Procedimiento de ensayo de puesta en marcha del firmware del ROVER en banco de pruebas.

Este cuaderno interactivo tiene como objetivo verificar la funcionalidad del firmware del ROVER en el banco de pruebas y debe ejecutarse **ANTES** de su teleoperación para verificar que la comunicación, lectura de sensores y control funcionan correctamente.

Está organizado en las siguientes secciones

Contenido

1. Precondiciones

Antes de comenzar el procedimiento.

1. Conectar la unidad por USB sin alimentación externa (baterías) y actualizar el firmware a la versión que se quiera validar. **NO alimentar aún con las baterías**.
2. Apoyar la unidad de modo que las ruedas giren en el aire y verificar el conexionado de los periféricos.
3. Verificar la alimentación y conectar las baterías.
4. Verificar que L298N y tacómnetros están iluminados.

2. Test de conectividad

In [ ]:

```
#!pip install pyserial
```

In [1]:

```
%load_ext autoreload
%autoreload 2

import sys
import pandas
import numpy as np
import time
import datetime

%matplotlib inline
import matplotlib.pyplot as plt
```

In [2]:

```
ROVER_PORT = '/dev/ttyACM0'
ROVER_BAUDRATE = 9600

from rover import RoverClient
rover = RoverClient(ROVER_PORT,ROVER_BAUDRATE)
```

Recepción de telemetría

In [16]:

```
rover.get_report_counts()
```

Out[16]:

```
{'GENERAL_TELEMETRY': 61,
 'COMMAND_EXECUTION_STATUS': 0,
 'IMU_AHRS_STATE': 21,
 'MOTION_CONTROL_STATE': 82,
 'GPS_STATE': 20,
 'INVALID': 0}
```

Estado inicial de telemetrías

In [17]:

```
rover.print_general_tmy()
```

```
ACCEPTED_PACKETS: 0
REJECTED_PACKETS: 0
LAST_OPCODE: 0x00
```

```
LAST_ERROR: 0x00
STATUS: 0x00
```

In [18]:

```
assert(rover.TMY_PARAM_ACCEPTED_PACKETS == 0)
assert(rover.TMY_PARAM_REJECTED_PACKETS == 0)
assert(rover.TMY_PARAM_LAST_OPCODE == 0)
assert(rover.TMY_PARAM_LAST_ERROR == 0)
assert(rover.TMY_PARAM_STATUS == 0)
```

Control básico y recepción de telemetrías de estado

In [20]:

```
rover.print_general_tmy()
```

```
ACCEPTED_PACKETS: 0
REJECTED_PACKETS: 0
LAST_OPCODE: 0x00
LAST_ERROR: 0x00
STATUS: 0x00
```

In [21]:

```
accepted_packets_before = rover.TMY_PARAM_ACCEPTED_PACKETS
rejected_packets_before = rover.TMY_PARAM_REJECTED_PACKETS
last_opcode_before = rover.TMY_PARAM_LAST_OPCODE
last_error_before = rover.TMY_PARAM_LAST_ERROR

rover.led_on()
time.sleep(2)

accepted_packets_after = rover.TMY_PARAM_ACCEPTED_PACKETS
rejected_packets_after = rover.TMY_PARAM_REJECTED_PACKETS
last_opcode_after = rover.TMY_PARAM_LAST_OPCODE
last_error_after = rover.TMY_PARAM_LAST_ERROR

assert(accepted_packets_after == (accepted_packets_before+1))
assert(rejected_packets_after == rejected_packets_before)
assert(last_opcode_after == rover.CMD_LED_ON)
```

In [22]:

```
rover.print_general_tmy()
```

```
ACCEPTED_PACKETS: 1
```

```
REJECTED_PACKETS: 0
LAST_OPCODE: 0x01
LAST_ERROR: 0x00
STATUS: 0x00
```

In [23]:

```
accepted_packets_before = rover.TMY_PARAM_ACCEPTED_PACKETS
rejected_packets_before = rover.TMY_PARAM_REJECTED_PACKETS
last_opcode_before = rover.TMY_PARAM_LAST_OPCODE
last_error_before = rover.TMY_PARAM_LAST_ERROR

rover.led_off()
time.sleep(1)

accepted_packets_after = rover.TMY_PARAM_ACCEPTED_PACKETS
rejected_packets_after = rover.TMY_PARAM_REJECTED_PACKETS
last_opcode_after = rover.TMY_PARAM_LAST_OPCODE
last_error_after = rover.TMY_PARAM_LAST_ERROR

assert(accepted_packets_after == (accepted_packets_before+1))
assert(rejected_packets_after == rejected_packets_before)
assert(last_opcode_after == rover.CMD_LED_OFF)
```

In [24]:

```
rover.print_general_tmy()
```

```
ACCEPTED_PACKETS: 2
REJECTED_PACKETS: 0
LAST_OPCODE: 0x02
LAST_ERROR: 0x00
STATUS: 0x00
```

4. Test de control de motores (manual)

Estado inicial de motores.

In [25]:

```
rover.set_motor_throttles(
    [0.0, 0.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
```

```
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
```

```
TACHO4_SPEED: 0.000
TACHO1_COUNT: 0.000
TACHO2_COUNT: 0.000
TACHO3_COUNT: 0.000
TACHO4_COUNT: 0.000
MOTOR_A_THROTTLE: 0.0
MOTOR_B_THROTTLE: 0.0
MOTOR_A_SETPOINT_SPEED: 0.000
MOTOR_B_SETPOINT_SPEED: 0.000
```

In [ ]:

```
rover.print_motor_tmy()
```

In [26]:

```
assert(rover.TMY_PARAM_MOTOR_A_THROTTLE == 0)
assert(rover.TMY_PARAM_MOTOR_B_THROTTLE == 0)
```

Funciones para mostrar las telemetrías de los motores y reproducir una secuencia.

In [27]:

```
def plot_motor_motion_profiles(tmy_readings,title):
    tmy_names = ["MOTOR_A_THROTTLE", "MOTOR_B_THROTTLE",
                 "TACHO1_SPEED", "TACHO2_SPEED", "TACHO3_SPEED", "TACHO4_SPEED"]
    n = len(tmy_names)
    fig,axes = plt.subplots(n,1,figsize=(18,n*6))
    for i,tmy in enumerate(tmy_names):
        axes[i].scatter(tmy_readings[:,0],tmy_readings[:,1+i])
        axes[i].set_title(tmy)
        axes[i].grid(which="Both")
        axes[i].set_xlabel("Muestra")
        axes[i].set_ylabel(tmy)

    for i,tmy in enumerate(tmy_names[2:]):
        axes[2+i].set_ylim([0,200])

    fig.suptitle(title);

def play_program_and_record_tmy(rover, program,interval=0.1):
    tmy_readings = []
    for i in range(program.shape[1]):
        tmy_readings.append( np.array([ i,
            rover.TMY_PARAM_MOTOR_A_THROTTLE, rover.TMY_PARAM_MOTOR_B_THROTTLE,
            rover.TMY_PARAM_TACHO1_SPEED,
            rover.TMY_PARAM_TACHO2_SPEED,
            rover.TMY_PARAM_TACHO3_SPEED,
            rover.TMY_PARAM_TACHO4_SPEED]) )
        time.sleep(interval)
        rover.set_motor_throttles( [program[0][i], program[1][i]],
                                  RoverClient.MOTOR_A | RoverClient.MOTOR_B )
    return np.array(tmy_readings)
```

Las siguientes pruebas generan rampas ascendentes y descendentes en ambos sentidos. Asegurarse de comenzar en reposo.

In [29]:

```
# Máxima velocidad a alcanzar
MAX_THROTTLE = 0.4 # 40%
SUSTAIN_THROTTLE = 0.3 # 30%

# Iteraciones
N_ITERATIONS = 64

# Intervalo entre comandos [s]
INTERVAL = 0.1
```

In [28]:

```
rover.set_motor_throttles(
    [0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```

Moverse hacia adelante incrementando la velocidad gradualmente, mantenerla por unos segundos, y decrementar (motor A).

In [30]:

```
ramp_up = np.array([
    np.linspace(0,MAX_THROTTLE, N_ITERATIONS), # MOTOR A
     np.linspace(0,0, N_ITERATIONS)            # MOTOR B
])

sustain = np.vstack([
        np.full((1,int(N_ITERATIONS/4)),fill_value=SUSTAIN_THROTTLE),  # MOTOR A
        np.zeros(int(N_ITERATIONS/4))])                                # MOTOR B

ramp_down = np.array([
    np.linspace(MAX_THROTTLE,0, N_ITERATIONS),  # MOTOR A
     np.linspace(0,0, N_ITERATIONS)  # MOTOR B
])
profile = np.hstack([ramp_up,sustain,ramp_down])
```

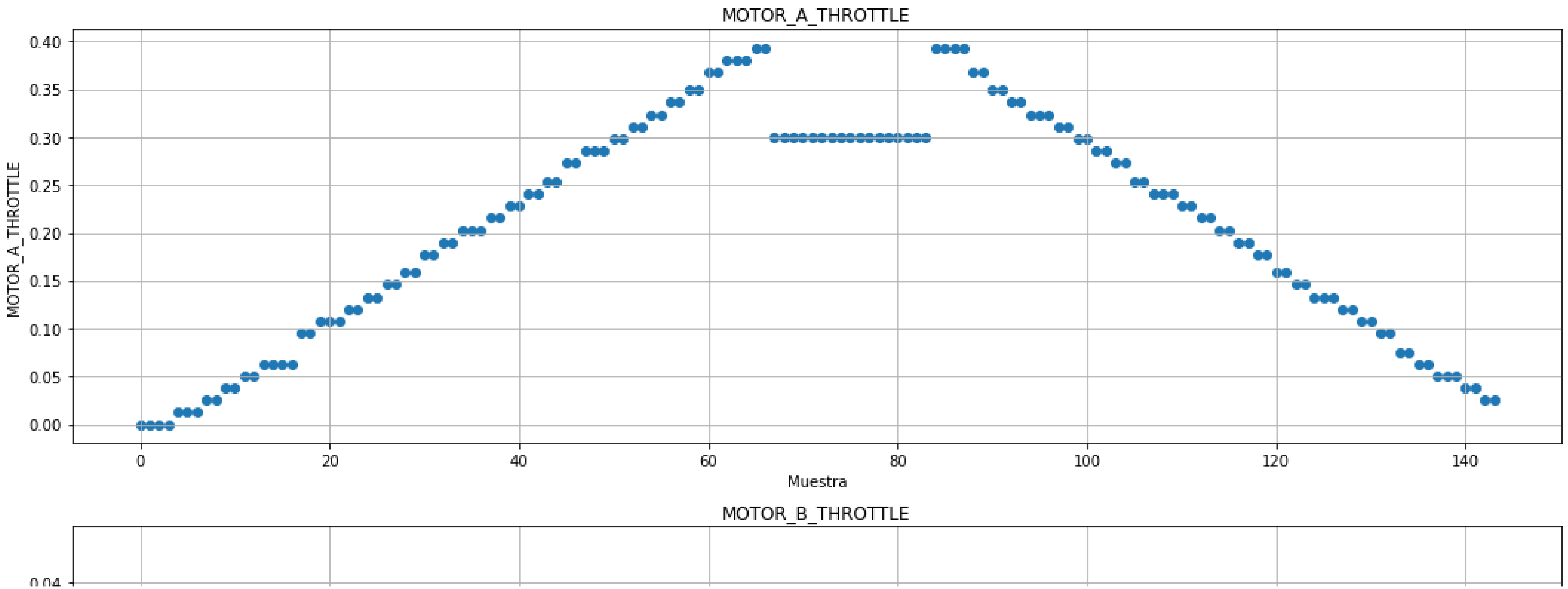
In [31]:

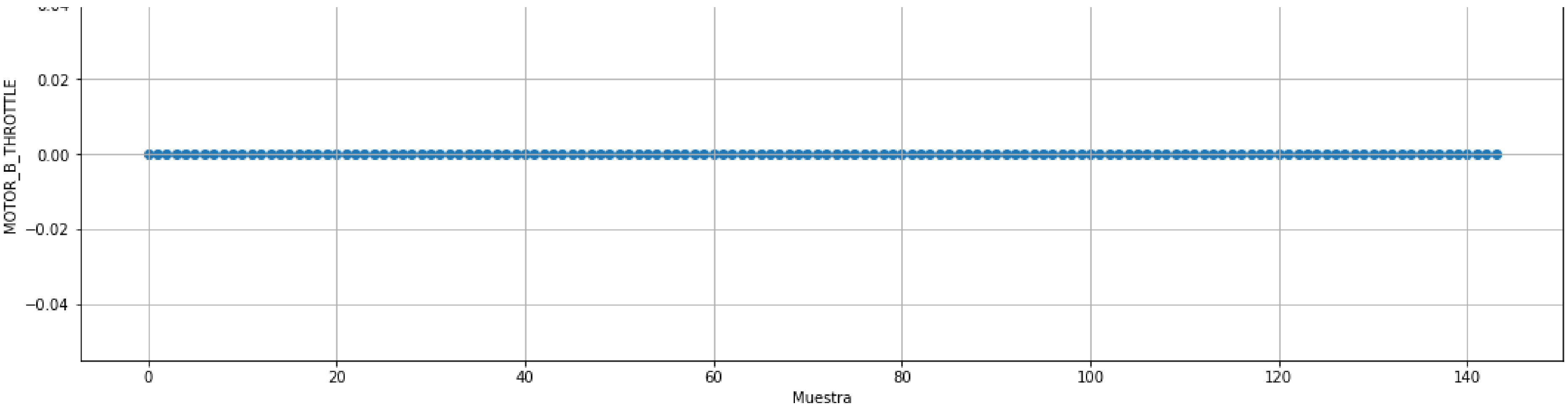
```
tmy_readings = play_program_and_record_tmy(rover,profile,INTERVAL)

# Detener
rover.set_motor_throttles(
    [0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```

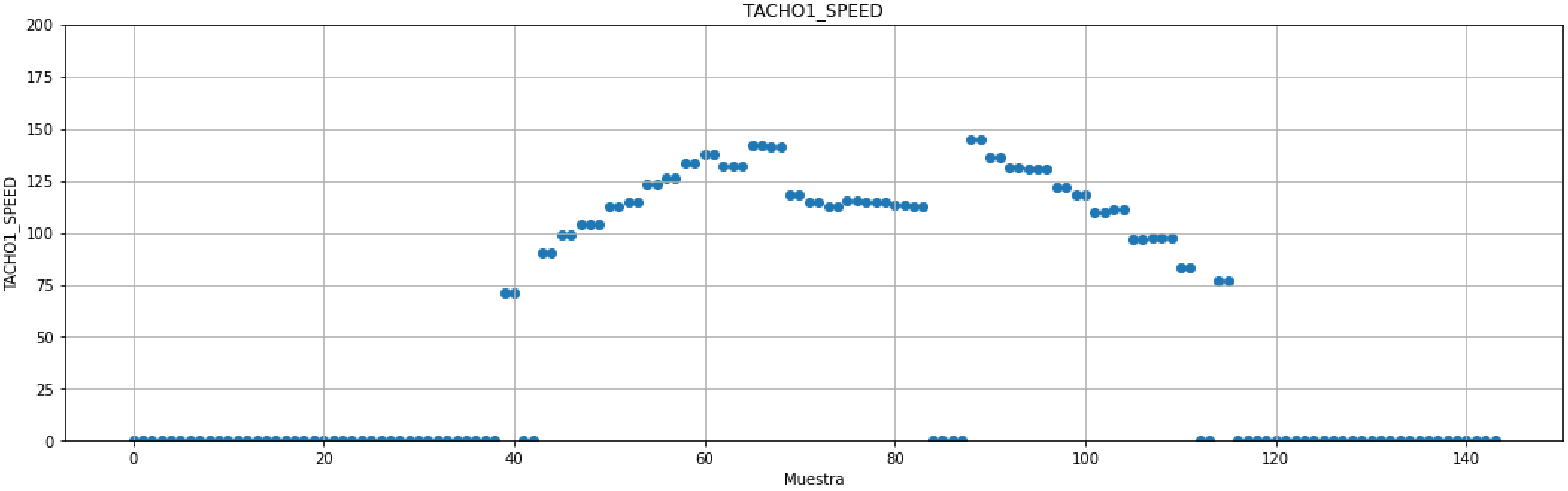
In [32]:

```
plot_motor_motion_profiles(tmy_readings,title="Perfil motor A")
```

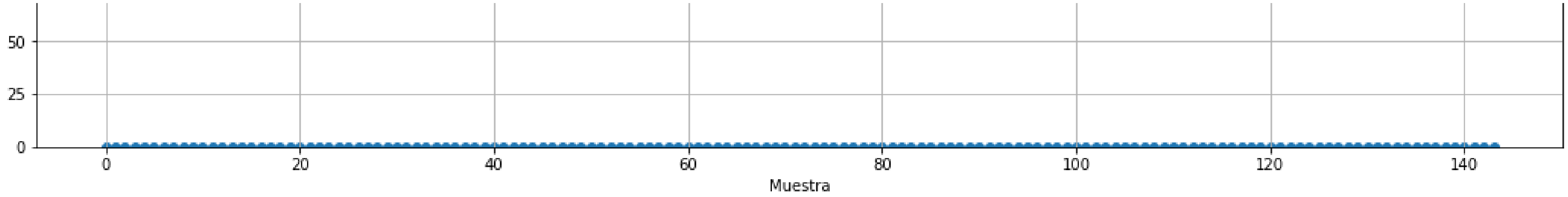
Perfil motor A

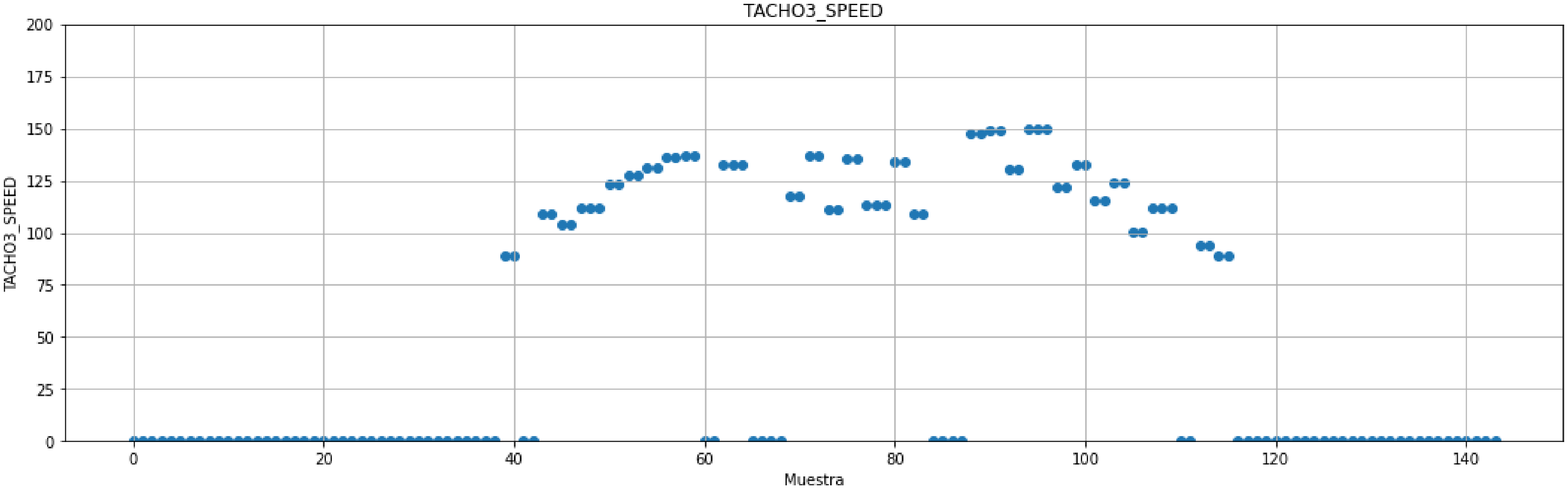


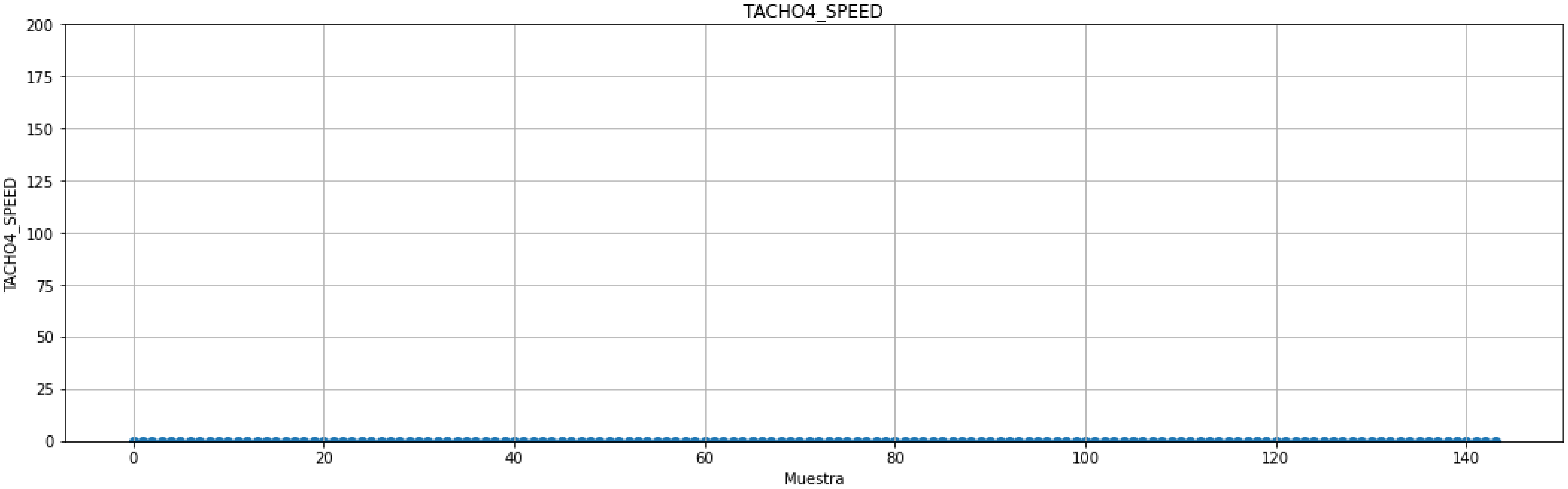

0.04
0.02
0.00
−0.02
−0.04
MOTOR_B_THROTTLE
0
20
40
60
80
100
120
140
Muestra


TACHO1_SPEED
200
175
150
125
100
75
50
25
0
TACHO1_SPEED
0
20
40
60
80
100
120
140
Muestra

TACHO2_SPEED
200
175
150
125
100
75
TACHO2_SPEED


50
25
0
0
20
40
60
80
100
120
140
Muestra


TACHO3_SPEED
TACHO3_SPEED
200
175
150
125
100
75
50
25
0
0
20
40
60
80
100
120
140
Muestra


TACHO4_SPEED
TACHO4_SPEED
200
175
150
125
100
75
50
25
0
0
20
40
60
80
100
120
140
Muestra

Moverse hacia adelante incrementando la velocidad gradualmente, mantenerla por unos segundos, y decrementar (motor B).

In [34]:

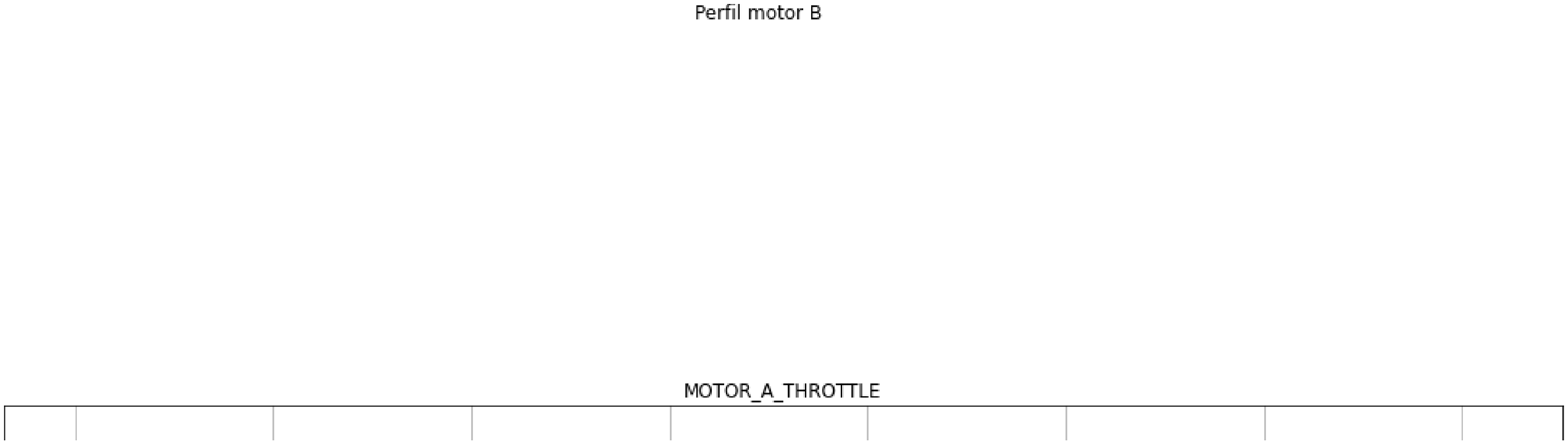
```
ramp_up = np.array([
    np.linspace(0,0, N_ITERATIONS),            # MOTOR A
    np.linspace(0,MAX_THROTTLE, N_ITERATIONS)  # MOTOR B
])

sustain = np.vstack([
        np.zeros(int(N_ITERATIONS/4)),                               # MOTOR A
        np.full((1,int(N_ITERATIONS/4)),fill_value=SUSTAIN_THROTTLE)])  # MOTOR B

ramp_down = np.array([
    np.linspace(0,0, N_ITERATIONS),            # MOTOR A
    np.linspace(MAX_THROTTLE,0, N_ITERATIONS)  # MOTOR B
])
profile = np.hstack([ramp_up,sustain,ramp_down])
```

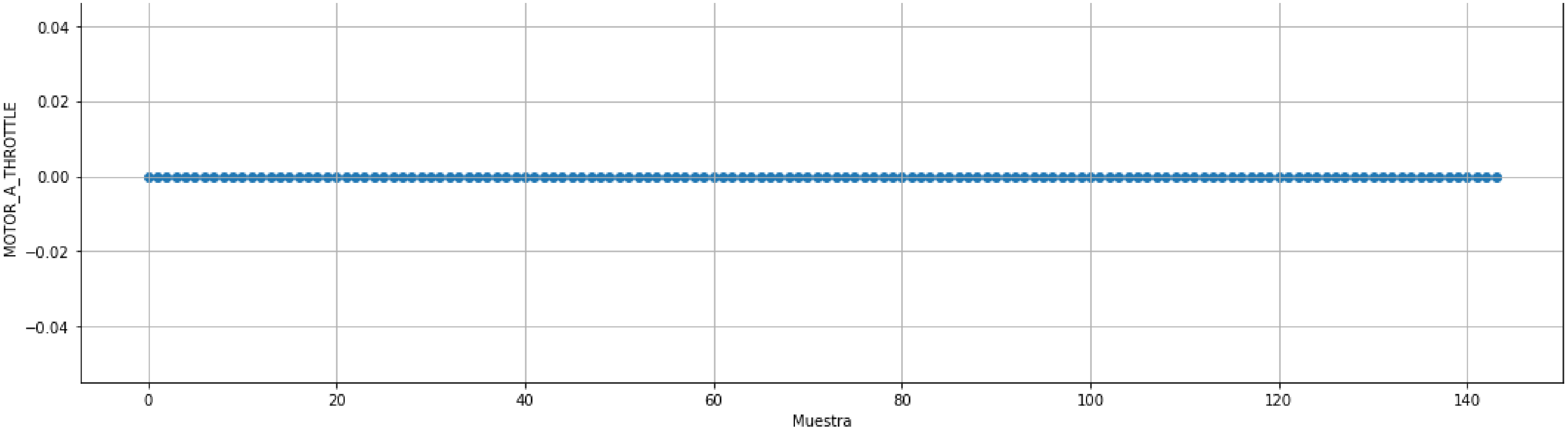
In [35]:

```
tmy_readings = play_program_and_record_tmy(rover,profile,INTERVAL)

# Detener
rover.set_motor_throttles(
    [0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```

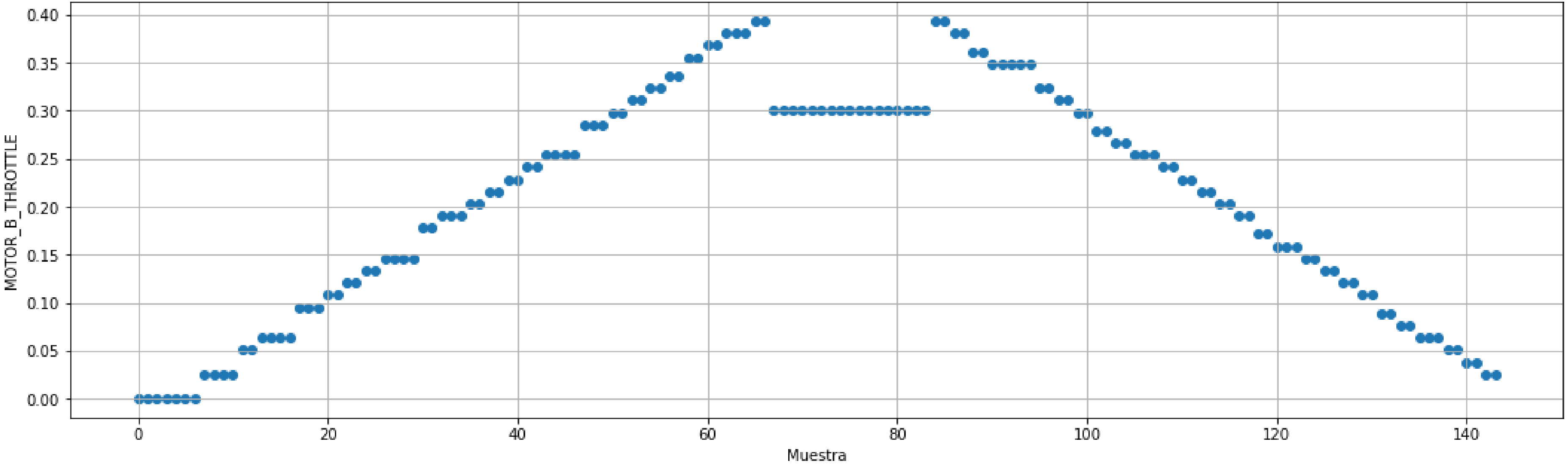
In [37]:

```
plot_motor_motion_profiles(tmy_readings,title="Perfil motor B")
```

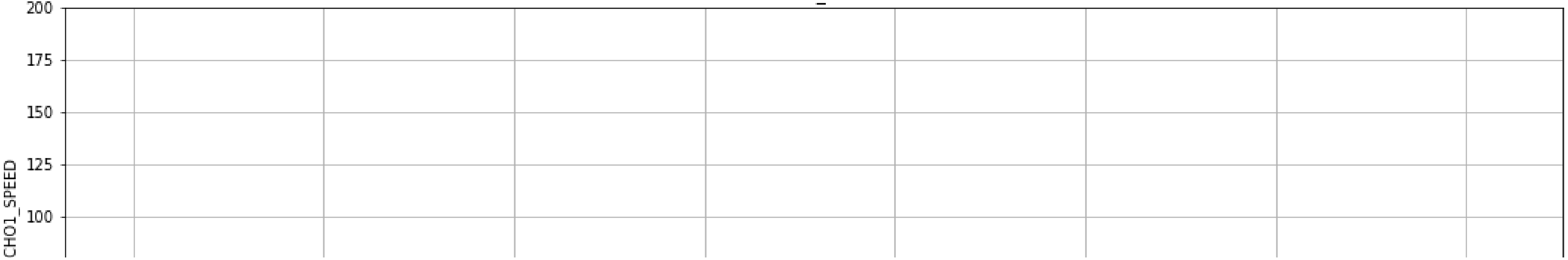


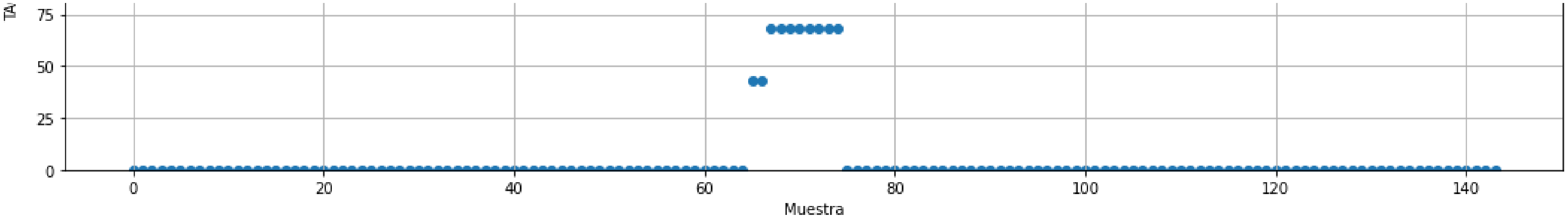


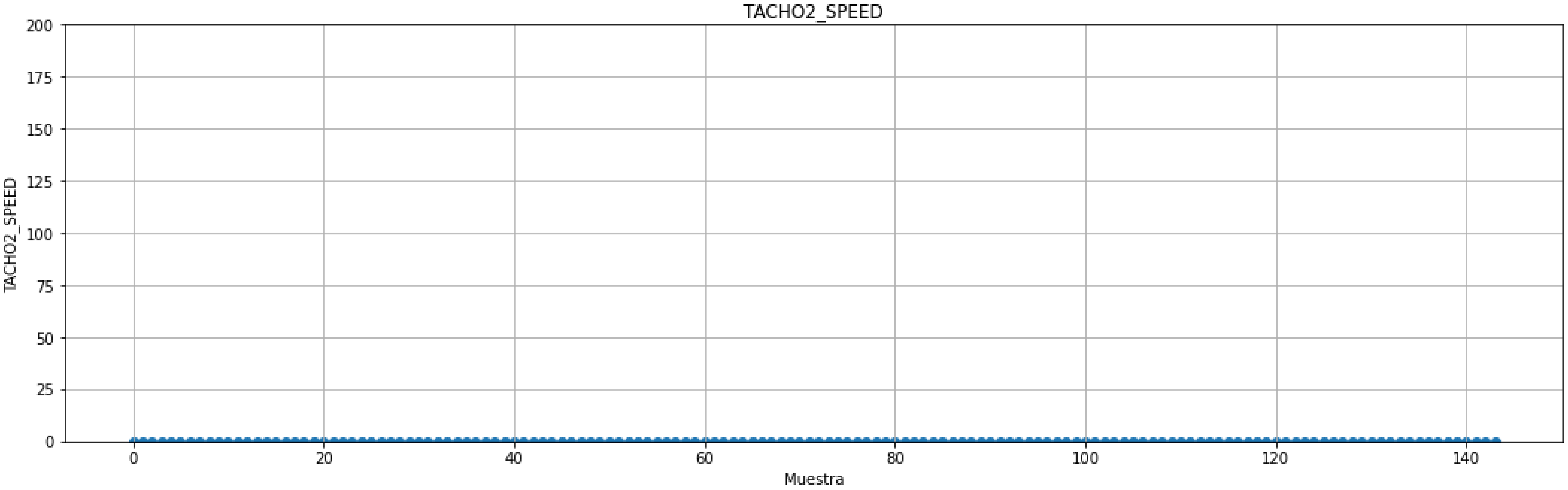
MOTOR_B_THROTTLE

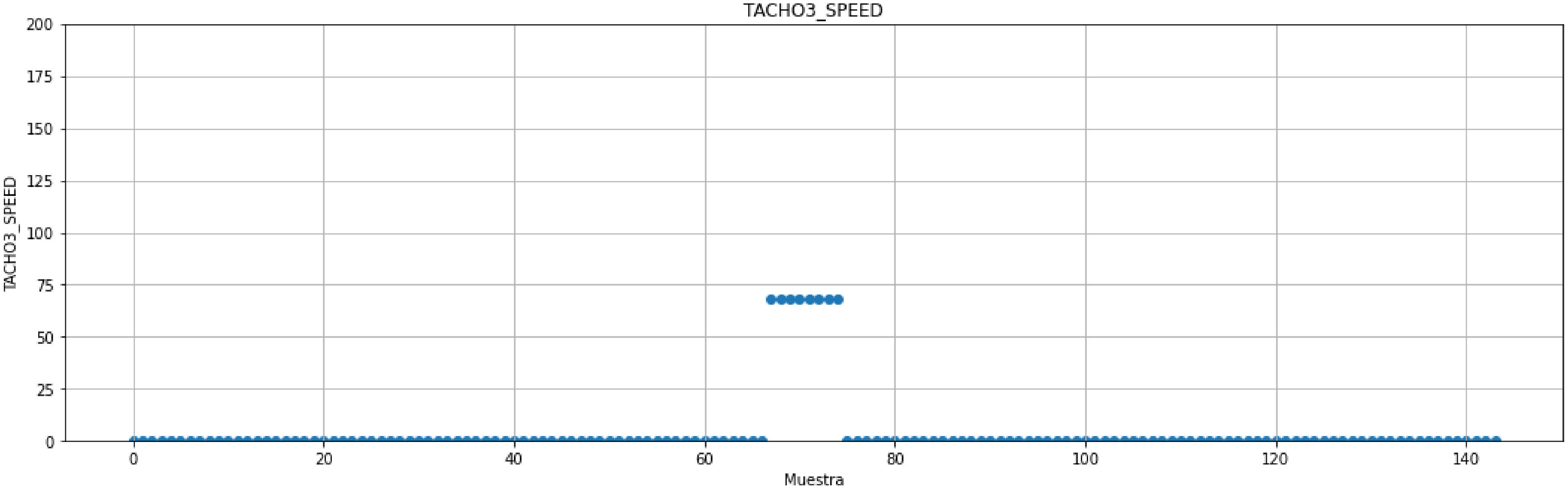


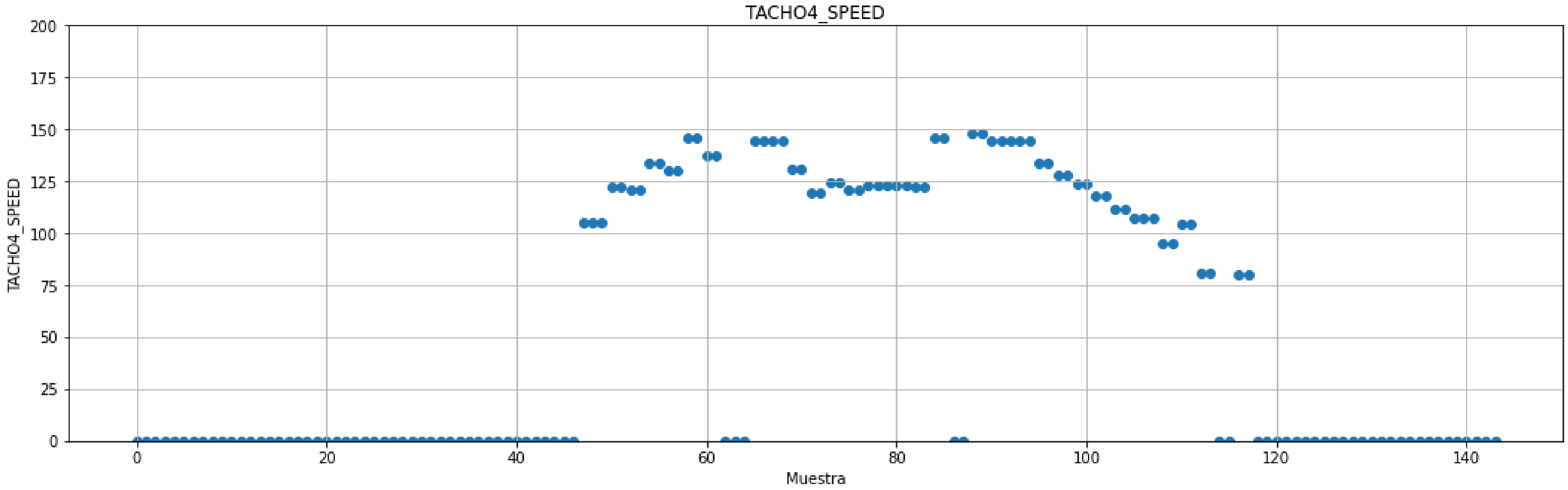
TACHO1_SPEED




TA
75
50
25
0
0
20
40
60
80
100
120
140
Muestra


TACHO2_SPEED
TACHO2_SPEED
200
175
150
125
100
75
50
25
0
0
20
40
60
80
100
120
140
Muestra


TACHO3_SPEED
TACHO3_SPEED
200
175
150
125
100
75
50
25
0
0
20
40
60
80
100
120
140
Muestra



5. Test de lectura de tacómetros

Iniciar la prueba en reposo.

In [38]:

```
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```

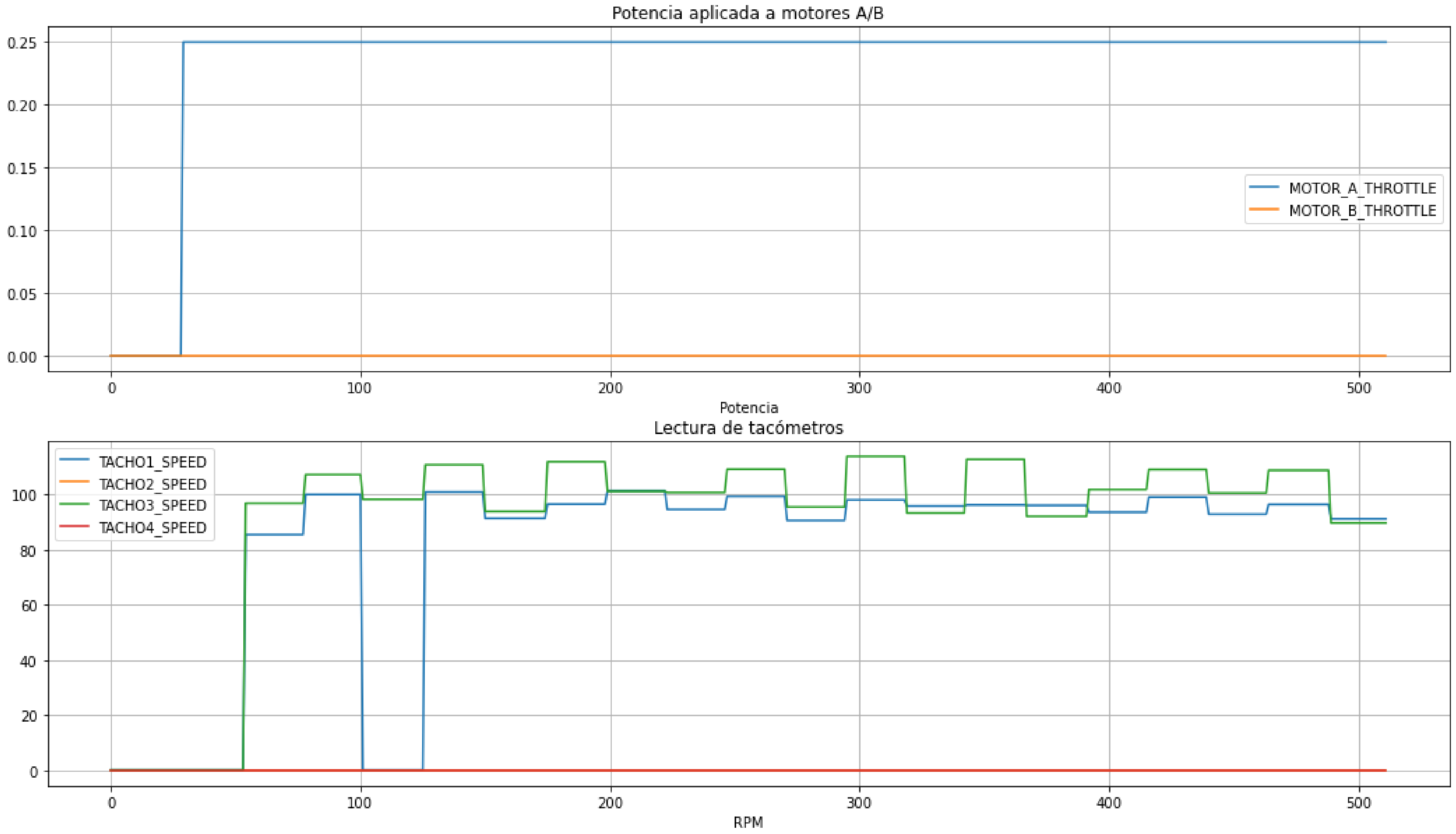
Función para capturar valores de potencia aplicados y lecturas de tacómetros.

In [39]:

```
def capture_and_plot_tachometer_tmy(samples = 512,interval=0.01):
    tmy_readings = []
    for i in range(samples):
        tmy_readings.append( np.array([ i,
            rover.TMY_PARAM_MOTOR_A_THROTTLE, rover.TMY_PARAM_MOTOR_B_THROTTLE,
            rover.TMY_PARAM_TACHO1_SPEED,
            rover.TMY_PARAM_TACHO2_SPEED,
            rover.TMY_PARAM_TACHO3_SPEED,
            rover.TMY_PARAM_TACHO4_SPEED]) )
        time.sleep(interval)
    tmy_readings = np.array(tmy_readings)
    fig,axes = plt.subplots(2,1,figsize=(18,10))
    axes[0].plot(tmy_readings[:,0],tmy_readings[:,1])
    axes[0].plot(tmy_readings[:,0],tmy_readings[:,2])
    axes[1].plot(tmy_readings[:,0],tmy_readings[:,3])
    axes[1].plot(tmy_readings[:,0],tmy_readings[:,2])
    axes[1].plot(tmy_readings[:,0],tmy_readings[:,5])
    axes[1].plot(tmy_readings[:,0],tmy_readings[:,6])

    axes[0].grid(which="Both")
    axes[1].grid(which="Both")
    axes[0].legend( ["MOTOR_A_THROTTLE", "MOTOR_B_THROTTLE"] )
    axes[1].legend( ["TACHO1_SPEED", "TACHO2_SPEED", "TACHO3_SPEED", "TACHO4_SPEED"])
    axes[0].set_title("Potencia aplicada a motores A/B");
    axes[1].set_title("Lectura de tacómetros");
    axes[0].set_xlabel("Muestra")
    axes[1].set_xlabel("Muestra")
    axes[0].set_xlabel("Potencia")
    axes[1].set_xlabel("RPM")
    return
```

In [40]:

```
rover.set_motor_throttles([0.25, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
tmy_readings = capture_and_plot_tachometer_tmy(512)
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```

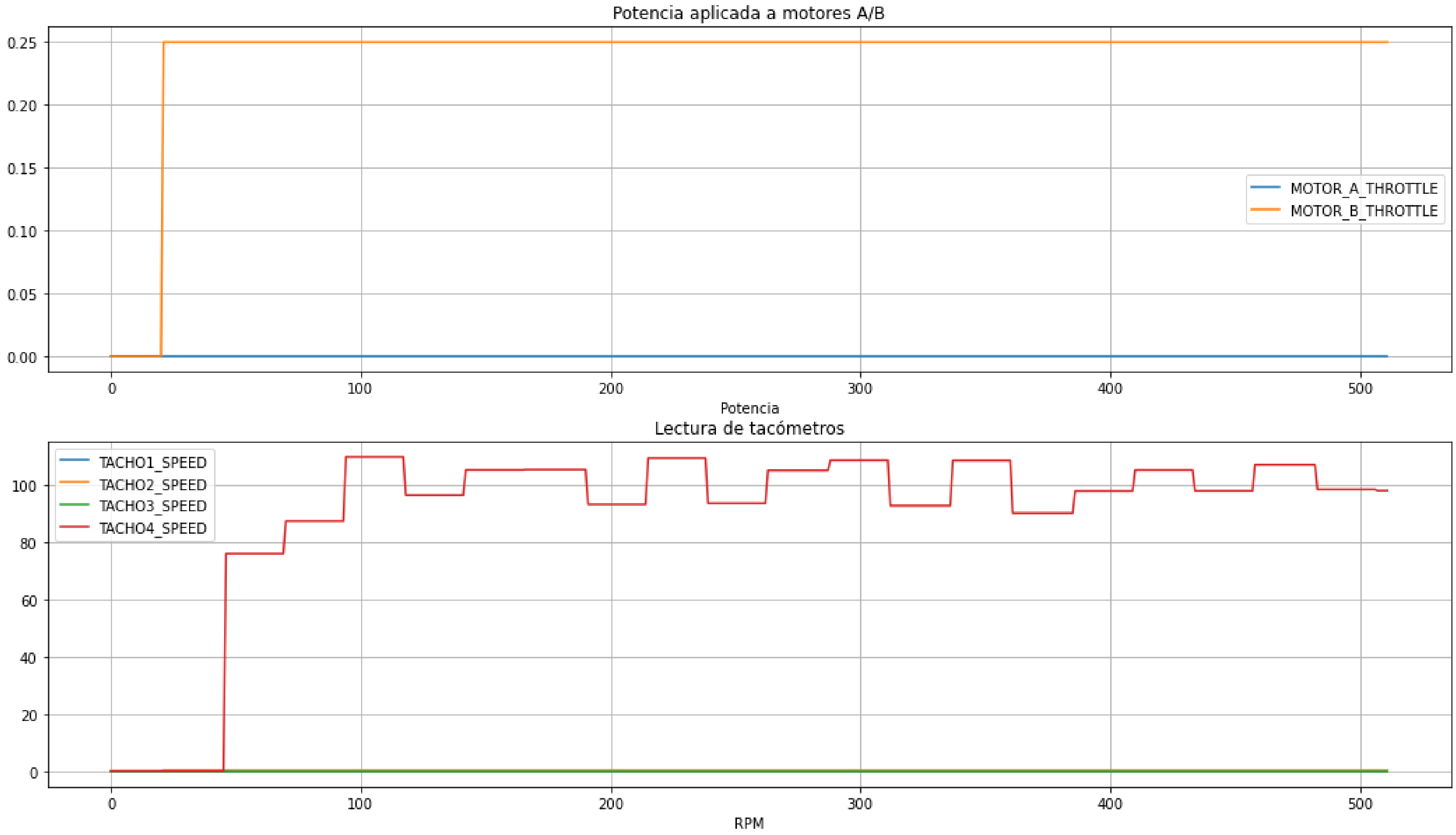


Potencia aplicada a motores A/B

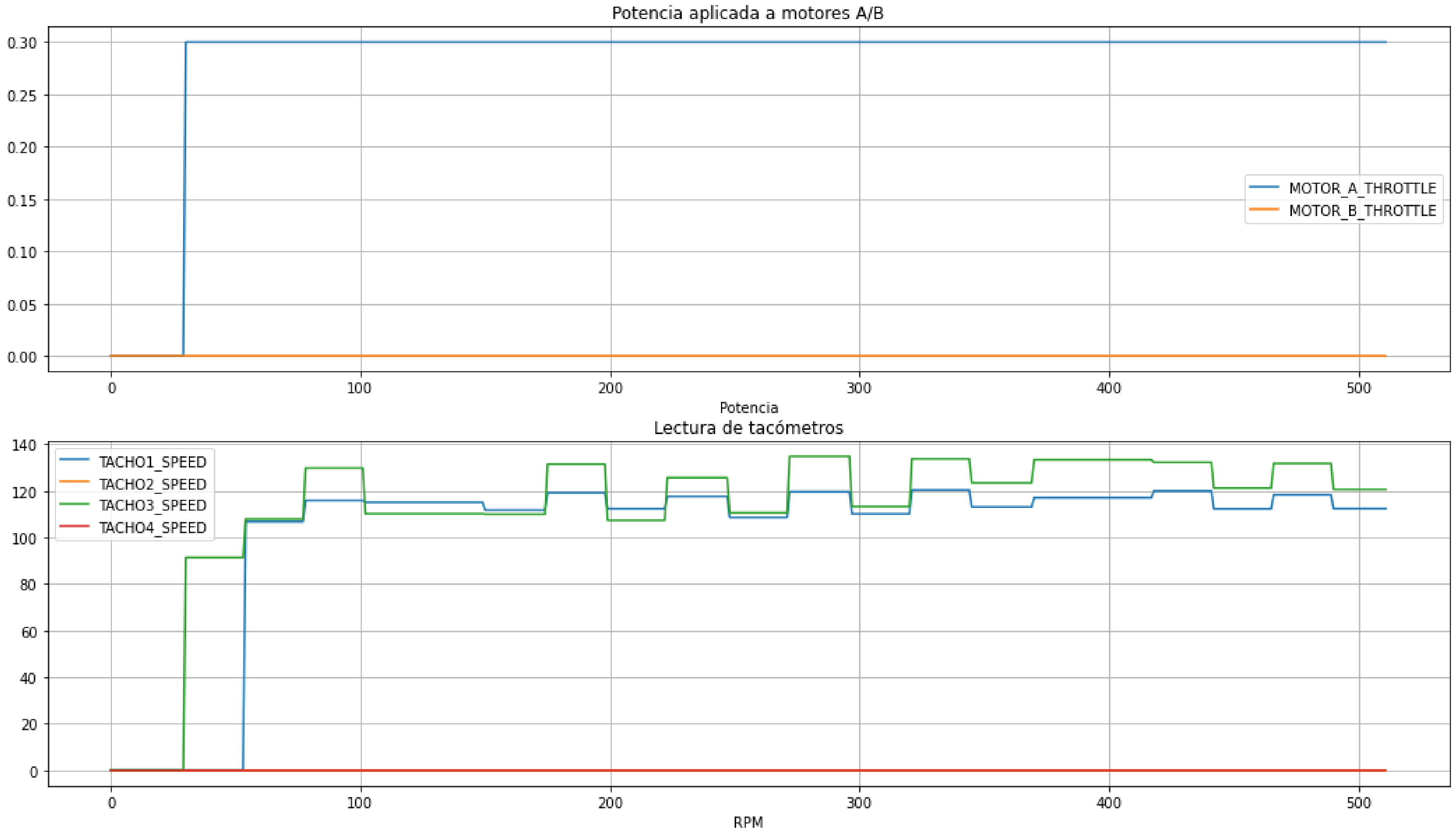
Lectura de tacómetros

In [42]:

```
rover.set_motor_throttles([0, 0.25], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
tmy_readings = capture_and_plot_tachometer_tmy(512)
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```



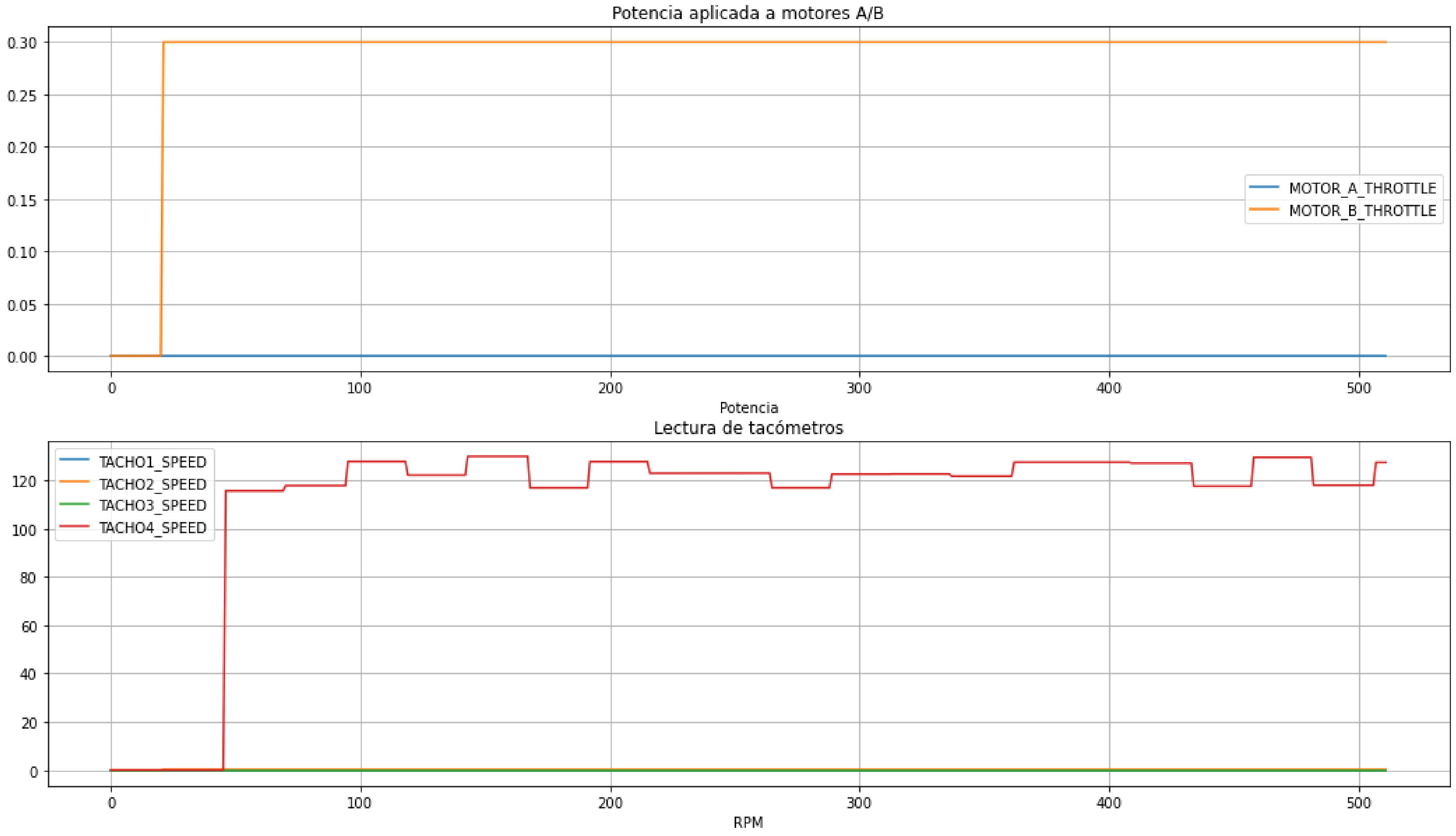
```
In [43]:
rover.set_motor_throttles([0.3, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
tmy_readings = capture_and_plot_tachometer_tmy(512)
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```


Potencia aplicada a motores A/B

Lectura de tacómetros

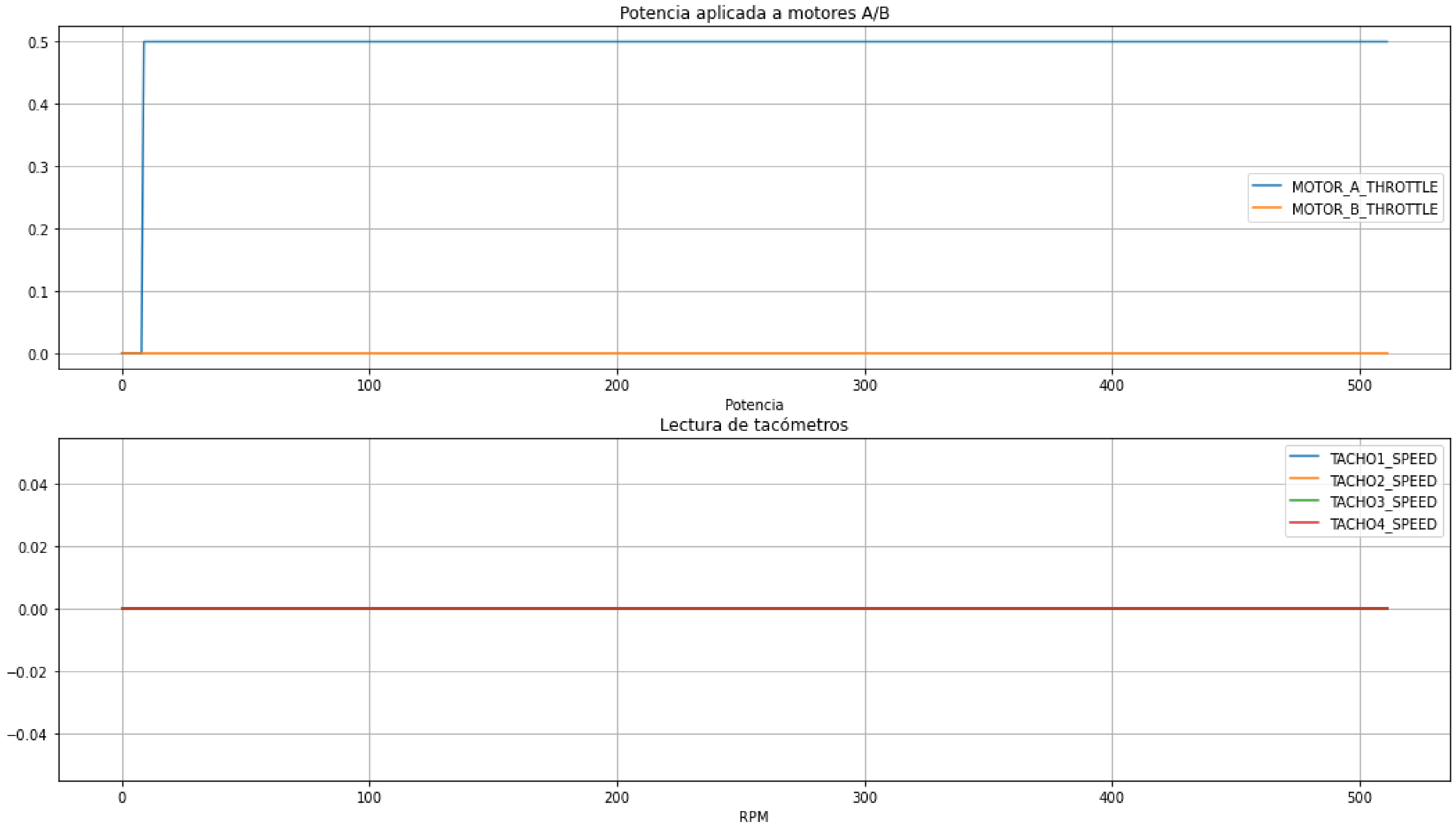
In [44]:

```
rover.set_motor_throttles([0.0, 0.3], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
tmy_readings = capture_and_plot_tachometer_tmy(512)
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```



In [45]:

```
rover.set_motor_throttles([0.5, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
tmy_readings = capture_and_plot_tachometer_tmy(512)
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```

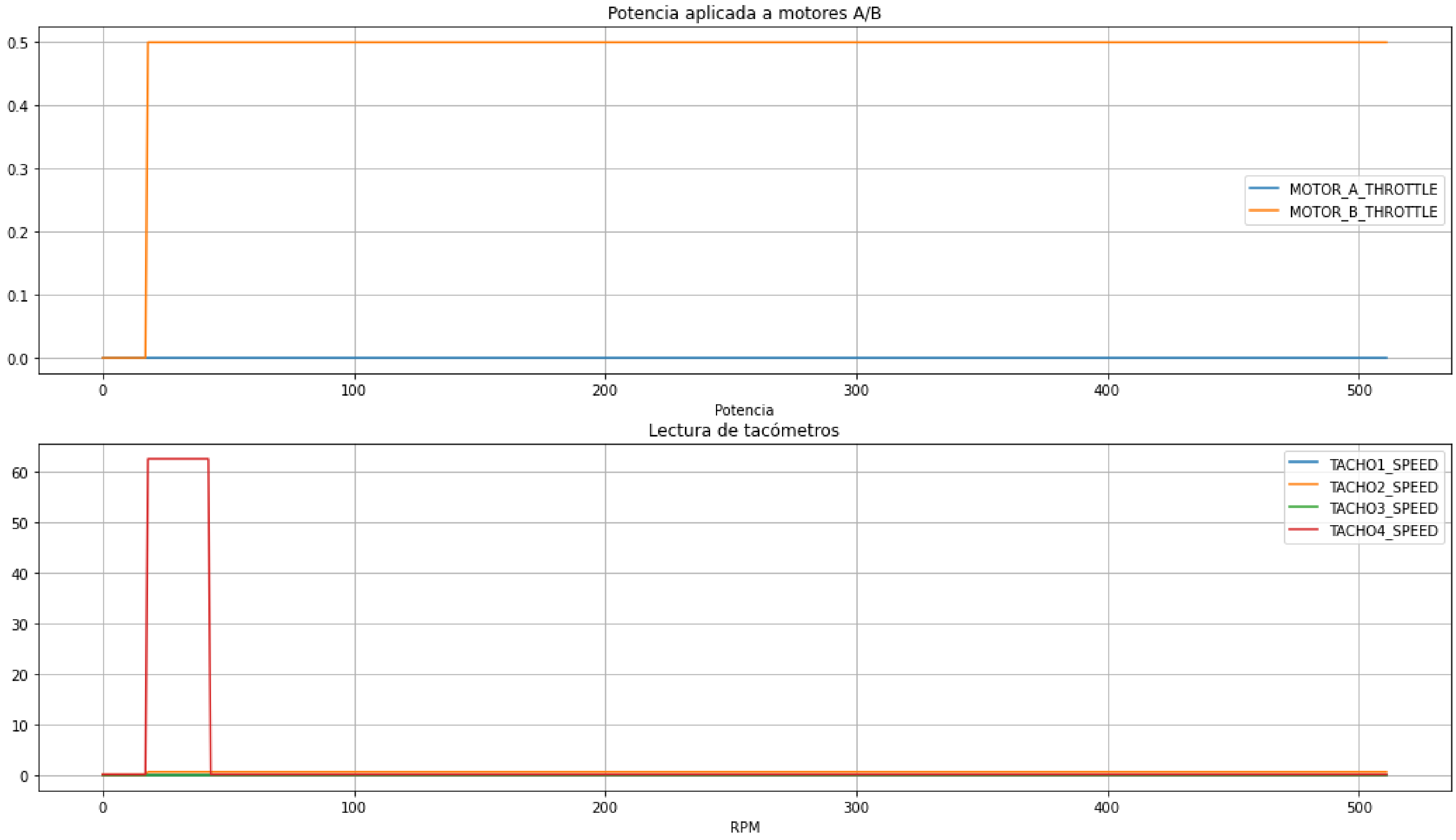


Potencia aplicada a motores A/B

Lectura de tacómetros

In [46]:

```
rover.set_motor_throttles([0.0, 0.5], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
tmy_readings = capture_and_plot_tachometer_tmy(512)
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
```



6. Test de lectura de IMU

In [47]:

```
rover.print_imu_state()
```

```
IMU_RAW_ACCEL_X: 0.000
IMU_RAW_ACCEL_Y: 0.000
IMU_RAW_ACCEL_Z: 0.000
```

```
IMU_RAW_GYRO_X: 0.000
IMU_RAW_GYRO_Y: 0.000
IMU_RAW_GYRO_Z: 0.000
IMU_RAW_MAG_X: 0.000
IMU_RAW_MAG_Y: 0.000
IMU_RAW_MAG_Z: 0.000
IMU_RAW_TEMP: 0.000
IMU_QUAT_X: 0.000
IMU_QUAT_Y: 0.000
IMU_QUAT_Z: 0.000
IMU_QUAT_W: 0.000
```

7. Test de lectura de GPS

In [ ]:

```
# No implementado
```

8. Test de lazo de control PID

In [48]:

```
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
```

```
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 0.000
TACHO1_COUNT: 1353.000
TACHO2_COUNT: 9978.000
TACHO3_COUNT: 1196.000
TACHO4_COUNT: 1317.000
MOTOR_A_THROTTLE: 0.0
MOTOR_B_THROTTLE: 0.0
MOTOR_A_SETPOINT_SPEED: 0.000
MOTOR_B_SETPOINT_SPEED: 0.000
```

In [49]:

```
INTERVAL = 3

# Detenido
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
```

```
# 10 RPM
rover.set_motor_speed_setpoint(
    [30.0, 30.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# 20 RPM
rover.set_motor_speed_setpoint(
    [20.0, 20.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# 30 RPM
rover.set_motor_speed_setpoint(
    [30.0, 30.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# 40 RPM
rover.set_motor_speed_setpoint(
    [40.0, 40.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# 50 RPM
rover.set_motor_speed_setpoint(
    [50.0, 50.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# 40 RPM
rover.set_motor_speed_setpoint(
    [40.0, 40.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# 30 RPM
rover.set_motor_speed_setpoint(
    [30.0, 30.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# 20 RPM
rover.set_motor_speed_setpoint(
    [20.0, 20.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# 10 RPM
rover.set_motor_speed_setpoint(
    [30.0, 30.0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
time.sleep(INTERVAL)

# Detenido
rover.set_motor_throttles([0, 0], RoverClient.MOTOR_A | RoverClient.MOTOR_B )
rover.print_motor_tmy()
```

```
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 0.000
TACHO1_COUNT: 1353.000
TACHO2_COUNT: 9978.000
TACHO3_COUNT: 1196.000
TACHO4_COUNT: 1317.000
MOTOR_A_THROTTLE: 0.0
MOTOR_B_THROTTLE: 0.0
MOTOR_A_SETPOINT_SPEED: 0.000
MOTOR_B_SETPOINT_SPEED: 0.000
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 0.000
TACHO1_COUNT: 1353.000
TACHO2_COUNT: 9978.000
TACHO3_COUNT: 1196.000
TACHO4_COUNT: 1317.000
MOTOR_A_THROTTLE: 0.0
MOTOR_B_THROTTLE: 0.0
MOTOR_A_SETPOINT_SPEED: 0.000
MOTOR_B_SETPOINT_SPEED: 0.000
TACHO1_SPEED: 78.105
TACHO2_SPEED: 0.000
TACHO3_SPEED: 100.217
TACHO4_SPEED: 116.356
TACHO1_COUNT: 1443.000
TACHO2_COUNT: 10335.000
```

```
TACHO3_COUNT: 1288.000
TACHO4_COUNT: 1411.000
MOTOR_A_THROTTLE: -1.0
MOTOR_B_THROTTLE: 0.3078269958496094
MOTOR_A_SETPOINT_SPEED: 30.000
MOTOR_B_SETPOINT_SPEED: 30.000
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 62.168
TACHO1_COUNT: 1562.000
TACHO2_COUNT: 10650.000
TACHO3_COUNT: 1393.000
TACHO4_COUNT: 1518.000
MOTOR_A_THROTTLE: 0.2142527550458908
MOTOR_B_THROTTLE: 0.2129775732755661
MOTOR_A_SETPOINT_SPEED: 20.000
MOTOR_B_SETPOINT_SPEED: 20.000
TACHO1_SPEED: 81.862
TACHO2_SPEED: 0.000
TACHO3_SPEED: 97.380
TACHO4_SPEED: 125.576
TACHO1_COUNT: 1674.000
TACHO2_COUNT: 11173.000
TACHO3_COUNT: 1498.000
TACHO4_COUNT: 1631.000
MOTOR_A_THROTTLE: 1.0
MOTOR_B_THROTTLE: 0.32130539417266846
MOTOR_A_SETPOINT_SPEED: 30.000
MOTOR_B_SETPOINT_SPEED: 30.000
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 148.574
TACHO1_COUNT: 1800.000
TACHO2_COUNT: 12769.000
TACHO3_COUNT: 1603.000
TACHO4_COUNT: 1779.000
MOTOR_A_THROTTLE: 0.4332062005996704
MOTOR_B_THROTTLE: 0.43304529786109924
MOTOR_A_SETPOINT_SPEED: 40.000
MOTOR_B_SETPOINT_SPEED: 40.000
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
```

```
TACHO3_SPEED: 0.000
TACHO4_SPEED: 0.000
TACHO1_COUNT: 1898.000
TACHO2_COUNT: 15476.000
TACHO3_COUNT: 1712.000
TACHO4_COUNT: 1948.000
MOTOR_A_THROTTLE: 0.0840364396572113
MOTOR_B_THROTTLE: 0.54776531457901
MOTOR_A_SETPOINT_SPEED: 50.000
MOTOR_B_SETPOINT_SPEED: 50.000
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 141.476
TACHO1_COUNT: 2001.000
TACHO2_COUNT: 17628.000
TACHO3_COUNT: 1816.000
TACHO4_COUNT: 2117.000
MOTOR_A_THROTTLE: 0.45848348736763
MOTOR_B_THROTTLE: 0.46102508902549744
MOTOR_A_SETPOINT_SPEED: 40.000
MOTOR_B_SETPOINT_SPEED: 40.000
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 135.753
TACHO1_COUNT: 2106.000
TACHO2_COUNT: 18625.000
TACHO3_COUNT: 1911.000
TACHO4_COUNT: 2251.000
MOTOR_A_THROTTLE: 0.36627301573753357
MOTOR_B_THROTTLE: 0.37010473012924194
MOTOR_A_SETPOINT_SPEED: 30.000
MOTOR_B_SETPOINT_SPEED: 30.000
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 0.000
TACHO1_COUNT: 2214.000
TACHO2_COUNT: 19065.000
TACHO3_COUNT: 2011.000
TACHO4_COUNT: 2356.000
MOTOR_A_THROTTLE: 0.27227821946144104
MOTOR_B_THROTTLE: 0.2760760188102722
```

```
MOTOR_A_SETPOINT_SPEED: 20.000
MOTOR_B_SETPOINT_SPEED: 20.000
TACHO1_SPEED: 0.000
TACHO2_SPEED: 0.000
TACHO3_SPEED: 0.000
TACHO4_SPEED: 139.269
TACHO1_COUNT: 2324.000
TACHO2_COUNT: 20199.000
TACHO3_COUNT: 2126.000
TACHO4_COUNT: 2490.000
MOTOR_A_THROTTLE: 0.3804228901863098
MOTOR_B_THROTTLE: 0.3849356770515442
MOTOR_A_SETPOINT_SPEED: 30.000
MOTOR_B_SETPOINT_SPEED: 30.000
```

Tear down

Desconectarse del rover para liberar el puerto serie.

In [50]:

```
rover.disconnect()
```