AL17051V5EV1 User Guide
High-Voltage, Step-Down Converter

General Description

This demonstration board utilizes the AL17051V5 to build a cost-effective solution for high-voltage buck converter applications.

AL17051V5 integrates a 700V MOSFET and works with a single winding inductor and very few external components to provide accurate constant voltage output and good dynamic performance.

A bill of materials is included in this user guide which describes the parts used on this board. A schematic and PCB layout is also included along with measured system performance characteristics and test waveforms. These materials can be used as a reference design for products to improve the product's time to market.

Key Features

1. Universal 85 to 265VAC Input Range
2. Constant Voltage (CV) Control
3. Internal MOSFET up to 700V
4. Low Operation Current: 100μA (Static)
5. Undervoltage Lock Out (UVLO)
6. Output Short Protection
7. Overload Protection
8. Overtemperature Protection (OTP)
9. Lower Standby Power

Applications

- Home Appliance Applications
- IoT Applications
- Industrial Controls
- Low Standby Power Applications

Specifications

Parameter	Value
AC Input Voltage	85Vac ~ 265Vac
Output Power	0.3W
Output Current	60mA
Output Voltage	5V
Efficiency	>70%@120VAC/60mA
Dimension	32mm*15mm
RoHS Compliance	Yes

Evaluation Board

Figure 1. Top View

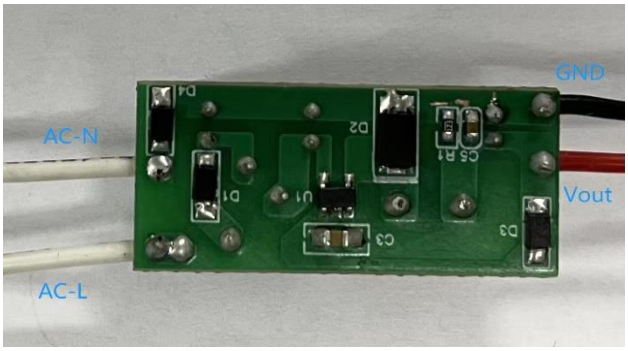


Figure 2. Bottom View

Connection Instructions:
AC Line Input: White L line
AC Neutral Input: White N line
Positive Output: Vout (Red)
Negative Output: Gnd (Black)

Board Layout

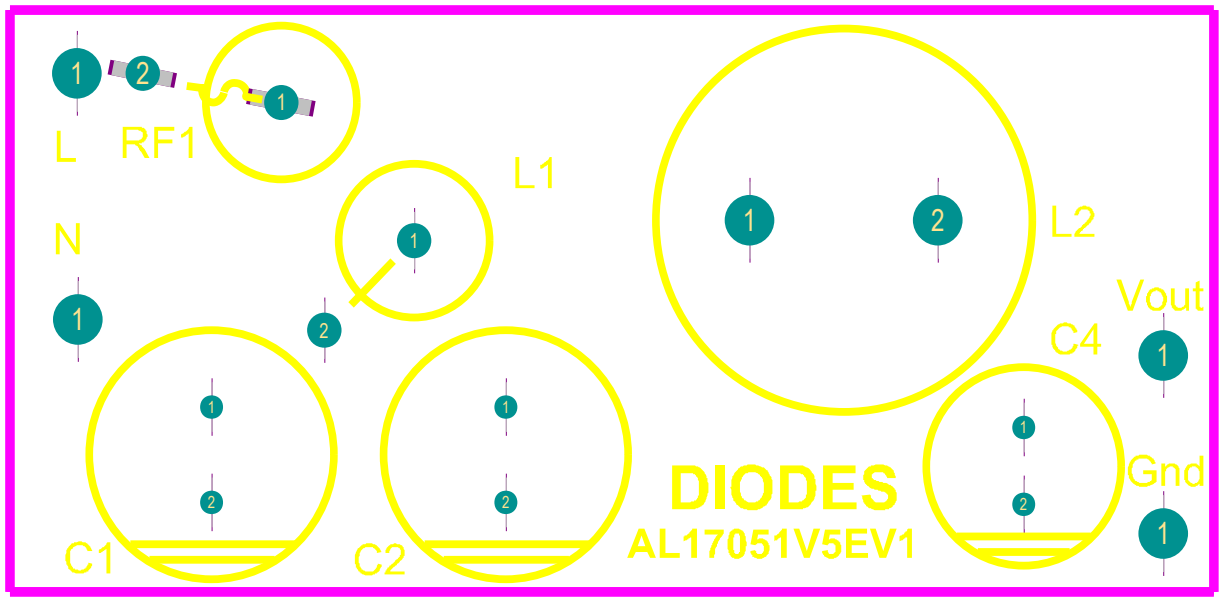


Figure 3. PCB Layout Top View

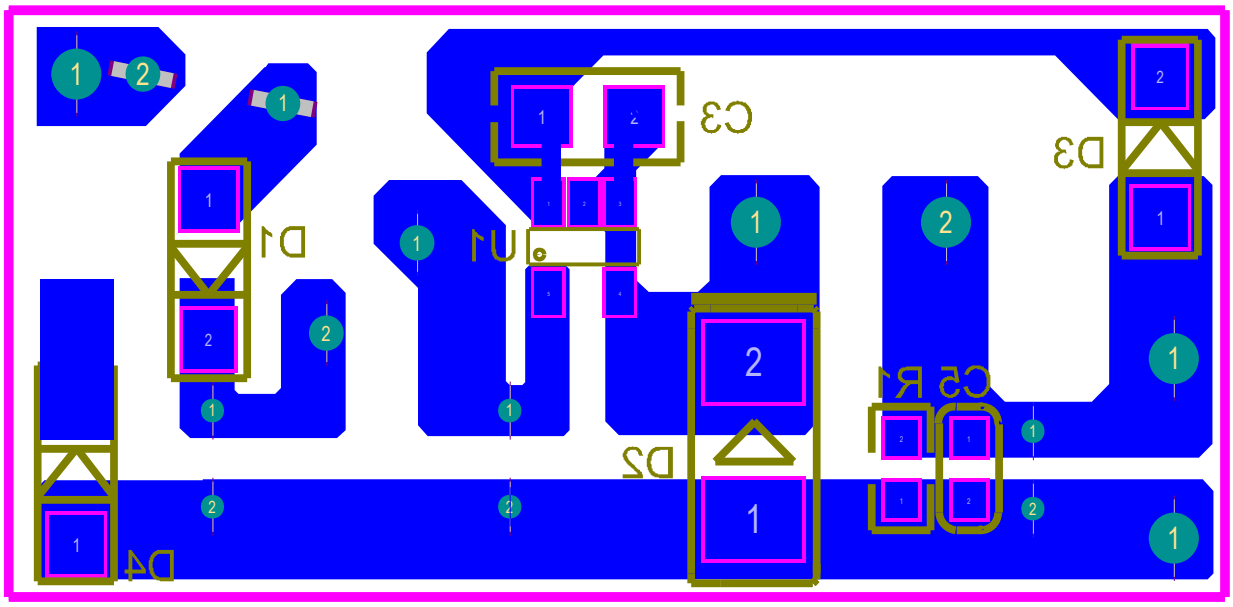


Figure 4. PCB Layout Bottom View

Quick Start Guide

1. Ensure that the AC source is switched OFF or disconnected.
2. Connect the AC line wires of power supply to “L” and “N” wires on the left side of the board.
3. Connect the red terminal of the electronic load to the “Vout” wire.
4. Connect the black terminal of the electronic load to the “Gnd” wire.
5. Turn on the main switch. The electronic load should show a 5V output.

Schematic

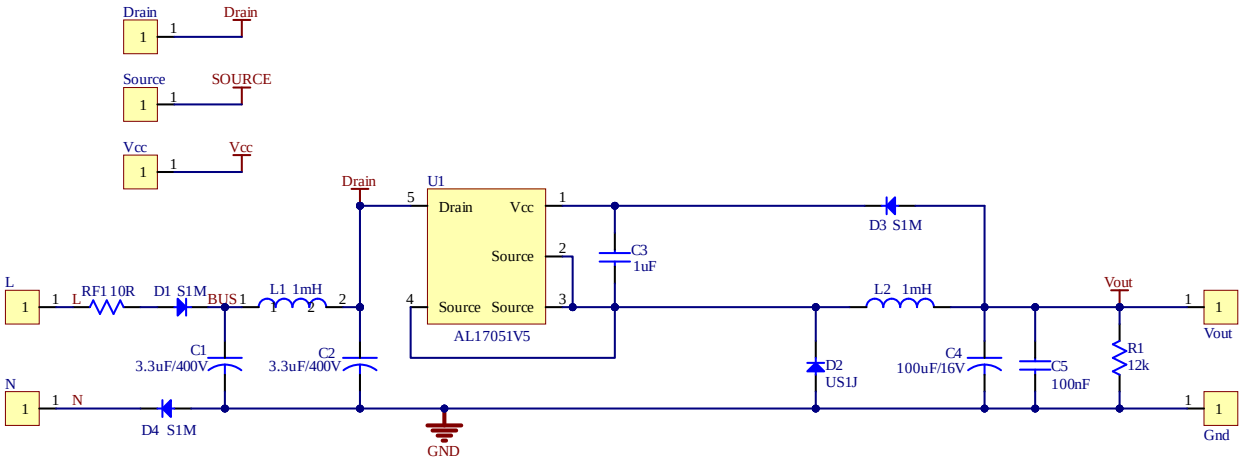


Figure 5. Schematic Circuit

Bill of Material

Item	Quantity	Package	Description
RF1	1	DIP	10Ω, Fuse Resistor, 5%, 1W
D1,D3,D4	3	SOD123	S1MSWFQ, Diode,1000V,1A, Diodes Incorporated (Diodes)
D2	1	SMA	US1J, Diode,600V,1A,trr=75ns, Diodes
C1,C2	2	DIP	3.3uF, Electrolytic Capacitor,400V,6.3*9, AISHI
C3	1	0805	1uF, Ceramic Capacitor, 25V,X5R,20%,FengHua
C4	1	DIP	100uF, Electrolytic Capacitor,16V,5*11,AISHI
C5	1	0603	100nF, Ceramic Capacitor,16V,X7R,10%,Fenghua
L1	1	DIP	1mH, Inductor, Color-ring, FengHua
L2	1	DIP	1mH, Inductor, Choke, 8095,Wurth (768772102)
R1	1	0603	12kΩ, SMD Film Resistor, 1%, UniOhm
U1	1	SOT25	AL17051V5W5-7, IC, Diodes

System Performance

The AL17051V5 evaluation board has excellent system performance. With very low BOM cost, the system can achieve high efficiency, low load regulation rate, low ripple and good load transient performance.

System efficiency

Figure 6 shows the measured efficiency versus load. The system efficiency at 55mA current load could reach 71.4% with 120Vac input and 66.7% with 230Vac input.

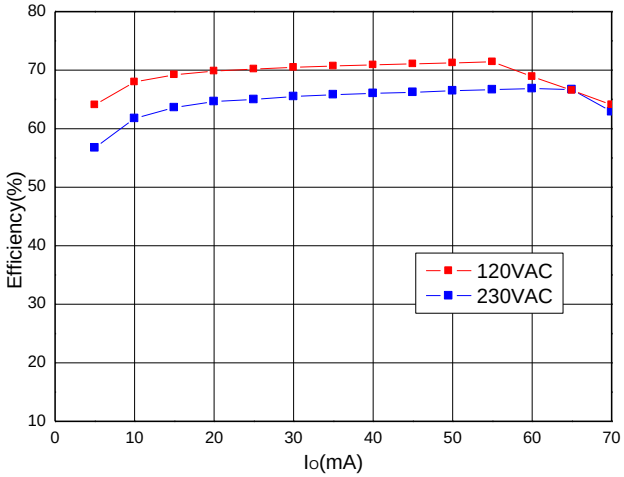


Figure 6. Efficiency vs. load current

Load Regulation

The measured output voltage versus load is shown in Figure 7. The output voltage ranges from 5.34V to 4.95V, indicating the load regulation rate lower than 8%.

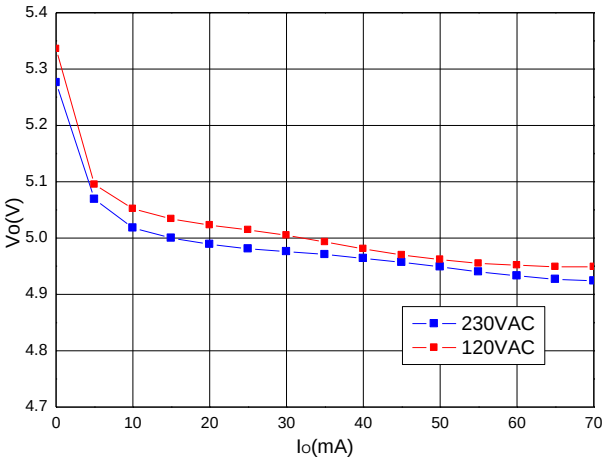


Figure 7. Output voltage vs. load current

Note: Forward voltage drop of D2 will make slight differences on the output voltage. Heavy dummy load (R1) also helps to decrease output voltage at no load condition.

Standby Power

The measured input voltage versus standby power is shown in Figure 8. The input voltage ranges from 85V to 265V, indicating the standby power lower than 10mW.

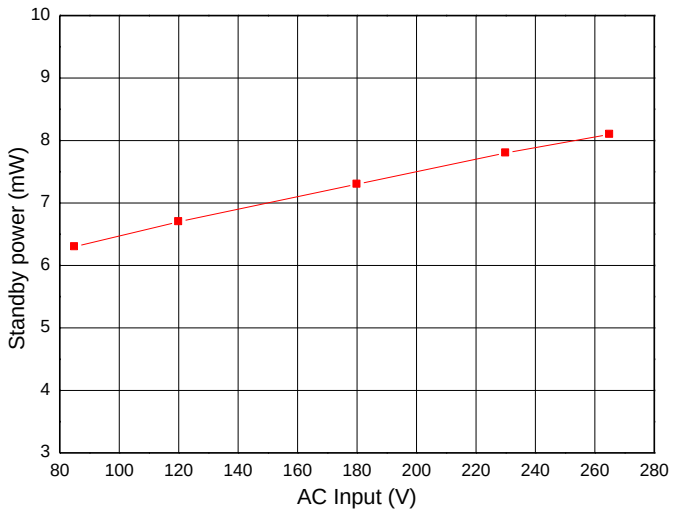


Figure 8. Input voltage vs. No load Power

Note: If want to lower standby power, need to increase R1 value, but need to double check output voltage at no-load condition.

Output Ripple

The output voltage ripple is measured at 60mA load at both 120Vac and 230Vac input. In Figure 9, channel 1 (Red color) shows the waveform of Vout.

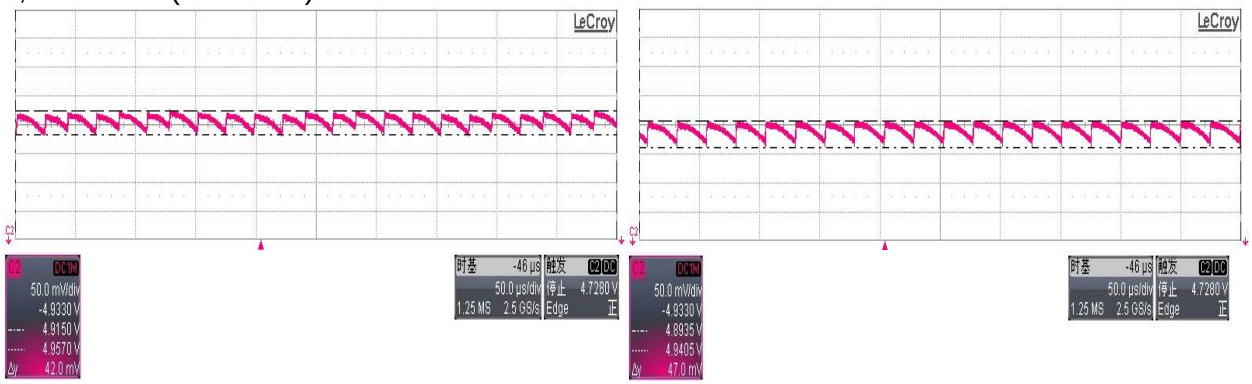


Figure 9. Output voltage ripple with 120Vac (Left) and 230Vac (Right)

The output voltage ripple peak to peak value is 42mV for 120Vac input and 47mV for 230Vac.

Load Transient Response

The load transient response is tested with the load repeatedly switching from 0mA to 60mA in 10Hz frequency. The load switching slew rate is 60mA/us. In Figure 10, channel 2 (Red color) shows the waveform of Vout and channel 4 (Green color) shows Iout.

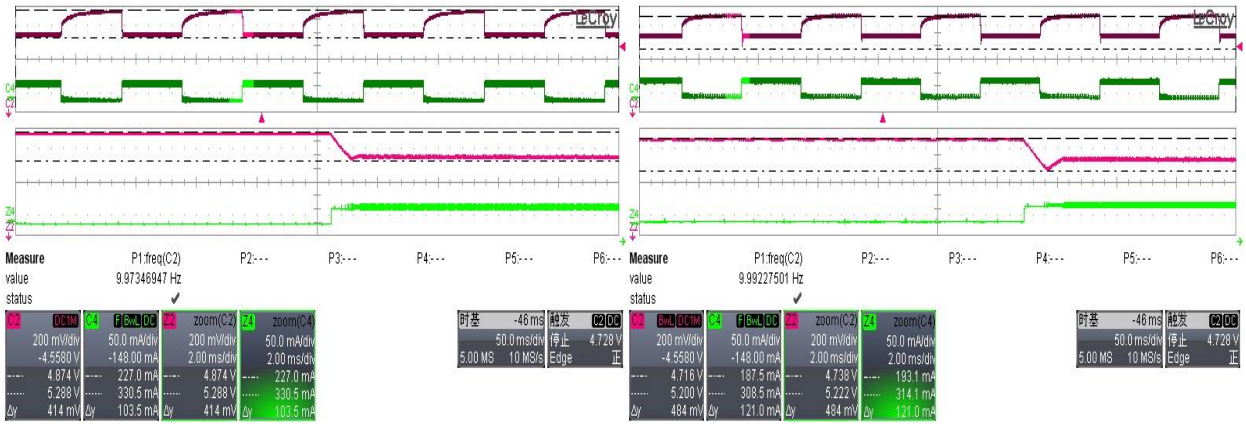
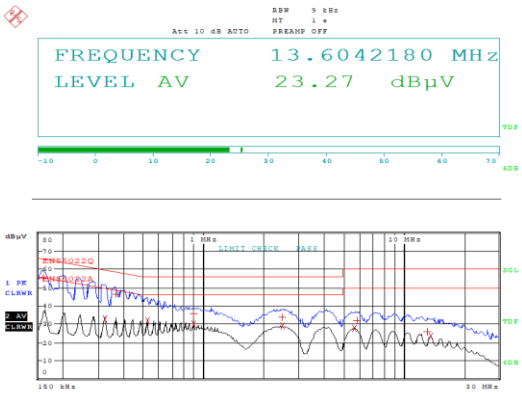


Figure 10. Load transient waveform with 120Vac (Left) and 230Vac (Right)

With 120Vac input, the maximum undershoot caused by the load transient is 414mV. With 230Vac input, the maximum undershoot caused by the load transition are 484mV. Thus, the minimum output voltage in worst case is 4.72V.

EMI Conduction Test

Line Terminal
(Vin=120V_{AC}, Margin>10dB)

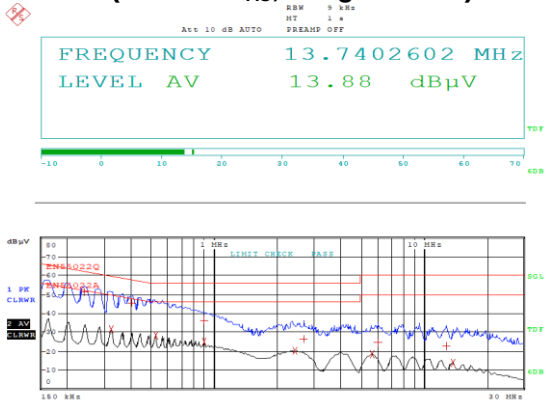


EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	157.651507515 kHz	55.33	-10.24
2	Average	322.728292586 kHz	33.21	-16.42
1	Quasi Peak	363.658318017 kHz	46.59	-12.04
2	Average	525.514079005 kHz	32.04	-13.95
1	Quasi Peak	890.465639904 kHz	35.59	-20.40
2	Average	890.465639904 kHz	30.37	-15.62
1	Quasi Peak	2.45695550736 MHz	33.93	-22.06
2	Average	2.45695550736 MHz	29.02	-16.97
2	Average	5.61140113855 MHz	27.87	-22.12
1	Quasi Peak	5.78143220445 MHz	32.16	-27.83
1	Quasi Peak	12.9439466322 MHz	26.08	-33.91
2	Average	13.6042179984 MHz	23.51	-26.48

Neutral Terminal
(Vin=120V_{AC}, Margin>10dB)

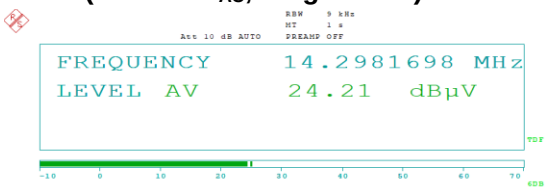


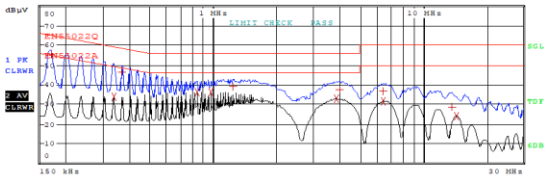
EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	239.439516487 kHz	51.45	-10.66
2	Average	322.728292586 kHz	31.71	-17.92
1	Quasi Peak	401.705024172 kHz	45.81	-11.99
2	Average	525.514079005 kHz	28.25	-17.74
1	Quasi Peak	890.465639904 kHz	36.22	-19.77
2	Average	890.465639904 kHz	24.79	-21.20
2	Average	2.40854377744 MHz	20.26	-25.73
1	Quasi Peak	2.66053074658 MHz	26.35	-29.64
2	Average	5.61140113855 MHz	18.38	-31.61
1	Quasi Peak	6.01618153549 MHz	24.43	-35.57
1	Quasi Peak	12.6888997473 MHz	22.77	-37.22
2	Average	13.7402601784 MHz	13.74	-36.25

Line Terminal (Vin=230V$_{AC}$,Margin>9dB)



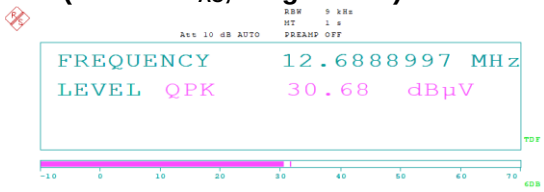


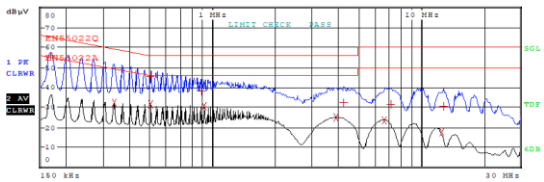
EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	169.02375452 kHz	55.59	-9.41
2	Average	335.832355405 kHz	34.09	-15.21
1	Quasi Peak	367.294901197 kHz	46.70	-11.85
2	Average	838.85891323 kHz	36.14	-9.85
2	Average	973.889156195 kHz	36.25	-9.74
1	Quasi Peak	1.23658080545 MHz	39.10	-16.89
2	Average	3.84467038339 MHz	32.75	-13.24
1	Quasi Peak	3.96116774068 MHz	37.68	-18.31
1	Quasi Peak	6.3862979296 MHz	36.57	-23.42
2	Average	6.3862979296 MHz	31.51	-18.49
1	Quasi Peak	13.6042179984 MHz	28.72	-31.27
2	Average	14.2981698401 MHz	24.19	-25.80

Neutral Terminal (Vin=230V$_{AC}$,Margin>9dB)





EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	167.350252 kHz	55.85	-9.23
2	Average	335.832355405 kHz	32.47	-16.82
1	Quasi Peak	505.008700673 kHz	45.81	-10.18
2	Average	505.008700673 kHz	31.53	-14.47
1	Quasi Peak	881.64914842 kHz	38.08	-17.92
2	Average	908.363999266 kHz	30.41	-15.58
2	Average	3.88311708723 MHz	24.94	-21.05
1	Quasi Peak	4.24690797041 MHz	32.68	-23.31
2	Average	6.57980914316 MHz	23.76	-26.23
1	Quasi Peak	7.12499045243 MHz	31.62	-28.37
2	Average	12.4388782936 MHz	17.44	-32.55
1	Quasi Peak	12.6888997473 MHz	30.57	-29.42

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