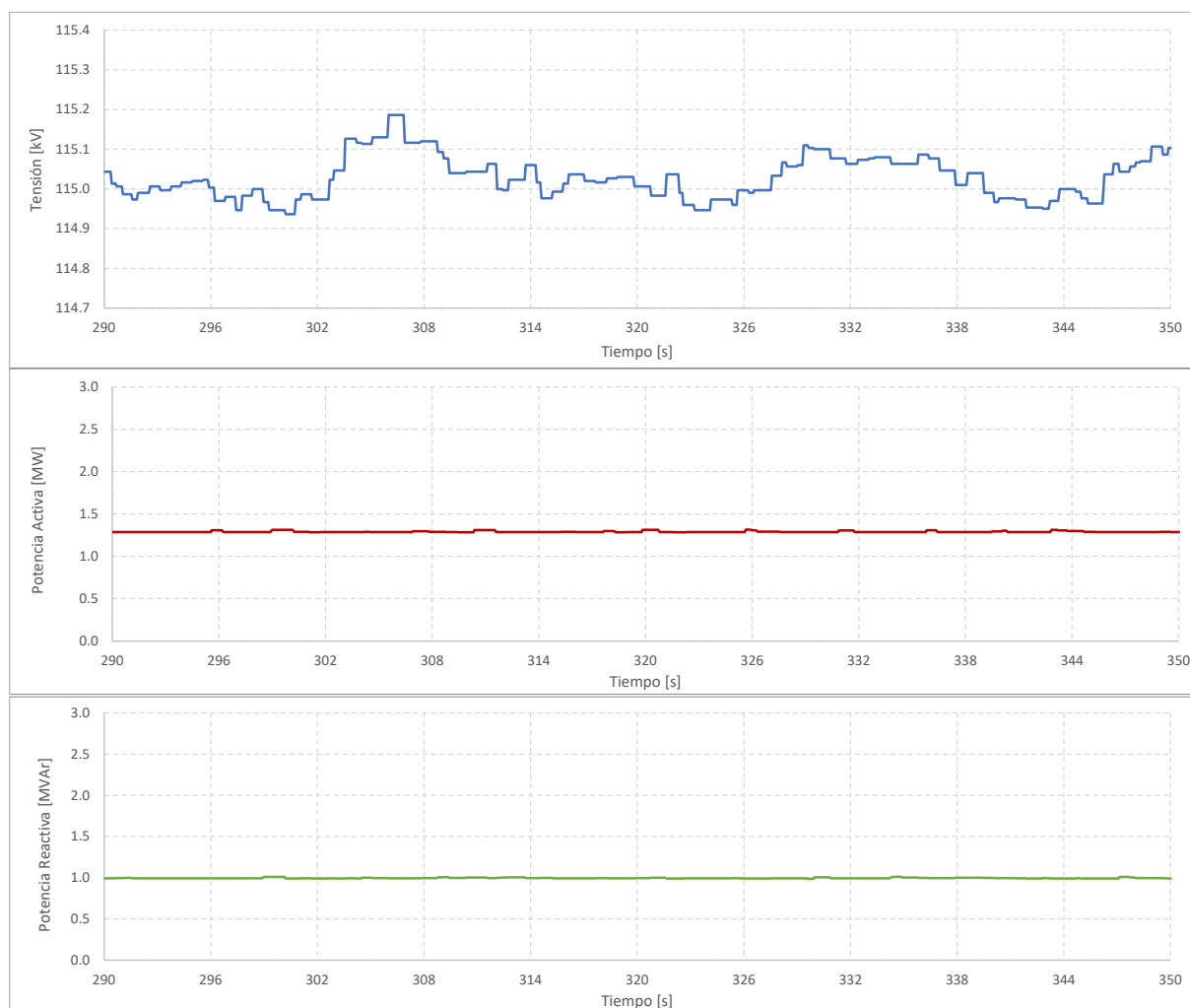
**Gráfico 30. Punto PQ 10 – Control Q**



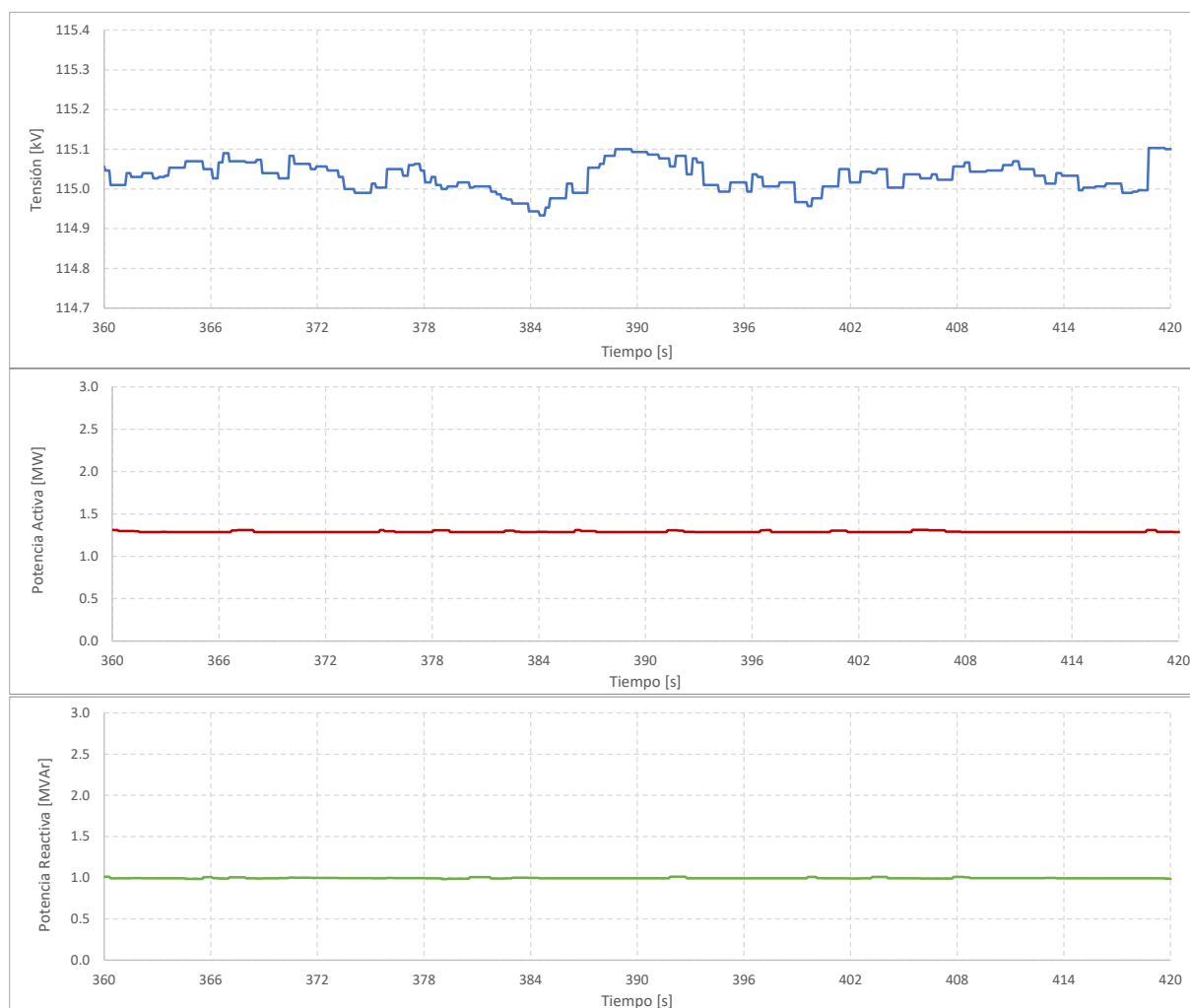
**Gráfico 31. Punto PQ 11 – Control Q**



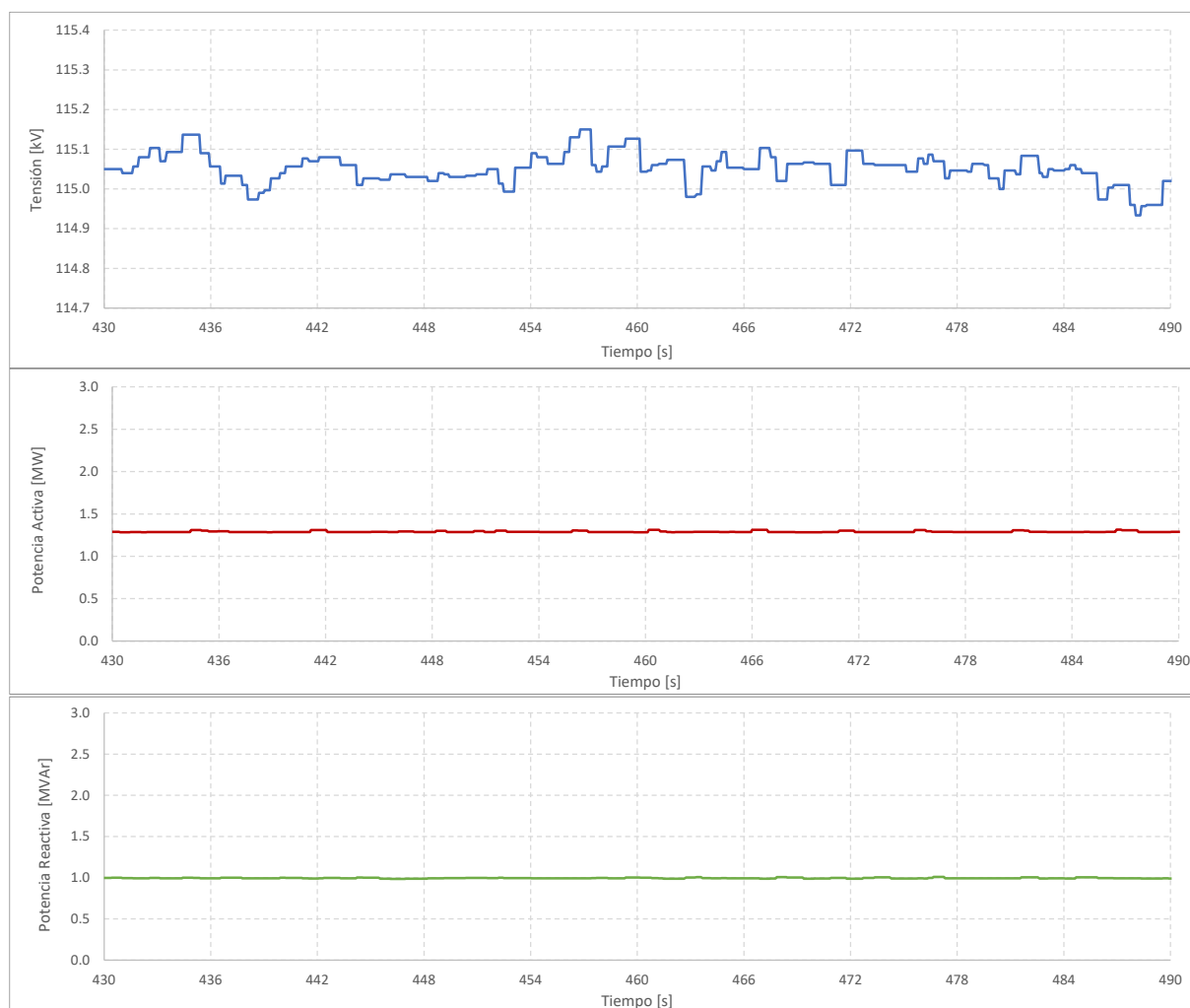
**Gráfico 32. Punto PQ 12 – Control Q**



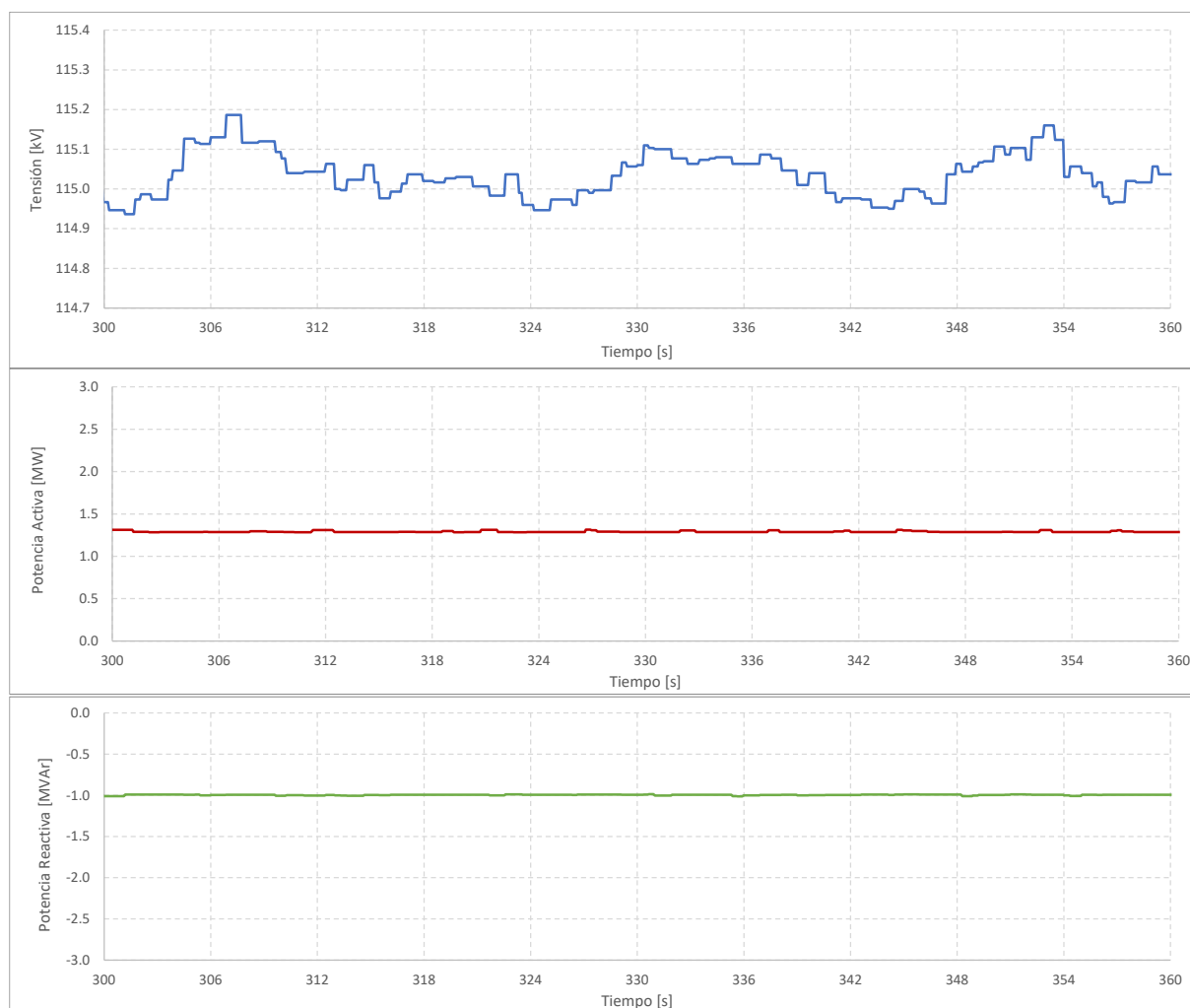
**Gráfico 33. Punto PQ 13 – Control VQ**



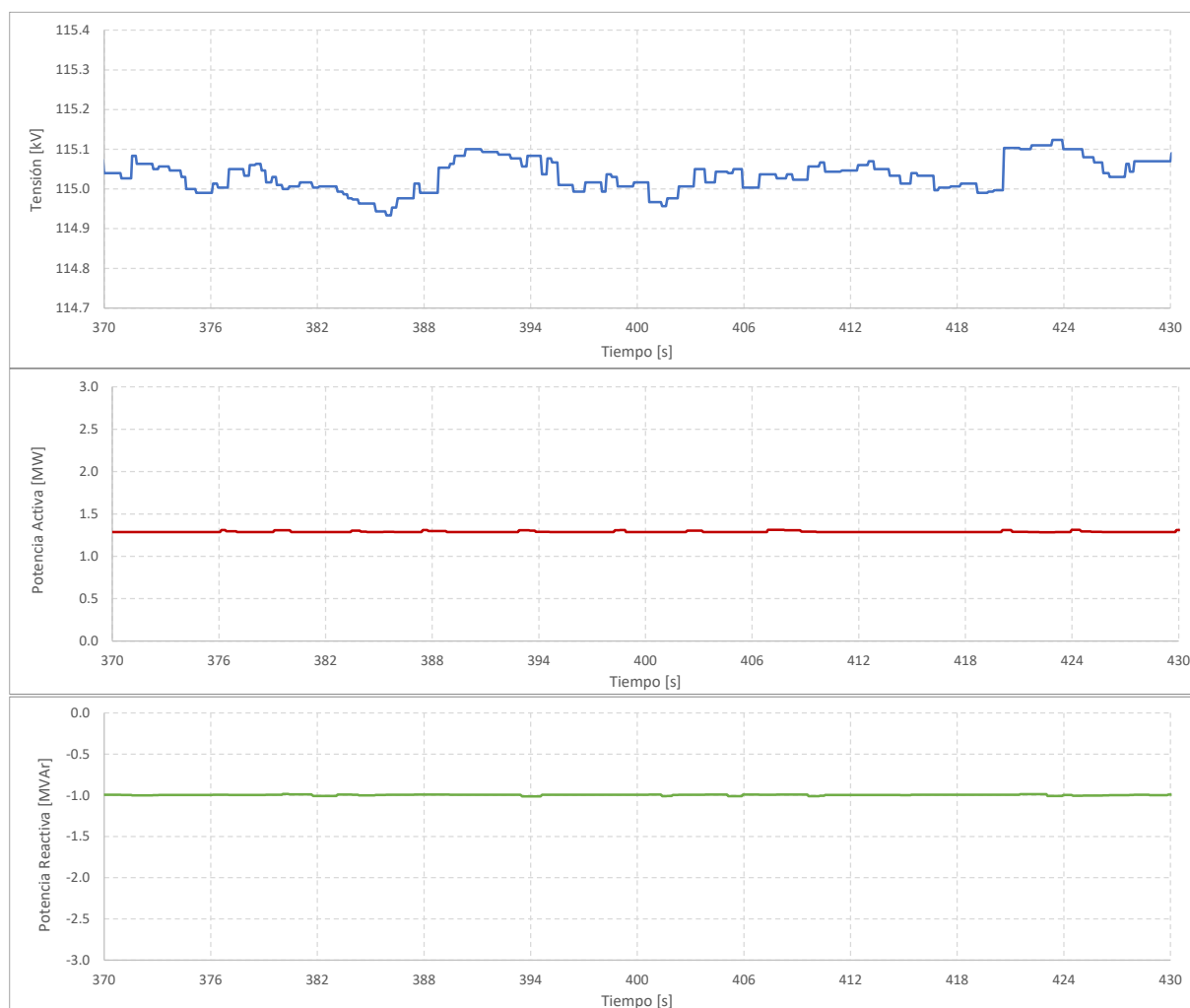
**Gráfico 34. Punto PQ 13 – Control Q**



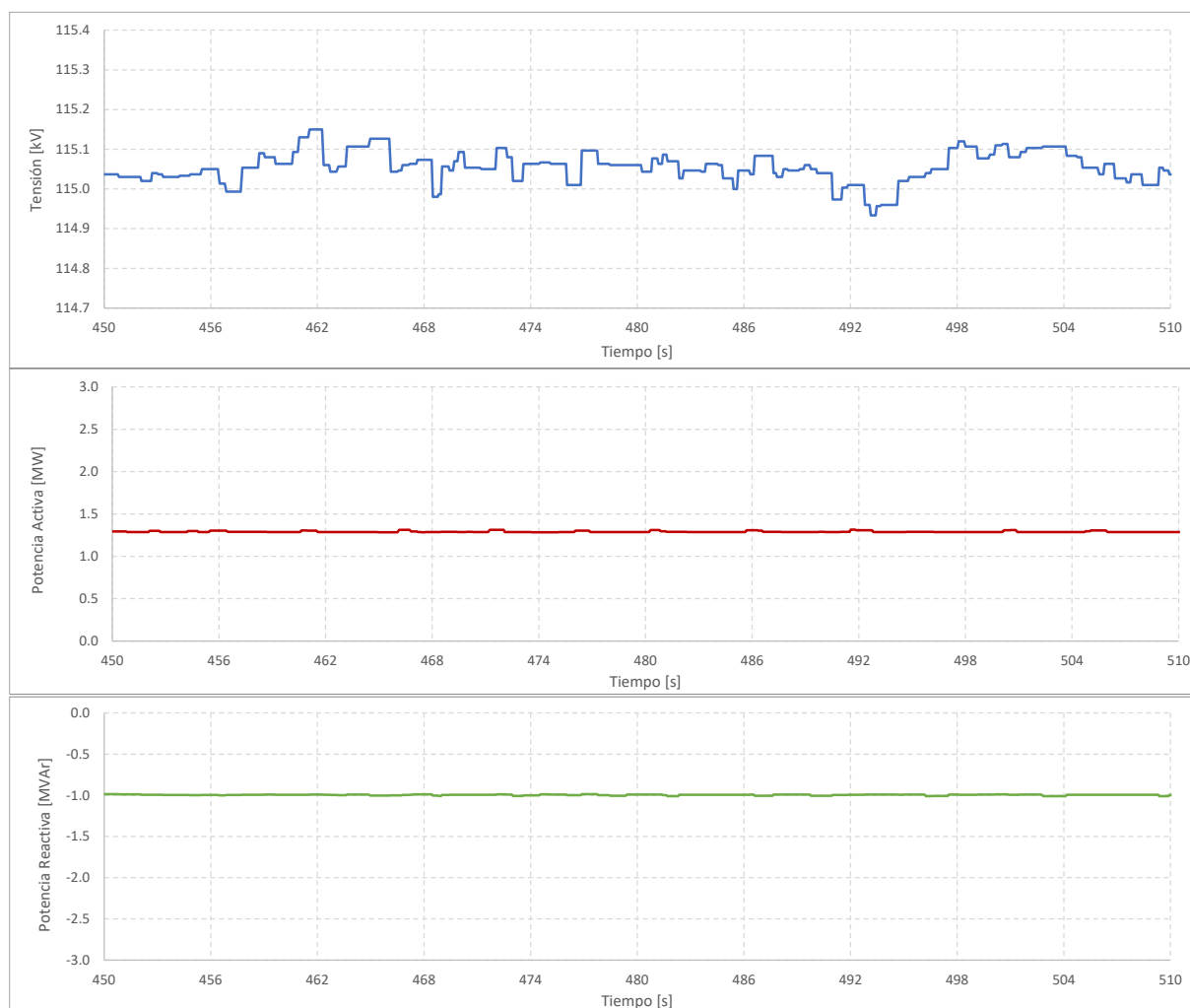
**Gráfico 35. Punto PQ 13 – Control FP**



**Gráfico 36. Punto PQ 14 – Control VQ**



**Gráfico 37. Punto PQ 14 – Control Q**



**Gráfico 38. Punto PQ 14 – Control FP**

## 7. CONCLUSIONES

La Planta Solar Fotovoltaica Bosques del Bolívar 503 ha sido sometida a una Auditoría de Pruebas de verificación de la curva de capacidad. La misma ha sido llevada a cabo bajo los lineamientos establecidos en el Acuerdo CNO 1833.

En función de lo realizado puede concluirse que:

- Los puntos medidos para dar cumplimiento con las pruebas de verificación de la curva de carga alcanzan los límites de la PQ de referencia, sin originarse oscilaciones indeseadas, dando como válidas las pruebas en la región de absorción como en la entrega de reactiva.
- Durante las pruebas no se presentaron alarmas relacionadas con la planta, sus límites o temperaturas máximas.

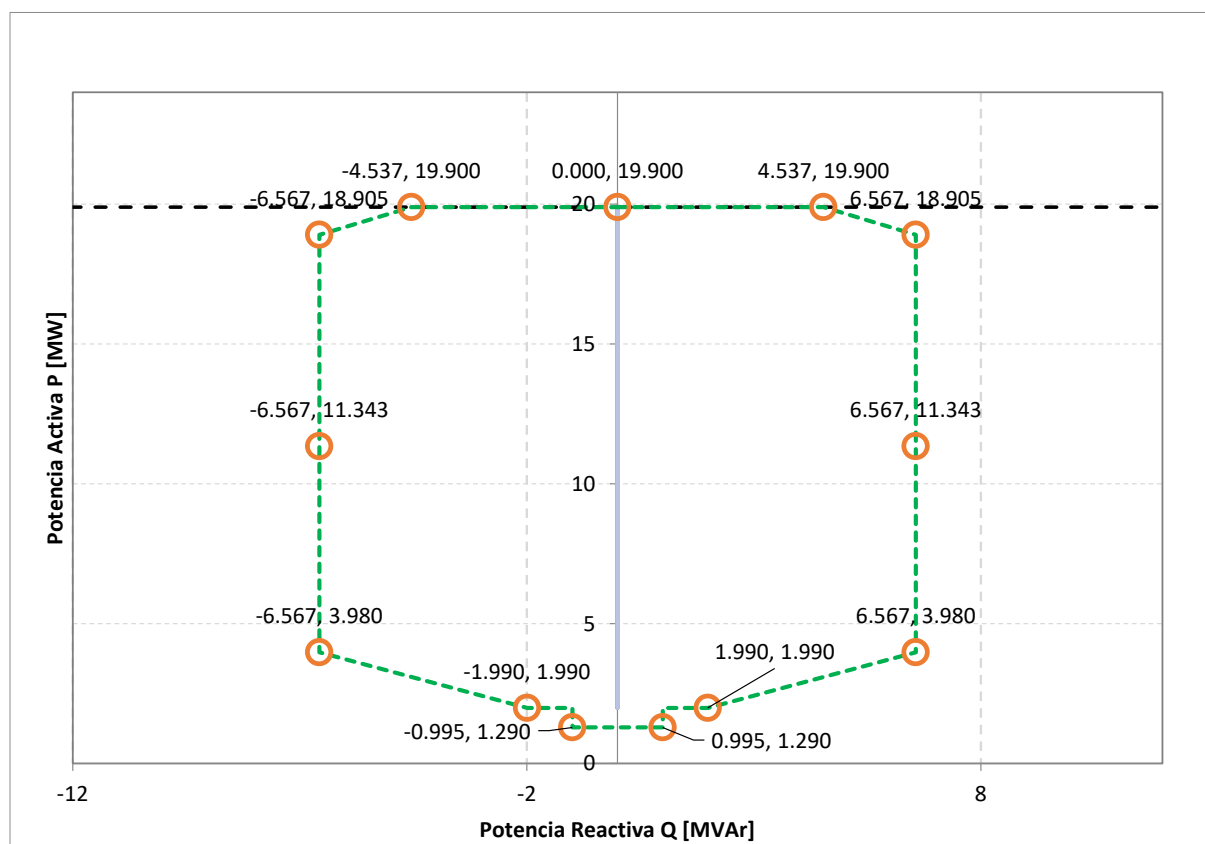
En el presente documento han sido expuestos los resultados de las pruebas realizadas. Con base en estos resultados y en la auditoría realizada, se determina que la PSFV Bosques del Bolívar 503:

### CUMPLE

En conclusión, la curva de capacidad a declarar por parte de la planta es la siguiente, que coincide con el requerimiento mínimo de la resolución CREG 060-2019:

**Tabla 6. Puntos de la curva PQ final a declarar**

| P (MW) | Q (MVar) |
|--------|----------|
| 1.990  | -1.990   |
| 11.343 | -6.567   |
| 19.900 | -4.537   |
| 1.990  | 1.990    |
| 11.343 | 6.567    |
| 19.900 | 4.537    |
| 3.980  | 6.567    |
| 3.980  | -6.567   |
| 18.905 | 6.567    |
| 18.905 | -6.567   |
| 1.290  | -0.995   |
| 1.290  | 0.995    |
| 19.900 | 0.000    |



**Gráfico 39. Curva PQ a declarar por parte de la planta.**

Nombre de la empresa:

**EEC-GME Global || GERS**

Nombre del auditor:

Ezequiel Atlas

Firma del auditor:

Fecha:

10/06/2024

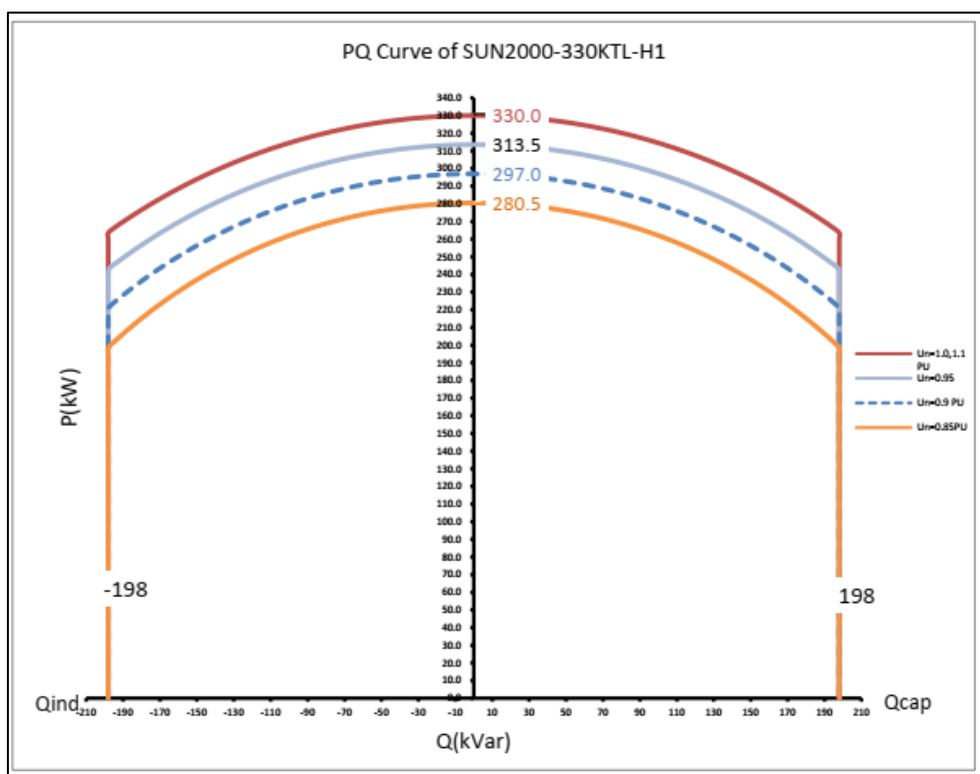
## ANEXOS

### 8. INFORMACIÓN TÉCNICA

#### 8.1. Inversores

| Efficiency                          |                   |
|-------------------------------------|-------------------|
| Max. Efficiency                     | ≥99.0%            |
| European Efficiency                 | ≥98.8%            |
| Input                               |                   |
| Max. Input Voltage                  | 1,500 V           |
| Number of MPP Trackers              | 6                 |
| Max. Current per MPPT               | 65 A              |
| Max. Short Circuit Current per MPPT | 115 A             |
| Max. PV Inputs per MPPT             | 4/5/5/4/5/5       |
| Start Voltage                       | 550 V             |
| MPPT Operating Voltage Range        | 500 V ~ 1,500 V   |
| Nominal Input Voltage               | 1,080 V           |
| Output                              |                   |
| Nominal AC Active Power             | 300,000 W         |
| Max. AC Apparent Power              | 330,000 VA        |
| Max. AC Active Power (cosφ=1)       | 330,000 W         |
| Nominal Output Voltage              | 800 V, 3W + PE    |
| Rated AC Grid Frequency             | 50 Hz / 60 Hz     |
| Nominal Output Current              | 216.6 A           |
| Max. Output Current                 | 238.2 A           |
| Adjustable Power Factor Range       | 0.8 LG ... 0.8 LD |
| Total Harmonic Distortion           | < 1%              |
| Protection                          |                   |
| Smart String-Level Disconnect(SSLD) | Yes               |
| Anti-islanding Protection           | Yes               |
| AC Overcurrent Protection           | Yes               |
| DC Reverse-polarity Protection      | Yes               |
| PV-array String Fault Monitoring    | Yes               |
| DC Surge Arrester                   | Type II           |
| AC Surge Arrester                   | Type II           |
| DC Insulation Resistance Detection  | Yes               |
| AC Grounding Fault Protection       | Yes               |
| Residual Current Monitoring Unit    | Yes               |

**Gráfico 40. Ficha técnica de los inversores**



**Gráfico 41. Curva de capacidad de los inversores**

## 8.2. Centros de transformación

| Technical Specifications(Preliminary)       |                                                                              |                               |
|---------------------------------------------|------------------------------------------------------------------------------|-------------------------------|
| Input                                       |                                                                              |                               |
| Available Inverters / PCS                   | SUN2000-330KTL-H1/ SUN2000-330KTL-H2                                         |                               |
| Maximum LV AC Inputs                        | 22                                                                           |                               |
| AC Power                                    | 6,600 kVA @40°C / 5,940 kVA @50°C <sup>1</sup>                               |                               |
| Rated Input Voltage                         | 800 V                                                                        |                               |
| LV Main Switches                            | ACB (2,900 A / 800 V / 3P, 2 x 1 pcs), MCCB (400 A / 800 V / 3P, 2 x 11 pcs) |                               |
| Output                                      |                                                                              |                               |
| Rated Output Voltage                        | 11 kV, 15 kV, 20 kV, 22 kV, 30 kV, 33 kV, 35 kV <sup>2</sup>                 | 13.8 kV, 34.5 kV <sup>2</sup> |
| Frequency                                   | 50 Hz                                                                        | 60 Hz                         |
| Transformer Type                            | Oil-immersed, Conservator Type                                               |                               |
| Transformer Cooling Type                    | ONAN                                                                         |                               |
| Transformer Tappings                        | ± 2 x 2.5%                                                                   |                               |
| Transformer Oil Type                        | Mineral Oil (PCB Free)                                                       |                               |
| Transformer Vector Group                    | Dy11-y11                                                                     |                               |
| Transformer Min. Peak Efficiency Index      | Tier 1 or Tier 2 In Accordance with EN 50588-1                               |                               |
| RMU Type                                    | SF <sub>6</sub> Gas Insulated                                                |                               |
| RMU Transformer Protection Unit             | MV Vacuum Circuit Breaker Unit                                               |                               |
| RMU Cable Incoming / Outgoing Unit          | Direct Cable Unit or Cable Load Break Switch Unit                            |                               |
| Auxiliary Transformer                       | Dry Type Transformer, 5 kVA                                                  |                               |
| Protection                                  |                                                                              |                               |
| Transformer Monitoring & Protection         | Oil Level, Oil Temperature, Oil Pressure and Buchholz                        |                               |
| Protection Degree of MV & LV Room           | IP 54                                                                        |                               |
| Internal Arcing Fault Classification of STS | IAC A 20 kA 1s                                                               |                               |
| MV Relay Protection                         | 50/51, 50N/51N                                                               |                               |
| LV Overvoltage Protection                   | Type I-II                                                                    |                               |
| Anti-rodent Protection                      | C5 in accordance with ISO 12944                                              |                               |
| Features                                    |                                                                              |                               |
| 2 kVA UPS                                   | Optional <sup>3</sup>                                                        |                               |
| MV Surge Arrester for MV VCB                | Optional <sup>3</sup>                                                        |                               |
| General                                     |                                                                              |                               |
| Dimensions (W x H x D)                      | 6,058 x 2,896 x 2,438 mm (20' HC Container)                                  |                               |
| Weight                                      | < 22 t                                                                       |                               |
| Operating Temperature Range                 | -25°C ~ 60°C <sup>4</sup> (-13°F ~ 140°F)                                    |                               |
| Relative Humidity                           | 0% ~ 95%                                                                     |                               |
| Max. Operating Altitude                     | 1,000 m <sup>5</sup>                                                         |                               |
| MV-LV AC Connections                        | Prewired and Pretested, No Internal Cabling Onsite                           |                               |
| LV & MV Room Cooling                        | Smart Cooling without Air-across for Higher Availability                     |                               |
| Communication                               | Modbus-RTU, Preconfigured with Smartlogger3000B                              |                               |
| Applicable Standards                        | IEC 62271-202, EN 50588-1, IEC 60076, IEC 62271-200, IEC 61439-1             |                               |

## Technical Specifications (Preliminary)

| Input                                       |                                                                          |                               |
|---------------------------------------------|--------------------------------------------------------------------------|-------------------------------|
| Available Inverters / PCS                   | SUN2000-330KTL-H1/ SUN2000-330KTL-H2                                     |                               |
| Maximum LV AC Inputs                        | 11                                                                       |                               |
| AC Power                                    | 3,300 kVA @40°C / 2,970 kVA @50°C <sup>1</sup>                           |                               |
| Rated Input Voltage                         | 800 V                                                                    |                               |
| LV Main Switches                            | ACB (2,900 A / 800 V / 3P, 1 x 1 pcs), MCCB (400 A / 800 V / 3P, 11 pcs) |                               |
| Output                                      |                                                                          |                               |
| Rated Output Voltage                        | 11 kV, 15 kV, 20 kV, 22 kV, 30 kV, 33 kV, 35 kV <sup>2</sup>             | 13.8 kV, 34.5 kV <sup>2</sup> |
| Frequency                                   | 50 Hz                                                                    | 60 Hz                         |
| Transformer Type                            | Oil-immersed, Conservator Type                                           |                               |
| Transformer Cooling Type                    | ONAN                                                                     |                               |
| Transformer Tappings                        | ± 2 x 2.5%                                                               |                               |
| Transformer Oil Type                        | Mineral Oil (PCB Free)                                                   |                               |
| Transformer Vector Group                    | Dy11                                                                     |                               |
| Transformer Min. Peak Efficiency Index      | Tier 1 or Tier 2 In Accordance with EN 50588-1                           |                               |
| RMU Type                                    | SF <sub>6</sub> Gas Insulated                                            |                               |
| RMU Transformer Protection Unit             | MV Vacuum Circuit Breaker Unit                                           |                               |
| RMU Cable Incoming / Outgoing Unit          | Direct Cable Unit or Cable Load Break Switch Unit                        |                               |
| Auxiliary Transformer                       | Dry Type Transformer, 5 kVA                                              |                               |
| Protection                                  |                                                                          |                               |
| Transformer Monitoring & Protection         | Oil Level, Oil Temperature, Oil Pressure and Buchholz                    |                               |
| Protection Degree of MV & LV Room           | IP 54                                                                    |                               |
| Internal Arcing Fault Classification of STS | IAC A 20 kA 1s                                                           |                               |
| MV Relay Protection                         | 50/51, 50N/51N                                                           |                               |
| LV Overvoltage Protection                   | Type I-II                                                                |                               |
| Anti-rodent Protection                      | C5 in accordance with ISO 12944                                          |                               |
| Features                                    |                                                                          |                               |
| 2 kVA UPS                                   | Optional <sup>3</sup>                                                    |                               |
| MV Surge Arrester for MV VCB                | Optional <sup>3</sup>                                                    |                               |
| General                                     |                                                                          |                               |
| Dimensions (W x H x D)                      | 6,058 x 2,896 x 2,438 mm (20' HC Container)                              |                               |
| Weight                                      | < 15 t                                                                   |                               |
| Operating Temperature Range                 | -25°C ~ 60°C <sup>4</sup> (-13°F ~ 140°F)                                |                               |
| Relative Humidity                           | 0% ~ 95%                                                                 |                               |
| Max. Operating Altitude                     | 1,000 m <sup>5</sup>                                                     |                               |
| MV-LV AC Connections                        | Prewired and Pretested, No Internal Cabling Onsite                       |                               |
| LV & MV Room Cooling                        | Smart Cooling without Air-across for Higher Availability                 |                               |
| Communication                               | Modbus-RTU, Preconfigured with Smartlogger3000B                          |                               |
| Applicable Standards                        | IEC 62271-202, EN 50588-1, IEC 60076, IEC 62271-200, IEC 61439-1         |                               |

**Gráfico 42. Centros de transformación**

### 8.3. Transformador de potencia

| Fecha: 15/12/2022        |                                                                                             | FICHA TÉCNICA TRANSFORMADOR DE POTENCIA 110kV/34.5kV |                                                   | Código: BSB-STE-IB-EMC-ES-313-RA |               |
|--------------------------|---------------------------------------------------------------------------------------------|------------------------------------------------------|---------------------------------------------------|----------------------------------|---------------|
| CARACTERÍSTICAS TÉCNICAS |                                                                                             | UNIDAD                                               | SOLICITADO                                        | OFERTADO                         | OBSERVACIONES |
| 1                        | Normas de fabricación                                                                       | ---                                                  | IEC 60076<br>IEEE Std C57.12<br>IEEE 693<br>RETIE | IEC 60076                        |               |
| 2                        | Normas de pruebas y tolerancias                                                             | ---                                                  | IEC 60076                                         | IEC 60076                        |               |
| 3                        | Tipo                                                                                        | ---                                                  | Inmerso                                           | Inmerso                          |               |
| 4                        | Número de fases                                                                             | ---                                                  | 3                                                 | 3                                |               |
| 5                        | Frecuencia asignada $f_r$                                                                   | Hz                                                   | 60                                                | 60                               |               |
| 6                        | Medio aislante y refrigerante                                                               | ---                                                  | Inmerso en aceite mineral                         | Aceite inhibido tipo 2           |               |
| 7                        | Uso                                                                                         | ---                                                  | Exterior                                          | Exterior                         |               |
| 8                        | Tipo de refrigeración                                                                       | ---                                                  | ONAN                                              | ONAN                             |               |
| 9                        | Polaridad                                                                                   | ---                                                  | Aditiva                                           | Aditiva                          |               |
| 10                       | Potencia asignada                                                                           | ---                                                  |                                                   |                                  |               |
| 10,1                     | Potencia asignada, ONAN                                                                     | MVA                                                  | 30                                                | 30                               |               |
| 11                       | Relación de transformación asignada, sin carga:                                             | ---                                                  |                                                   |                                  |               |
| 11,1                     | Primario / Secundario                                                                       | kV/kV                                                | 110/34,5                                          | 110/34,5                         |               |
| 12                       | Tensión asignada derivación principal, $U_r$                                                | ---                                                  |                                                   |                                  |               |
| 12,1                     | Devanado primario, AT.                                                                      | kV                                                   | 110                                               | 110                              |               |
| 12,2                     | Devanado secundario, MT                                                                     | kV                                                   | 34,5                                              | 34,5                             |               |
| 12,3                     | Devanado Terciario (Compensación), BT                                                       | kV                                                   | ---                                               | A establecer                     |               |
| 13                       | Tensión más elevada para el material, $U_m$                                                 | ---                                                  |                                                   |                                  |               |
| 13,1                     | Devanado primario, AT.                                                                      | kV                                                   | 123                                               | 123                              |               |
| 13,2                     | Devanado secundario, MT.                                                                    | kV                                                   | 36                                                | 36                               |               |
| 13,3                     | Neutro Primario                                                                             | kV                                                   | ---                                               | A establecer                     |               |
| 13,4                     | Neutro Secundario, MT                                                                       | kV                                                   | ---                                               | 36                               |               |
| 14                       | Tensión soportada asignada al impulso tipo rayo, $U_p$ , BIL (1,2/50 $\mu$ s onda completa) | ---                                                  |                                                   |                                  |               |
| 14,1                     | Devanado primario, AT.                                                                      | kVpico                                               | 550                                               | 550                              |               |

|      |                                                                                                      |        |              |                                         |  |
|------|------------------------------------------------------------------------------------------------------|--------|--------------|-----------------------------------------|--|
| 14,2 | Devanado secundario, MT.                                                                             | kVpico | 200          | 200                                     |  |
| 14,3 | Neutro Secundario, MT                                                                                | kVpico | 200          | 200                                     |  |
| 15   | Tensión soportada asignada al impulso tipo rayo, $U_p$ , BIL (1,2/50 $\mu$ s onda cortada)           | ---    |              |                                         |  |
| 15,1 | Devanado primario, AT.                                                                               | kVpico | 550          | 550                                     |  |
| 15,2 | Devanado secundario, MT.                                                                             | kVpico | 170          | 170                                     |  |
| 15,3 | Neutro Secundario, MT                                                                                | kVpico | ---          | A establecer                            |  |
| 16   | Tensión soportada asignada de corta duración a frecuencia industrial 1 min seco, $U_d$               | ---    |              |                                         |  |
| 16,1 | Devanado primario, AT.                                                                               | kV     | 230          | 230                                     |  |
| 16,2 | Devanado secundario, MT.                                                                             | kV     | 70           | 70                                      |  |
| 17   | Conexión de los devanados                                                                            | ---    |              |                                         |  |
| 17,1 | Devanado primario, AT.                                                                               | ---    | Estrella (y) | Estrella (y)                            |  |
| 17,2 | Devanado secundario, (MT).                                                                           | ---    | Estrella (y) | Estrella (y)                            |  |
| 17,4 | Símbolos de acoplamiento (Conexión y desfase angular)                                                | ---    | YNyn0        | YNyn0                                   |  |
| 17.5 | Factor K                                                                                             | ---    | Por definir  | 1                                       |  |
| 18   | Impedancia de corto circuito a 75 °C, 60 Hz, ONAN, relación kV/kV nominal en la derivación principal | ---    |              |                                         |  |
| 18,1 | Potencia base MVA nominales AT / MT (30 MVA)                                                         | %      | 10           | 10                                      |  |
| 18,2 | Potencia base MVA nominales AT / BT (20 MVA)                                                         | %      | ---          | A establecer según diseño de ingeniería |  |
| 18,3 | Potencia base MVA nominales MT / BT (20 MVA)                                                         | %      | ---          | A establecer según diseño de ingeniería |  |
| 19   | Impedancia de secuencia positiva                                                                     | ---    |              |                                         |  |

**Gráfico 43. Datos del transformador de potencia**

## **9. CERTIFICADOS DE CALIBRACIÓN**

## Calibration Report

### General information

**Certificate No.** 0060352AA37F\_20240213205404

**Date of issue** 14-Feb-2024

**Calibration date** 13-Feb-2024

**Calibration due date** 13-Feb-2027

**Client** \_\_\_\_\_

### UUT information

**Manufacture** Elspec

**Product type** Pure

**FW version** 1.1.0.20

**Serial number** 00.60.35.2A.A3.7F



Operator: Doron Arussi



Reviewer: Yevgeny Strezh

- Calibrated results related only to the calibrated item.
- The instruments has been calibrated in accordance with the manufacturer's Instruments User's Handbook using standards that are traceable to the international System of Units (SI).
- All test equipment used to perform the tests is calibrated in an accredited laboratory, and data is kept by the company.
- The results pertain solely to the items that were tested and should not be inferred to other items owned by the customer.
- The calibration certificate may not be reproduced other then in full and without signature is not valid.
- Reported uncertainties represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of  $k=1.96$ .
- Calibration standards used are traceable to National and international standards.

#### Reporting Compliance With Specification:

The column headed 'Status' indicates compliance or otherwise with the specification taking into account the measurement uncertainty (RDS method), the four possible conditions are indicated as follows:

**■** - The equipment complies with the stated specification at the measured points, due allowance having been made for the uncertainty of the measurements.

**Pass\*** - The measurement result is inside the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliance based on the stated level of confidence. However the results indicate that compliance is more probable than non-compliance with the specification limit.

**Fail\*** - The measurement result is outside the specification limit by a margin less than the measurement uncertainty; it is therefore not possible to state non-compliance based on the stated level of confidence. However the results indicate that non-compliance is more probable than compliance with the specification limit.

**■** - The equipment does not comply with the stated specification at the measured points, due allowance having been made for the uncertainty of the measurements.

## Testing points

### Frequency

#### Frequency measurement

| Fnom [Hz] | Injected value [Hz] | Measured value [Hz] | Error [Hz] | Threshold [Hz] | Status | Uncertainty |
|-----------|---------------------|---------------------|------------|----------------|--------|-------------|
| 50        | 42.500000           | 42.500000           | 0.000000   | 0.010000       | Pass   | 380 uHz     |
| 50        | 50.000000           | 50.000206           | 0.000206   | 0.010000       | Pass   | 380 uHz     |
| 50        | 57.500000           | 57.500004           | 0.000004   | 0.010000       | Pass   | 380 uHz     |
| 60        | 51.000000           | 51.000019           | 0.000019   | 0.010000       | Pass   | 380 uHz     |
| 60        | 60.000000           | 60.000000           | 0.000000   | 0.010000       | Pass   | 380 uHz     |
| 60        | 69.000000           | 69.000130           | 0.000130   | 0.010000       | Pass   | 380 uHz     |

### RMS

#### Voltage RMS channels measurement

##### Channel 1

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57          | 5.700000           | 5.659083           | 0.040917  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 57          | 57.000000          | 56.962711          | 0.037289  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 57          | 85.500000          | 85.541809          | 0.041809  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 230         | 23.000000          | 22.940516          | 0.059484  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 230         | 230.000000         | 230.032150         | 0.032150  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 230         | 345.000000         | 345.099548         | 0.099548  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 400         | 40.000000          | 39.919739          | 0.080261  | 0.400000      | Pass   | 200 uV/V    |
| 50        | 400         | 400.000000         | 400.047913         | 0.047913  | 0.400000      | Pass   | 200 uV/V    |
| 50        | 400         | 600.000000         | 600.238831         | 0.238831  | 0.400000      | Pass   | 200 uV/V    |
| 60        | 57          | 6.900000           | 6.849285           | 0.050715  | 0.250000      | Pass   | 200 uV/V    |
| 60        | 57          | 69.000000          | 68.890984          | 0.109016  | 0.250000      | Pass   | 200 uV/V    |
| 60        | 57          | 103.500000         | 103.441093         | 0.058907  | 0.250000      | Pass   | 200 uV/V    |
| 60        | 230         | 24.000000          | 23.930471          | 0.069529  | 0.250000      | Pass   | 200 uV/V    |
| 60        | 230         | 240.000000         | 239.950012         | 0.049988  | 0.250000      | Pass   | 200 uV/V    |
| 60        | 230         | 360.000000         | 359.977142         | 0.022858  | 0.250000      | Pass   | 200 uV/V    |
| 60        | 480         | 48.000000          | 47.908138          | 0.091862  | 0.480000      | Pass   | 200 uV/V    |
| 60        | 480         | 480.000000         | 480.053589         | 0.053589  | 0.480000      | Pass   | 200 uV/V    |
| 60        | 480         | 720.000000         | 720.327026         | 0.327026  | 0.480000      | Pass   | 200 uV/V    |

##### Channel 2

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57          | 5.700000           | 5.659837           | 0.040163  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 57          | 57.000000          | 56.968239          | 0.031761  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 57          | 85.500000          | 85.548660          | 0.048660  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 230         | 23.000000          | 22.942087          | 0.057913  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 230         | 230.000000         | 230.047470         | 0.047470  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 230         | 345.000000         | 345.117462         | 0.117462  | 0.250000      | Pass   | 200 uV/V    |
| 50        | 400         | 40.000000          | 39.922306          | 0.077694  | 0.400000      | Pass   | 200 uV/V    |
| 50        | 400         | 400.000000         | 400.067200         | 0.067200  | 0.400000      | Pass   | 200 uV/V    |

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 400         | 600.000000         | 600.256653         | 0.256653  | 0.400000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 6.900000           | 6.849808           | 0.050192  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 69.000000          | 68.893616          | 0.106384  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 103.500000         | 103.445305         | 0.054695  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 24.000000          | 23.931314          | 0.068686  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 240.000000         | 239.958008         | 0.041992  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 360.000000         | 359.984894         | 0.015106  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 480         | 48.000000          | 47.909576          | 0.090424  | 0.480000      | Pass   | 200 $\mu$ V/V |
| 60        | 480         | 480.000000         | 480.057617         | 0.057617  | 0.480000      | Pass   | 200 $\mu$ V/V |
| 60        | 480         | 720.000000         | 720.342346         | 0.342346  | 0.480000      | Pass*  | 200 $\mu$ V/V |

## Channel 3

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 57          | 5.700000           | 5.660063           | 0.039937  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 57          | 57.000000          | 56.955048          | 0.044952  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 57          | 85.500000          | 85.528313          | 0.028313  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 230         | 23.000000          | 22.936827          | 0.063173  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 230         | 230.000000         | 229.995926         | 0.004074  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 230         | 345.000000         | 345.044464         | 0.044464  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 400         | 40.000000          | 39.912964          | 0.087036  | 0.400000      | Pass   | 200 $\mu$ V/V |
| 50        | 400         | 400.000000         | 399.985809         | 0.014191  | 0.400000      | Pass   | 200 $\mu$ V/V |
| 50        | 400         | 600.000000         | 600.147034         | 0.147034  | 0.400000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 6.900000           | 6.849033           | 0.050967  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 69.000000          | 68.878380          | 0.121620  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 103.500000         | 103.422409         | 0.077591  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 24.000000          | 23.926107          | 0.073893  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 240.000000         | 239.908234         | 0.091766  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 360.000000         | 359.912903         | 0.087097  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 480         | 48.000000          | 47.898895          | 0.101105  | 0.480000      | Pass   | 200 $\mu$ V/V |
| 60        | 480         | 480.000000         | 479.968658         | 0.031342  | 0.480000      | Pass   | 200 $\mu$ V/V |
| 60        | 480         | 720.000000         | 720.202393         | 0.202393  | 0.480000      | Pass   | 200 $\mu$ V/V |

## Channel 4

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 57          | 5.700000           | 5.661035           | 0.038965  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 57          | 57.000000          | 56.955456          | 0.044544  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 57          | 85.500000          | 85.528725          | 0.028725  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 230         | 23.000000          | 22.936649          | 0.063351  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 230         | 230.000000         | 229.996094         | 0.003906  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 230         | 345.000000         | 345.042023         | 0.042023  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 50        | 400         | 40.000000          | 39.913170          | 0.086830  | 0.400000      | Pass   | 200 $\mu$ V/V |
| 50        | 400         | 400.000000         | 399.983612         | 0.016388  | 0.400000      | Pass   | 200 $\mu$ V/V |
| 50        | 400         | 600.000000         | 600.134277         | 0.134277  | 0.400000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 6.900000           | 6.850389           | 0.049611  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 69.000000          | 68.879318          | 0.120682  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 57          | 103.500000         | 103.424278         | 0.075722  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 24.000000          | 23.926460          | 0.073540  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 240.000000         | 239.910217         | 0.089783  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 230         | 360.000000         | 359.913788         | 0.086212  | 0.250000      | Pass   | 200 $\mu$ V/V |
| 60        | 480         | 48.000000          | 47.899620          | 0.100380  | 0.480000      | Pass   | 200 $\mu$ V/V |

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 60        | 480         | 480.000000         | 479.964294         | 0.035706  | 0.480000      | Pass   | 200 $\mu$ V/V |
| 60        | 480         | 720.000000         | 720.181152         | 0.181152  | 0.480000      | Pass   | 200 $\mu$ V/V |

## Low Voltage RMS channels measurement

### Channel 5

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000    | 0.050000           | 0.049760           | 0.000240  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 0.500000    | 0.500000           | 0.499887           | 0.000113  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 0.500000    | 0.750000           | 0.749893           | 0.000107  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 0.300000           | 0.299837           | 0.000163  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 3.000000           | 2.999662           | 0.000338  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 4.500000           | 4.499927           | 0.000073  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 0.500000           | 0.499797           | 0.000203  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 5.000000           | 4.999928           | 0.000072  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 7.500000           | 7.500458           | 0.000458  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.050000           | 0.049784           | 0.000216  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.500000           | 0.500137           | 0.000137  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.750000           | 0.750370           | 0.000370  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 0.300000           | 0.299957           | 0.000043  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 3.000000           | 3.001498           | 0.001498  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 4.500000           | 4.502548           | 0.002548  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 5.000000    | 0.500000           | 0.500134           | 0.000134  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 5.000000    | 5.000000           | 5.002948           | 0.002948  | 0.005000      | Pass   | 290 $\mu$ V/V |

### Channel 6

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000    | 0.050000           | 0.049757           | 0.000243  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 0.500000    | 0.500000           | 0.499880           | 0.000120  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 0.500000    | 0.750000           | 0.749875           | 0.000125  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 0.300000           | 0.299834           | 0.000166  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 3.000000           | 2.999614           | 0.000386  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 4.500000           | 4.499902           | 0.000098  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 0.500000           | 0.499792           | 0.000208  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 5.000000           | 4.999882           | 0.000118  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 7.500000           | 7.500414           | 0.000414  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.050000           | 0.049780           | 0.000220  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.500000           | 0.500127           | 0.000127  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.750000           | 0.750354           | 0.000354  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 0.300000           | 0.299957           | 0.000043  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 3.000000           | 3.001469           | 0.001469  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 4.500000           | 4.502553           | 0.002553  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 5.000000    | 0.500000           | 0.500131           | 0.000131  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 5.000000    | 5.000000           | 5.002931           | 0.002931  | 0.005000      | Pass   | 290 $\mu$ V/V |

### Channel 7

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000    | 0.050000           | 0.049776           | 0.000224  | 0.005000      | Pass   | 290 $\mu$ V/V |

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000    | 0.500000           | 0.499960           | 0.000040  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 0.500000    | 0.750000           | 0.749996           | 0.000004  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 0.300000           | 0.299880           | 0.000120  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 3.000000           | 3.000082           | 0.000082  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 4.500000           | 4.500579           | 0.000579  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 0.500000           | 0.499869           | 0.000131  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 5.000000           | 5.000638           | 0.000638  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 7.500000           | 7.501477           | 0.001477  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.050000           | 0.049797           | 0.000203  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.500000           | 0.500207           | 0.000207  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.750000           | 0.750472           | 0.000472  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 0.300000           | 0.300004           | 0.000004  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 3.000000           | 3.001934           | 0.001934  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 4.500000           | 4.503228           | 0.003228  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 5.000000    | 0.500000           | 0.500203           | 0.000203  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 5.000000    | 5.000000           | 5.003699           | 0.003699  | 0.005000      | Pass*  | 290 $\mu$ V/V |

### Channel 8

| Fnom [Hz] | Nominal [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000    | 0.050000           | 0.049775           | 0.000225  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 0.500000    | 0.500000           | 0.499957           | 0.000043  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 0.500000    | 0.750000           | 0.749992           | 0.000008  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 0.300000           | 0.299877           | 0.000123  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 3.000000           | 3.000068           | 0.000068  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 3.000000    | 4.500000           | 4.500530           | 0.000530  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 0.500000           | 0.499861           | 0.000139  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 5.000000           | 5.000577           | 0.000577  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 50        | 5.000000    | 7.500000           | 7.501315           | 0.001315  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.050000           | 0.049796           | 0.000204  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.500000           | 0.500197           | 0.000197  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 0.500000    | 0.750000           | 0.750459           | 0.000459  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 0.300000           | 0.299996           | 0.000004  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 3.000000           | 3.001890           | 0.001890  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 3.000000    | 4.500000           | 4.503120           | 0.003120  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 5.000000    | 0.500000           | 0.500192           | 0.000192  | 0.005000      | Pass   | 290 $\mu$ V/V |
| 60        | 5.000000    | 5.000000           | 5.003517           | 0.003517  | 0.005000      | Pass   | 290 $\mu$ V/V |

## Harmonics

### Voltage Harmonics channels measurement

#### Channel 1

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 230             | 3        | 23.000000          | 22.986441          | 0.013559  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 11       | 23.000000          | 23.005325          | 0.005325  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 21       | 23.000000          | 23.003759          | 0.003759  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 33       | 23.000000          | 22.994322          | 0.005678  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 49       | 23.000000          | 22.854481          | 0.145519  | 1.150000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 3        | 24.000000          | 23.978022          | 0.021978  | 1.200000      | Pass   | 0.96 mV/V   |

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 60        | 240             | 11       | 24.000000          | 23.998194          | 0.001806  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 21       | 24.000000          | 23.995930          | 0.004070  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 33       | 24.000000          | 23.985079          | 0.014921  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 49       | 24.000000          | 23.947704          | 0.052296  | 1.200000      | Pass   | 0.96 mV/V   |

## Channel 2

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 230             | 3        | 23.000000          | 22.988255          | 0.011745  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 11       | 23.000000          | 23.005829          | 0.005829  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 21       | 23.000000          | 23.001104          | 0.001104  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 33       | 23.000000          | 22.984329          | 0.015671  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 49       | 23.000000          | 22.829397          | 0.170603  | 1.150000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 3        | 24.000000          | 23.979296          | 0.020704  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 11       | 24.000000          | 23.997295          | 0.002705  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 21       | 24.000000          | 23.990080          | 0.009920  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 33       | 24.000000          | 23.968296          | 0.031704  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 49       | 24.000000          | 23.908340          | 0.091660  | 1.200000      | Pass   | 0.96 mV/V   |

## Channel 3

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 230             | 3        | 23.000000          | 22.982218          | 0.017782  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 11       | 23.000000          | 22.998062          | 0.001938  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 21       | 23.000000          | 22.985643          | 0.014357  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 33       | 23.000000          | 22.954533          | 0.045467  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 49       | 23.000000          | 22.771244          | 0.228756  | 1.150000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 3        | 24.000000          | 23.973251          | 0.026749  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 11       | 24.000000          | 23.988258          | 0.011742  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 21       | 24.000000          | 23.969822          | 0.030178  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 33       | 24.000000          | 23.926449          | 0.073551  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 49       | 24.000000          | 23.824409          | 0.175591  | 1.200000      | Pass   | 0.96 mV/V   |

## Channel 4

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 230             | 3        | 23.000000          | 22.982679          | 0.017321  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 11       | 23.000000          | 22.998945          | 0.001055  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 21       | 23.000000          | 22.989059          | 0.010941  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 33       | 23.000000          | 22.962770          | 0.037230  | 1.150000      | Pass   | 0.96 mV/V   |
| 50        | 230             | 49       | 23.000000          | 22.789623          | 0.210377  | 1.150000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 3        | 24.000000          | 23.973921          | 0.026079  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 11       | 24.000000          | 23.989643          | 0.010357  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 21       | 24.000000          | 23.975143          | 0.024857  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 33       | 24.000000          | 23.939241          | 0.060759  | 1.200000      | Pass   | 0.96 mV/V   |
| 60        | 240             | 49       | 24.000000          | 23.852077          | 0.147923  | 1.200000      | Pass   | 0.96 mV/V   |

## Low Voltage Harmonics channels measurement

## Channel 5

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 3               | 3        | 0.300000           | 0.299851           | 0.000149  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 11       | 0.300000           | 0.299810           | 0.000190  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 21       | 0.300000           | 0.299349           | 0.000651  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 33       | 0.300000           | 0.298469           | 0.001531  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 49       | 0.300000           | 0.295133           | 0.004867  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 3        | 0.300000           | 0.300042           | 0.000042  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 11       | 0.300000           | 0.299933           | 0.000067  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 21       | 0.300000           | 0.299307           | 0.000693  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 33       | 0.300000           | 0.298112           | 0.001888  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 49       | 0.300000           | 0.295525           | 0.004475  | 0.015000      | Pass   | 1.8 mV/V    |

## Channel 6

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 3               | 3        | 0.300000           | 0.299848           | 0.000152  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 11       | 0.300000           | 0.299840           | 0.000160  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 21       | 0.300000           | 0.299347           | 0.000653  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 33       | 0.300000           | 0.298467           | 0.001533  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 49       | 0.300000           | 0.294999           | 0.005001  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 3        | 0.300000           | 0.300043           | 0.000043  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 11       | 0.300000           | 0.299975           | 0.000025  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 21       | 0.300000           | 0.299309           | 0.000691  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 33       | 0.300000           | 0.298110           | 0.001890  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 49       | 0.300000           | 0.295357           | 0.004643  | 0.015000      | Pass   | 1.8 mV/V    |

## Channel 7

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 3               | 3        | 0.300000           | 0.299893           | 0.000107  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 11       | 0.300000           | 0.299879           | 0.000121  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 21       | 0.300000           | 0.299393           | 0.000607  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 33       | 0.300000           | 0.298514           | 0.001486  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 49       | 0.300000           | 0.295077           | 0.004923  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 3        | 0.300000           | 0.300087           | 0.000087  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 11       | 0.300000           | 0.300011           | 0.000011  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 21       | 0.300000           | 0.299354           | 0.000646  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 33       | 0.300000           | 0.298160           | 0.001840  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 49       | 0.300000           | 0.295446           | 0.004554  | 0.015000      | Pass   | 1.8 mV/V    |

## Channel 8

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 3               | 3        | 0.300000           | 0.299895           | 0.000105  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 11       | 0.300000           | 0.299893           | 0.000107  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 21       | 0.300000           | 0.299395           | 0.000605  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 33       | 0.300000           | 0.298517           | 0.001483  | 0.015000      | Pass   | 1.8 mV/V    |
| 50        | 3               | 49       | 0.300000           | 0.295024           | 0.004976  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 3        | 0.300000           | 0.300088           | 0.000088  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 11       | 0.300000           | 0.300027           | 0.000027  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 21       | 0.300000           | 0.299355           | 0.000645  | 0.015000      | Pass   | 1.8 mV/V    |
| 60        | 3               | 33       | 0.300000           | 0.298160           | 0.001840  | 0.015000      | Pass   | 1.8 mV/V    |

| Fnom [Hz] | Fundamental [V] | Harmonic | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|----------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 60        | 3               | 49       | 0.300000           | 0.295378           | 0.004622  | 0.015000      | Pass   | 1.8 mV/V    |

## DC

### Voltage DC channels measurement

#### Channel 1

| Fnom [Hz] | Fundamental [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57              | 5.700000           | 5.639472           | 0.060528  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 230             | 23.000000          | 22.984814          | 0.015186  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 400             | 40.000000          | 40.064919          | 0.064919  | 0.400000      | Pass   | 1.1 mV/V    |
| 60        | 69              | 6.900000           | 6.844923           | 0.055077  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 240             | 24.000000          | 23.985062          | 0.014938  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 480             | 48.000000          | 48.082253          | 0.082253  | 0.480000      | Pass   | 1.1 mV/V    |

#### Channel 2

| Fnom [Hz] | Fundamental [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57              | 5.700000           | 5.724132           | 0.024132  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 230             | 23.000000          | 23.067577          | 0.067577  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 400             | 40.000000          | 40.151291          | 0.151291  | 0.400000      | Pass   | 1.1 mV/V    |
| 60        | 69              | 6.900000           | 6.929483           | 0.029483  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 240             | 24.000000          | 24.065308          | 0.065308  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 480             | 48.000000          | 48.157337          | 0.157337  | 0.480000      | Pass   | 1.1 mV/V    |

#### Channel 3

| Fnom [Hz] | Fundamental [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57              | 5.700000           | 5.590623           | 0.109377  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 230             | 23.000000          | 22.929346          | 0.070654  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 400             | 40.000000          | 40.020344          | 0.020344  | 0.400000      | Pass   | 1.1 mV/V    |
| 60        | 69              | 6.900000           | 6.807945           | 0.092055  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 240             | 24.000000          | 23.946594          | 0.053406  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 480             | 48.000000          | 48.052216          | 0.052216  | 0.480000      | Pass   | 1.1 mV/V    |

#### Channel 4

| Fnom [Hz] | Fundamental [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57              | 5.700000           | 5.697346           | 0.002654  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 230             | 23.000000          | 23.041456          | 0.041456  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 400             | 40.000000          | 40.126320          | 0.126320  | 0.400000      | Pass   | 1.1 mV/V    |
| 60        | 69              | 6.900000           | 6.908113           | 0.008113  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 240             | 24.000000          | 24.046524          | 0.046524  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 480             | 48.000000          | 48.138252          | 0.138252  | 0.480000      | Pass   | 1.1 mV/V    |

### Low Voltage DC channels measurement

#### Channel 5

| Fnom [Hz] | Fundamental [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000        | 0.050000           | 0.048393           | 0.001607  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 3.000000        | 0.300000           | 0.296554           | 0.003446  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 5.000000        | 0.500000           | 0.496793           | 0.003207  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 0.500000        | 0.050000           | 0.048554           | 0.001446  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 3.000000        | 0.300000           | 0.297244           | 0.002756  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 5.000000        | 0.500000           | 0.497347           | 0.002653  | 0.005000      | Pass   | 400 $\mu$ V/V |

## Channel 6

| Fnom [Hz] | Fundamental [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000        | 0.050000           | 0.048020           | 0.001980  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 3.000000        | 0.300000           | 0.296191           | 0.003809  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 5.000000        | 0.500000           | 0.496453           | 0.003547  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 0.500000        | 0.050000           | 0.048173           | 0.001827  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 3.000000        | 0.300000           | 0.296877           | 0.003123  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 5.000000        | 0.500000           | 0.496995           | 0.003005  | 0.005000      | Pass   | 400 $\mu$ V/V |

## Channel 7

| Fnom [Hz] | Fundamental [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000        | 0.050000           | 0.047738           | 0.002262  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 3.000000        | 0.300000           | 0.296000           | 0.004000  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 5.000000        | 0.500000           | 0.496337           | 0.003663  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 0.500000        | 0.050000           | 0.048006           | 0.001994  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 3.000000        | 0.300000           | 0.296749           | 0.003251  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 5.000000        | 0.500000           | 0.496937           | 0.003063  | 0.005000      | Pass   | 400 $\mu$ V/V |

## Channel 8

| Fnom [Hz] | Fundamental [V] | Injected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000        | 0.050000           | 0.048057           | 0.001943  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 3.000000        | 0.300000           | 0.296271           | 0.003729  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 5.000000        | 0.500000           | 0.496574           | 0.003426  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 0.500000        | 0.050000           | 0.048305           | 0.001695  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 3.000000        | 0.300000           | 0.297029           | 0.002971  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 5.000000        | 0.500000           | 0.497193           | 0.002807  | 0.005000      | Pass   | 400 $\mu$ V/V |

## DC Noise

### Voltage DC Noise channels measurement

#### Channel 1

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57.000000       | 0                  | -0.058299          | 0.058299  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 230.000000      | 0                  | -0.017876          | 0.017876  | 0.250000      | Pass*  | 1.1 mV/V    |
| 50        | 400.000000      | 0                  | 0.052186           | 0.052186  | 0.400000      | Pass*  | 1.1 mV/V    |
| 60        | 69.000000       | 0                  | -0.048712          | 0.048712  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 240.000000      | 0                  | -0.018809          | 0.018809  | 0.250000      | Pass*  | 1.1 mV/V    |

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 60        | 480.000000      | 0                  | 0.061641           | 0.061641  | 0.480000      | Pass*  | 1.1 mV/V    |

## Channel 2

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57.000000       | 0                  | 0.020673           | 0.020673  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 230.000000      | 0                  | 0.058579           | 0.058579  | 0.250000      | Pass*  | 1.1 mV/V    |
| 50        | 400.000000      | 0                  | 0.136658           | 0.136658  | 0.400000      | Pass*  | 1.1 mV/V    |
| 60        | 69.000000       | 0                  | 0.035274           | 0.035274  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 240.000000      | 0                  | 0.068765           | 0.068765  | 0.250000      | Pass*  | 1.1 mV/V    |
| 60        | 480.000000      | 0                  | 0.137626           | 0.137626  | 0.480000      | Pass*  | 1.1 mV/V    |

## Channel 3

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57.000000       | 0                  | -0.107187          | 0.107187  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 230.000000      | 0                  | -0.071835          | 0.071835  | 0.250000      | Pass*  | 1.1 mV/V    |
| 50        | 400.000000      | 0                  | 0.009069           | 0.009069  | 0.400000      | Pass*  | 1.1 mV/V    |
| 60        | 69.000000       | 0                  | -0.079766          | 0.079766  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 240.000000      | 0                  | -0.052438          | 0.052438  | 0.250000      | Pass*  | 1.1 mV/V    |
| 60        | 480.000000      | 0                  | 0.036782           | 0.036782  | 0.480000      | Pass*  | 1.1 mV/V    |

## Channel 4

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 57.000000       | 0                  | -0.005603          | 0.005603  | 0.250000      | Pass   | 1.1 mV/V    |
| 50        | 230.000000      | 0                  | 0.033333           | 0.033333  | 0.250000      | Pass*  | 1.1 mV/V    |
| 50        | 400.000000      | 0                  | 0.115886           | 0.115886  | 0.400000      | Pass*  | 1.1 mV/V    |
| 60        | 69.000000       | 0                  | 0.017312           | 0.017312  | 0.250000      | Pass   | 1.1 mV/V    |
| 60        | 240.000000      | 0                  | 0.049159           | 0.049159  | 0.250000      | Pass*  | 1.1 mV/V    |
| 60        | 480.000000      | 0                  | 0.126135           | 0.126135  | 0.480000      | Pass*  | 1.1 mV/V    |

## Low Voltage DC Noise channels measurement

### Channel 5

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 0.500000        | 0                  | -0.001597          | 0.001597  | 0.005000      | Pass   | 400 uV/V    |
| 50        | 3.000000        | 0                  | -0.003477          | 0.003477  | 0.005000      | Pass   | 400 uV/V    |
| 50        | 5.000000        | 0                  | -0.003304          | 0.003304  | 0.005000      | Pass*  | 400 uV/V    |
| 60        | 0.500000        | 0                  | -0.001499          | 0.001499  | 0.005000      | Pass   | 400 uV/V    |
| 60        | 3.000000        | 0                  | -0.002970          | 0.002970  | 0.005000      | Pass   | 400 uV/V    |
| 60        | 5.000000        | 0                  | -0.002903          | 0.002903  | 0.005000      | Pass   | 400 uV/V    |

### Channel 6

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|-------------|
| 50        | 0.500000        | 0                  | -0.001961          | 0.001961  | 0.005000      | Pass   | 400 uV/V    |
| 50        | 3.000000        | 0                  | -0.003857          | 0.003857  | 0.005000      | Pass*  | 400 uV/V    |

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 5.000000        | 0                  | -0.003647          | 0.003647  | 0.005000      | Pass*  | 400 $\mu$ V/V |
| 60        | 0.500000        | 0                  | -0.001866          | 0.001866  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 3.000000        | 0                  | -0.003327          | 0.003327  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 5.000000        | 0                  | -0.003245          | 0.003245  | 0.005000      | Pass*  | 400 $\mu$ V/V |

### Channel 7

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000        | 0                  | -0.002276          | 0.002276  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 3.000000        | 0                  | -0.004103          | 0.004103  | 0.005000      | Pass*  | 400 $\mu$ V/V |
| 50        | 5.000000        | 0                  | -0.003838          | 0.003838  | 0.005000      | Pass*  | 400 $\mu$ V/V |
| 60        | 0.500000        | 0                  | -0.002049          | 0.002049  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 3.000000        | 0                  | -0.003540          | 0.003540  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 5.000000        | 0                  | -0.003365          | 0.003365  | 0.005000      | Pass*  | 400 $\mu$ V/V |

### Channel 8

| Fnom [Hz] | Fundamental [V] | Expected value [V] | Measured value [V] | Error [V] | Threshold [V] | Status | Uncertainty   |
|-----------|-----------------|--------------------|--------------------|-----------|---------------|--------|---------------|
| 50        | 0.500000        | 0                  | -0.001952          | 0.001952  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 50        | 3.000000        | 0                  | -0.003817          | 0.003817  | 0.005000      | Pass*  | 400 $\mu$ V/V |
| 50        | 5.000000        | 0                  | -0.003550          | 0.003550  | 0.005000      | Pass*  | 400 $\mu$ V/V |
| 60        | 0.500000        | 0                  | -0.001759          | 0.001759  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 3.000000        | 0                  | -0.003233          | 0.003233  | 0.005000      | Pass   | 400 $\mu$ V/V |
| 60        | 5.000000        | 0                  | -0.003164          | 0.003164  | 0.005000      | Pass*  | 400 $\mu$ V/V |

## Resources

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**Automation script version** 3.0.12

**Lab site** Elspec calibration lab, Beit Shean

**Test stand** TSC-5300-1001

## Reference instrument

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**Manufacture** Fluke

**Model** 6100A Poly Phase

**SN** 151860453

--- End of report ---