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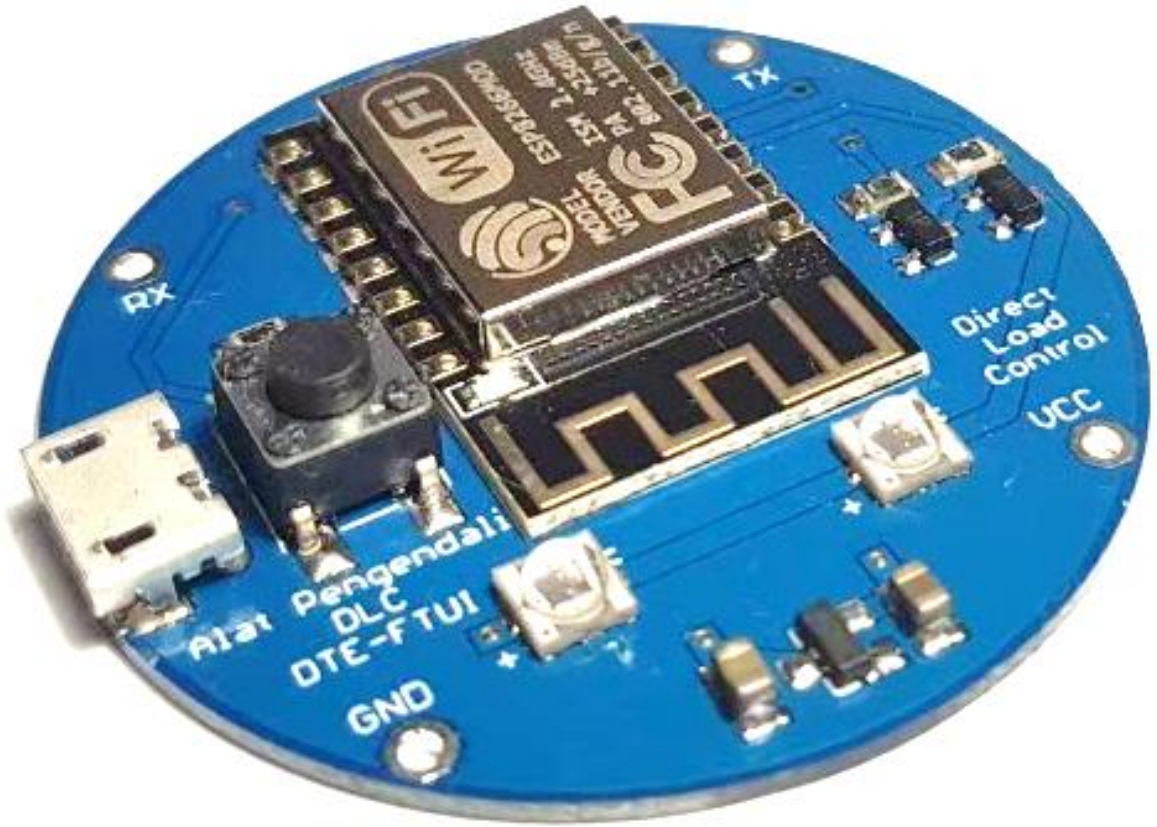


Design of Direct Load Control Device and Its Effect on Load Reduction

I Garniwa & N S Wardana

Background

- High electricity consumption from air conditioning units is able to disrupt power grid stability (i.e. may cause power outage)

Solution

- Implementation of *direct load control*

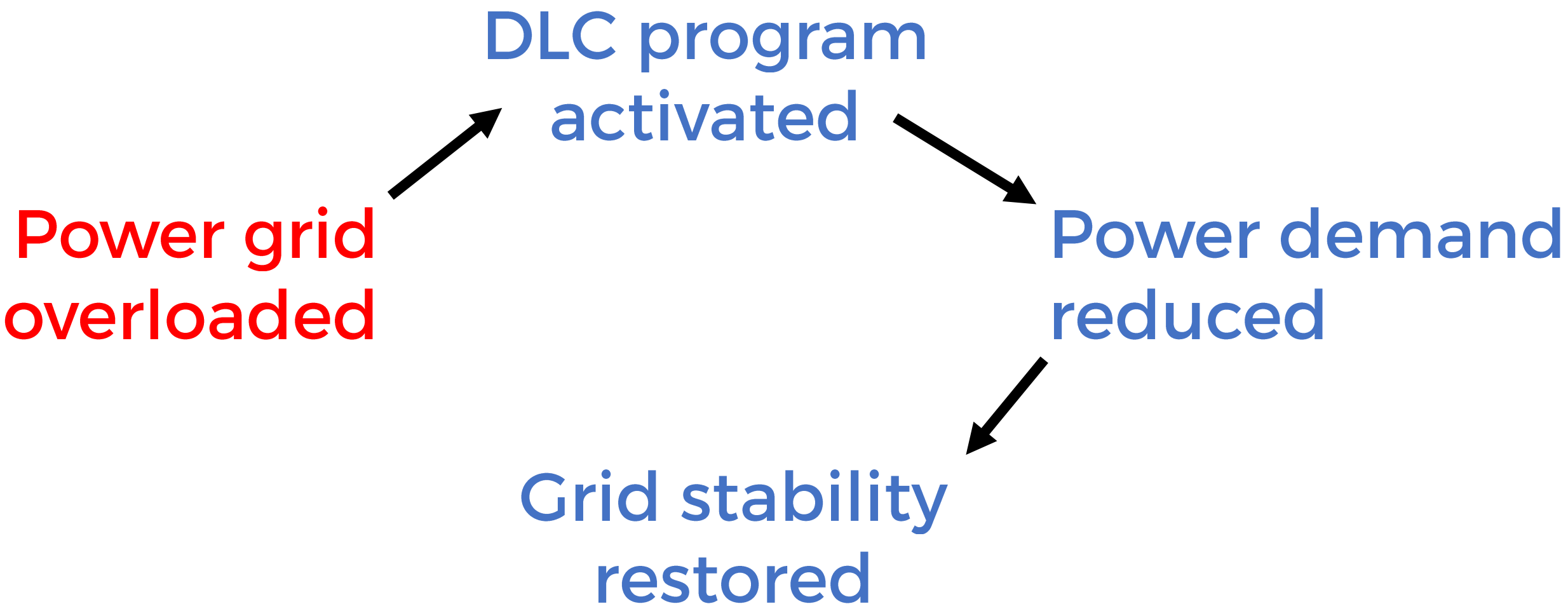
Implementation of DLC Device

- Installed at electrical consumer premises
- Control air conditioning units

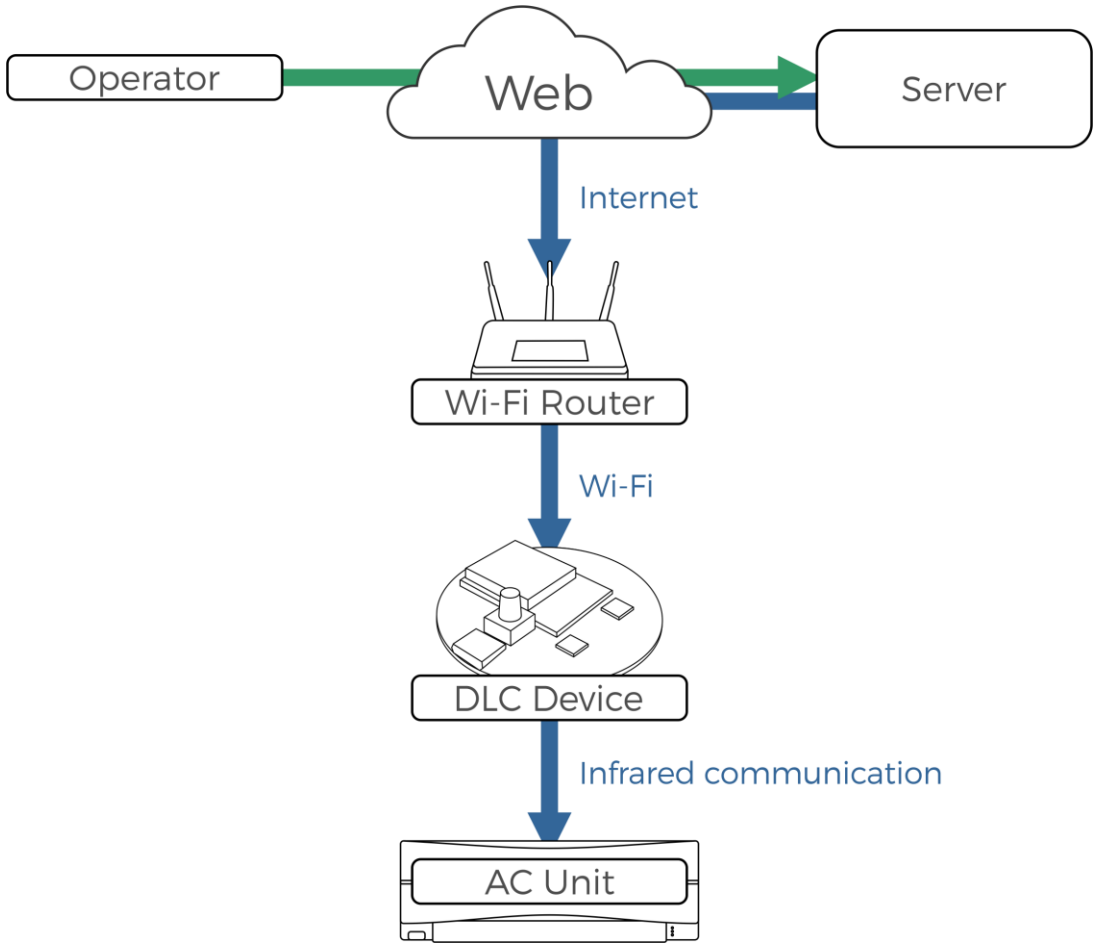
DLC Program

- Change cooling modes and temp setting at 00:00
- Turn off at 05:00

Use Case Scenario of Direct Load Control



Working Principle



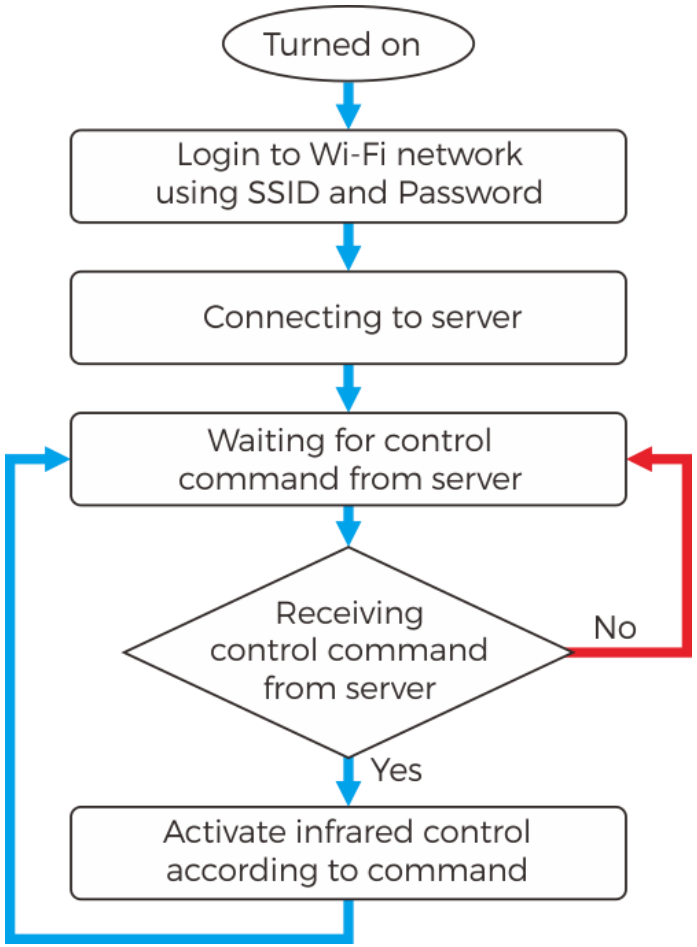


Figure 1. Operating principle (left) and software algorithm (right) of DLC device

System Design

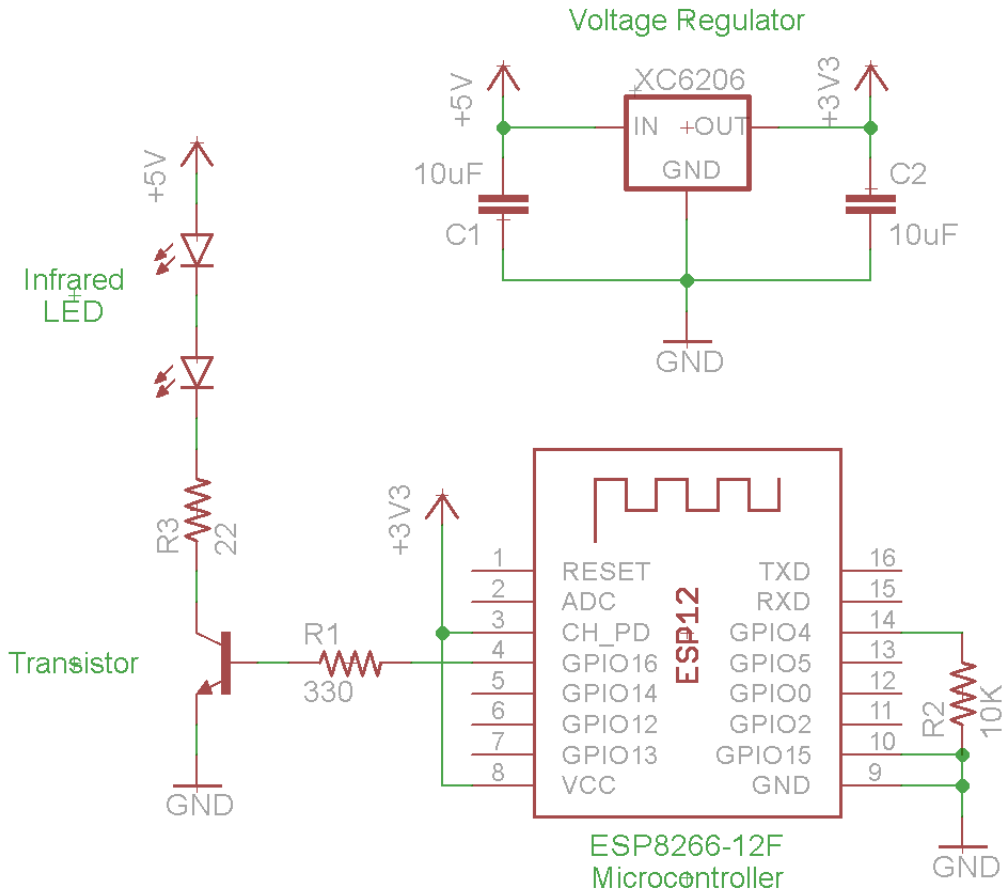


Figure 2. ESP-12F (right) and overall schematics (left)

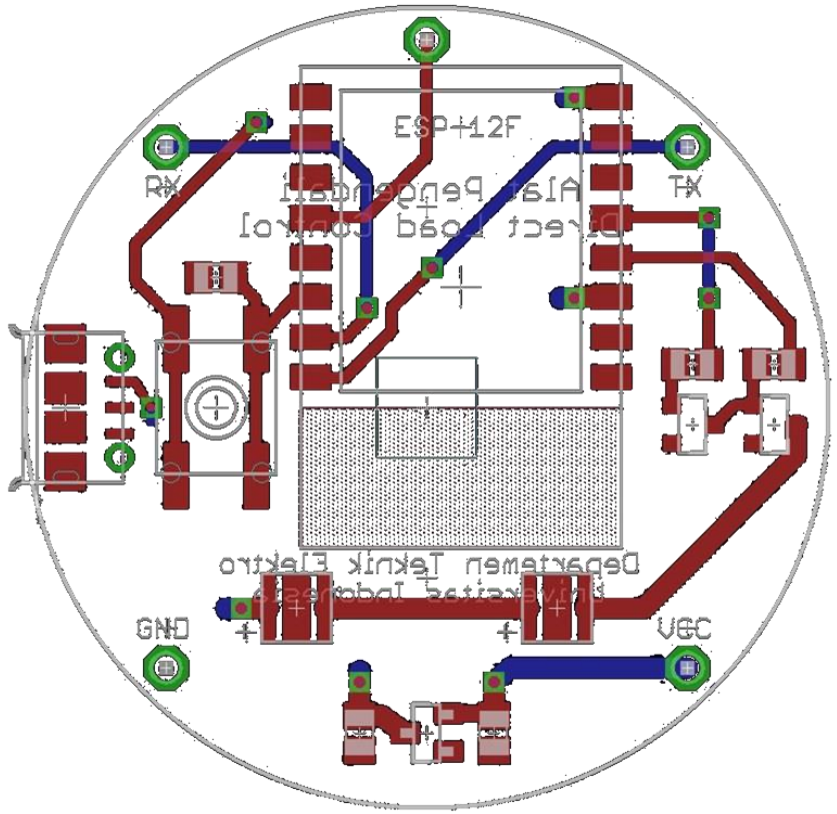


Figure 3. Board design

Experiment Setup

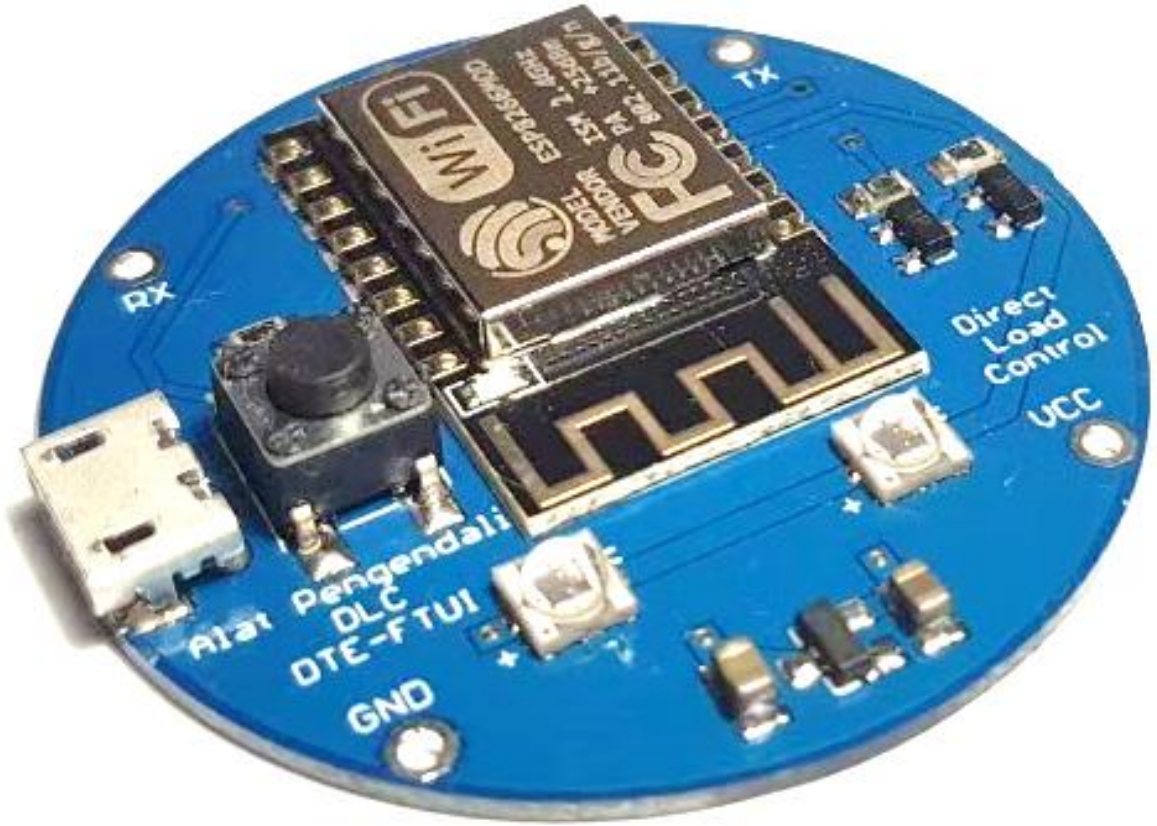
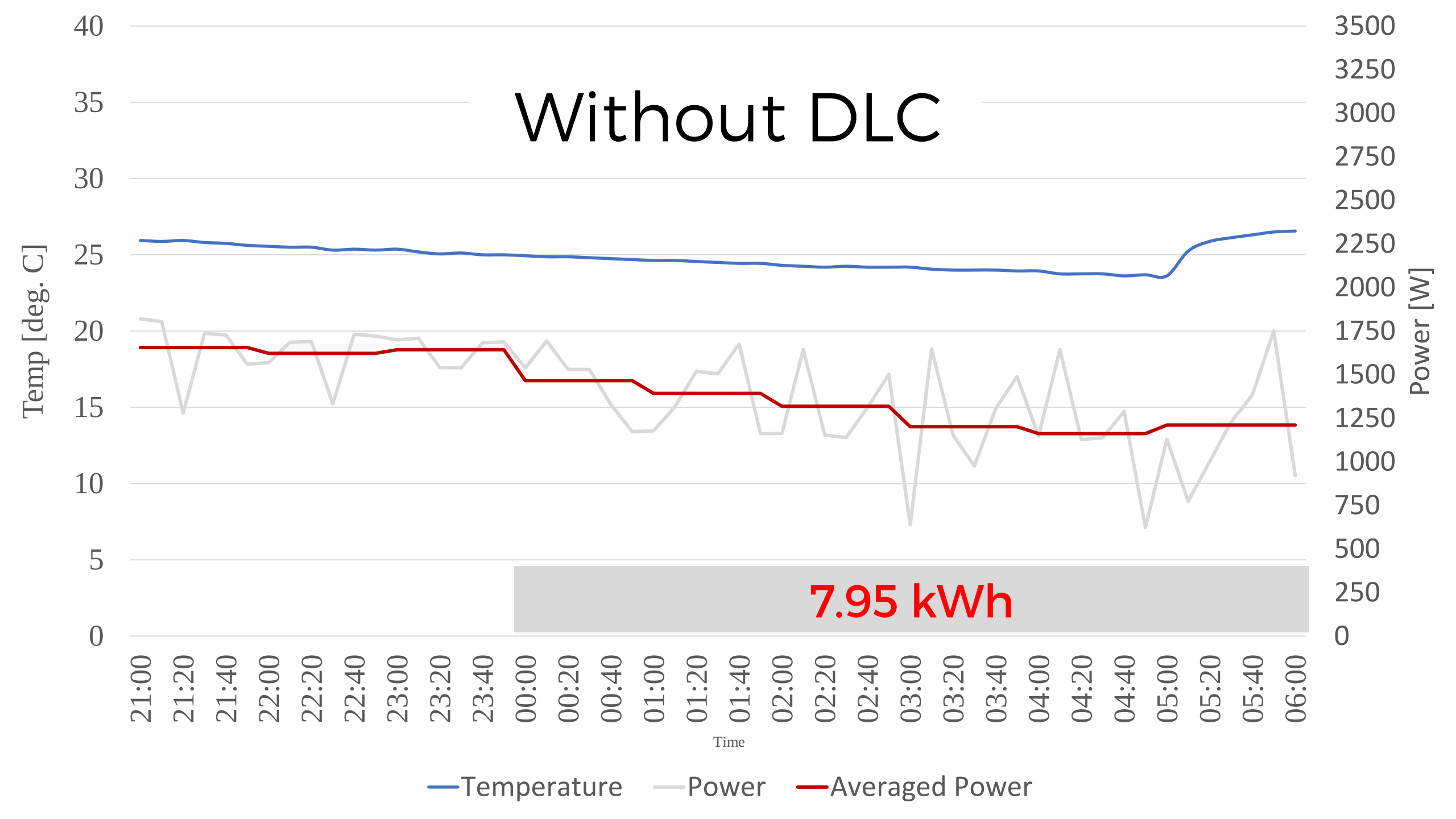
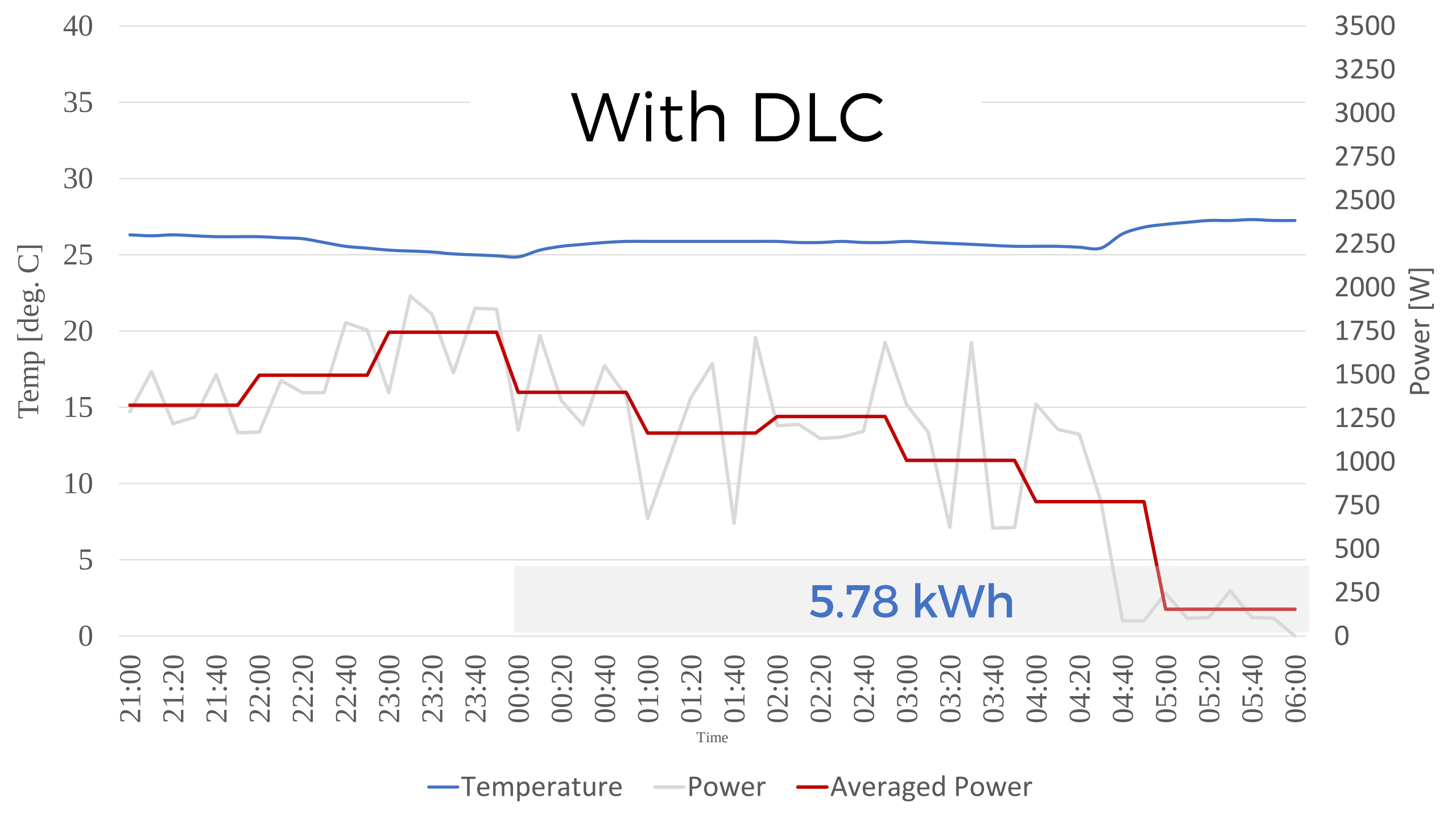


Figure 3. Final assembled board

Figure 5. Installation


Without DLC
Temp [deg. C]
Power [W]
40
35
30
25
20
15
10
5
0
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
7.95 kWh
21:00
21:20
21:40
22:00
22:20
22:40
23:00
23:20
23:40
00:00
00:20
00:40
01:00
01:20
01:40
02:00
02:20
02:40
03:00
03:20
03:40
04:00
04:20
04:40
05:00
05:20
05:40
06:00
Time
Temperature
Power
Averaged Power


With DLC
Temp [deg. C]
Power [W]
Time
5.78 kWh
Temperature
Power
Averaged Power
40
35
30
25
20
15
10
5
0
3500
3250
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
21:00
21:20
21:40
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03:40
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04:20
04:40
05:00
05:20
05:40
06:00

Summary

Without DLC

7.95 kWh → With DLC 5.78 kWh

▼ 27.3% load reduction

Without DLC

25.13 °C → With DLC 25.52 °C

▲ 1.5% temperature rise

Conclusion

1. Successfully demonstrated load reduction using direct load control
2. Significant load reduction (>65 kWh/mo) with no noticeable impact on temperature rise (<0.5 ºC)
3. May be implemented to large number of residential buildings
4. May be effective in maintaining grid stability during overload

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