MU4

EVALUATION DATA

Template	260711 iss 2
DWG. No.	260963 iss 1

TDK·Lambda

Index

Terminology Used:

	Definition	
Vin	…….	Input voltage
Vout	…….	Output voltage
Iin	…….	Input current
Iout	…….	Output current
Ta	…….	Ambient temperature
F	…….	Frequency

TDK Lambda UK Ltd.
Kingsley Avenue
Ilfracombe
Devon, EX34 8ES
United Kingdom

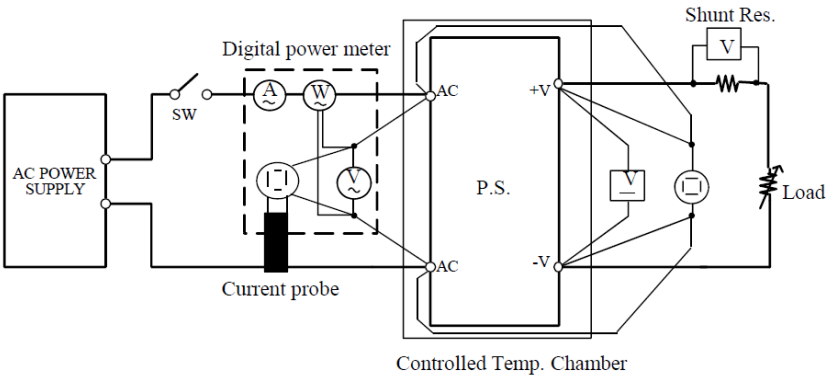
Website: https://uk.tdk-lambda.com

1. Evaluation Method

1.1 Circuit used for determination

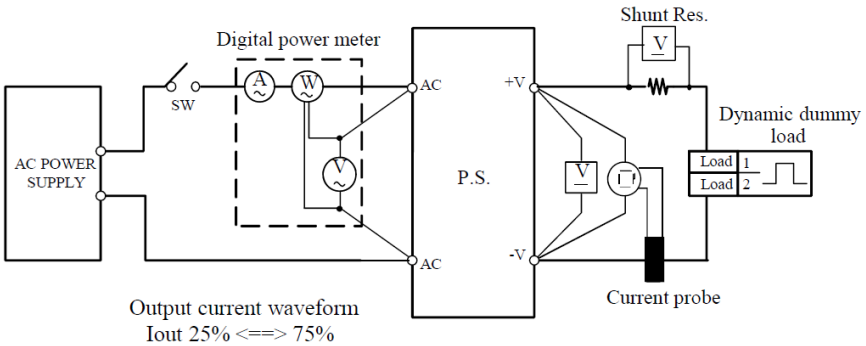
Circuit 1 used for determination

Steady state data
Over current protection (OCP) characteristics
Over voltage protection (OVP) characteristics
Output rise characteristics
Output fall characteristics
Hold up time characteristics
Response to brownout characteristics
Input current harmonics
Input current

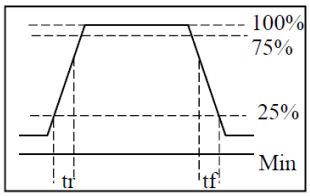


Circuit 2 used for determination

Dynamic load response characteristics

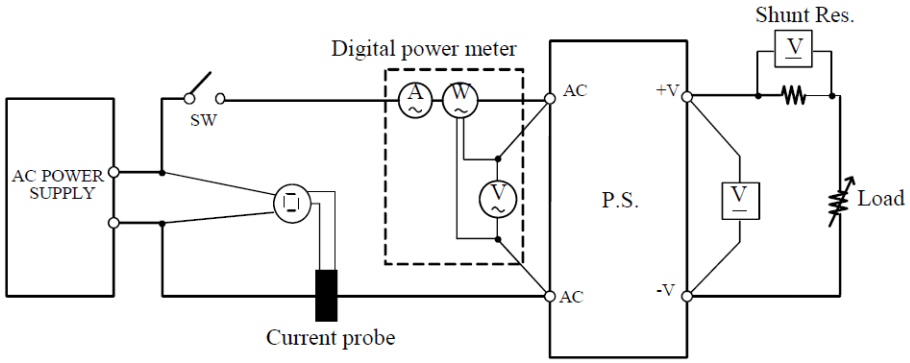


Output current waveform
Iout 25% <==> 75%



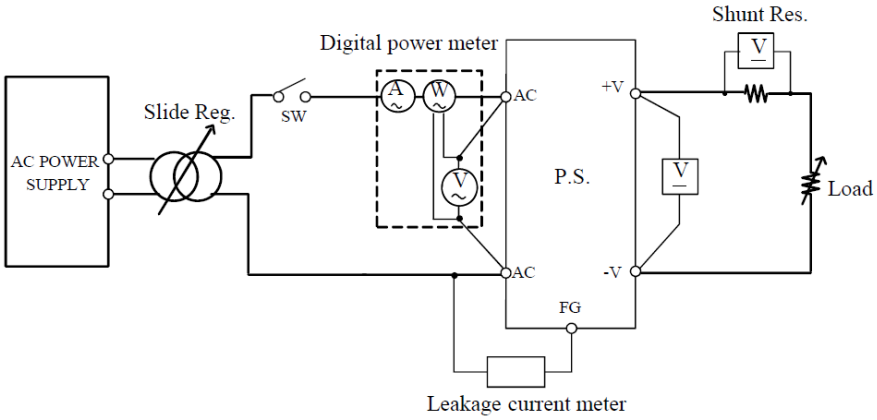
Circuit 3 used for determination

Inrush current waveform



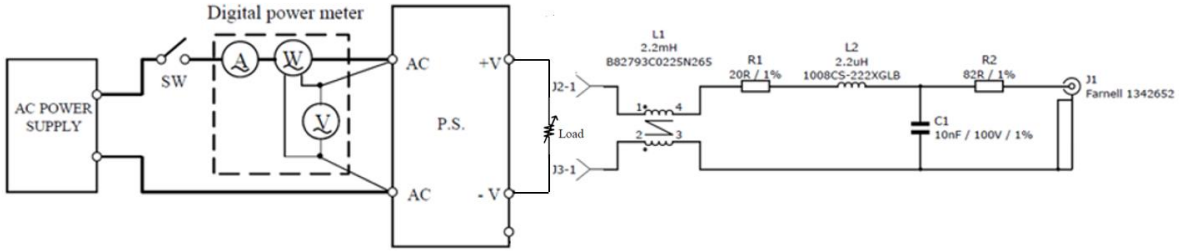
Circuit 4 used for determination

Leakage current characteristics



Circuit 5 used for determination

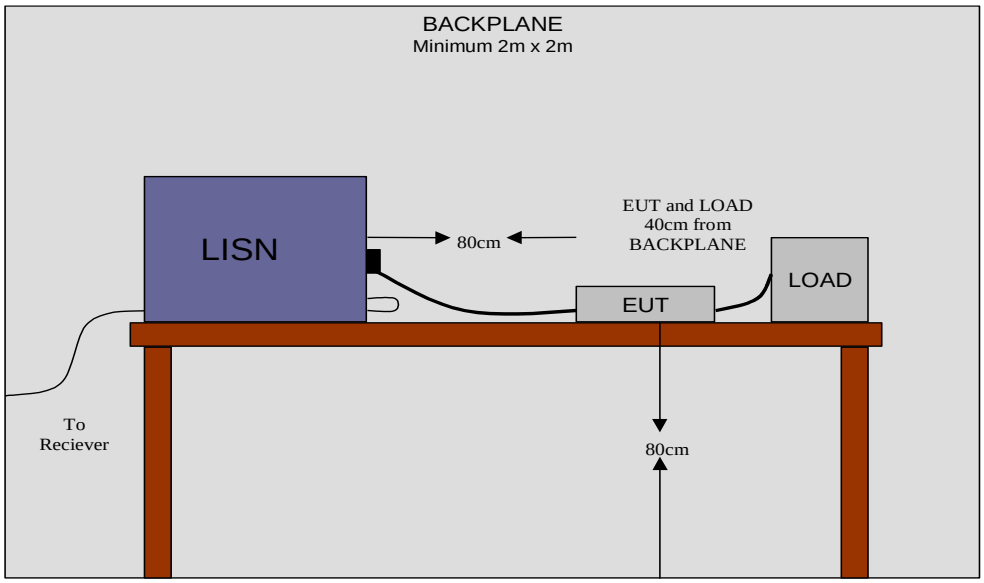
Output ripple and noise waveform



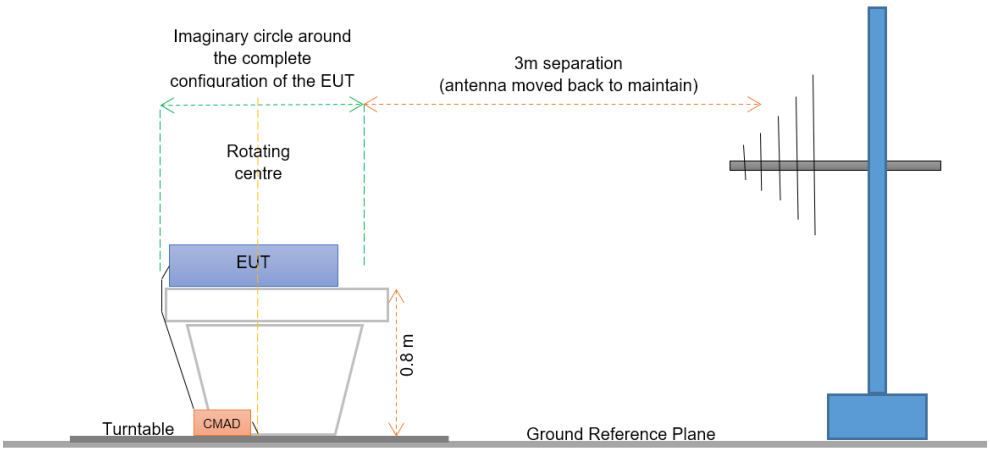
Configuration used for determination

Electro-Magnetic interference characteristics

(a) Conducted Emissions



(b) Radiated Emissions



1.2 List of equipment used

1.3

	Equipment Used	Manufacturer	Model No.
1	Chamber	Thermotron	SE-300-2-2
2	AC Source	Chroma	61505
3	Power Analyser	Vitrek	PA900
4	Load Mainframe 1	Chroma	6334A
5	Load Mainframe 2	Chroma	6334A
6	Scope	Rohde & Schwarz	RTM3004
7	Current Probe 1	Agilent	1146B
8	Current Probe 1	Agilent	1146B
9	Differential Prove	Keysight	N2791A
10	PC	Dell	OPTIPLEX 7020
11	MSO 44MXs-B Oscilloscope	LeCroy	E286
12	1503 Multimeter	Thurlby	C19
13	60V/25A DC supply	N/A	N/A
14	Rohde & Schwarz ESH3-Z2	N/A	357.8810.52
15	Rohde & Schwarz ESH3-Z5	N/A	831.5518.52
16	Rohde & Schwarz ESR (17)	N/A	1316.3003K03-102441-tM
17	Cable	N/A	EMI-RF-5
18	Cable	N/A	EMI-RF-6

2. Characteristics

2.1 Steady state data

(1) Regulation – line and load, temperature drift / start up and dropout voltage

5V SBS Module

1 Regulation – line and load Condition Ta: 25°C

Iout \ Vin	85Vac	100Vac	230Vac	264Vac	Line Regulation	
0%	4.975	4.976	4.977	4.977	2mV	0.1%
50%	4.968	4.969	4.969	4.969	1mV	0.1%
100%	4.961	4.961	4.962	4.962	1mV	0.1%
Load Regulation	14mV	15mV	15mV	15mV		
	0.3%	0.3%	0.3%	0.3%		

2 Temperature drift Condition Vin: 230Vac
Iout: 100%

Ta	-30°C	25°C	60°C	Temperature Stability	
Vout	4.981V	4.985V	4.973V	12mV	5%

3 Start-up voltage and Dropout voltage Condition Ta: 25°C
Iout: 100%

Start-up voltage (Vin)	79.9Vac
Dropout Voltage (Vin)	65.4Vac

12V SBS Module

1 Regulation – line and load

Condition Ta: 25°C

Iout \ Vin	85Vac	100Vac	230Vac	264Vac	Line Regulation	
0%	12.033	12.035	12.036	12.035	3mV	0.02%
50%	12.026	12.030	12.029	12.026	4mV	0.03%
100%	12.021	12.023	12.023	12.020	3mV	0.02%
Load Regulation	12mV	12mV	13mV	15mV		
	0.09%	0.09%	0.11%	0.12%		

2 Temperature drift

Condition Vin: 230Vac
Iout: 100%

Ta	-30°C	25°C	60°C	Temperature Stability	
Vout	11.852V	11.911V	11.939V	87mV	0.70%

3 Start-up voltage and Dropout voltage

Condition Ta: 25°C
Iout: 100%

Start-up voltage (Vin)	79.3Vac
Dropout Voltage (Vin)	67.0Vac

24V SBS Module

1 Regulation – line and load Condition Ta: 25°C

Iout \ Vin	85Vac	100Vac	230Vac	264Vac	Line Regulation	
0%	23.999	24.000	24.001	24.000	2mV	0.01%
50%	24.091	24.093	24.093	24.093	2mV	0.01%
100%	24.113	24.113	24.113	24.113	0mV	0.0%
Load Regulation	114mV	113mV	112mV	113mV		
	0.48%	0.47%	0.46%	0.47%		

2 Temperature drift Condition Vin: 230Vac
Iout: 100%

Ta	-30°C	25°C	60°C	Temperature Stability	
Vout	23.998V	23.973V	24.041V	43mV	0.18%

3 Start-up voltage and Dropout voltage Condition Ta: 25°C
Iout: 100%

Start-up voltage (Vin)	76.1Vac
Dropout Voltage (Vin)	73.2Vac

48V SBS Module

1 Regulation – line and load Condition Ta: 25°C

Iout \ Vin	85Vac	100Vac	230Vac	264Vac	Line Regulation	
0%	48.101	48.111	48.111	48.119	18mV	0.04%
50%	48.108	48.173	48.169	48.184	76mV	0.16%
100%	48.169	48.181	48.181	48.181	12mV	0.02%
Load Regulation	68mV	80mV	80mV	62mV		
	0.14%	0.17%	0.17%	0.13%		

2 Temperature drift Condition Vin: 230Vac
Iout: 100%

Ta	-30°C	25°C	60°C	Temperature Stability	
Vout	47.803V	47.909V	47.651	258mV	0.54%

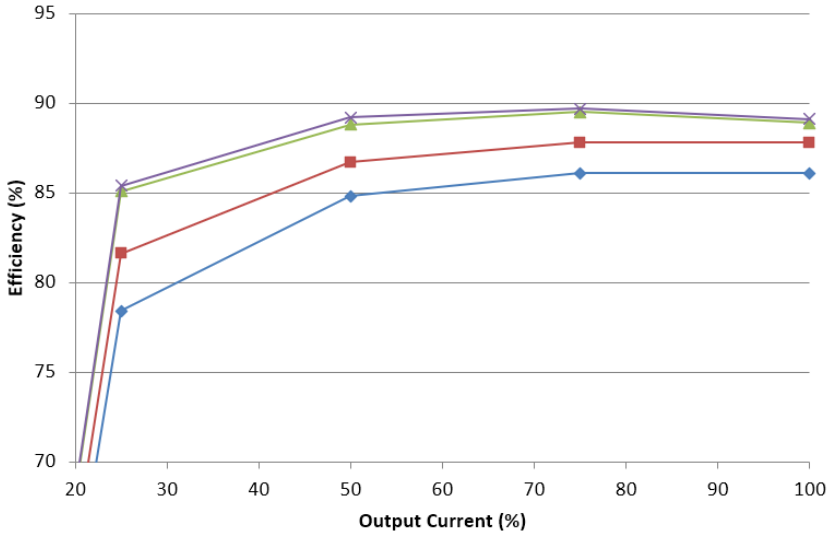
3 Start-up voltage and Dropout voltage Condition Ta: 25°C
Iout: 100%

Start-up voltage (Vin)	78.8Vac
Dropout Voltage (Vin)	66.9Vac

(2) Efficiency vs. Output current

Conditions: Vin : 85Vac
: 115Vac
: 230Vac
: 264Vac
Ta : 25°C

MU4FSDL-5SBS-12SBS-24SBS-48SBS

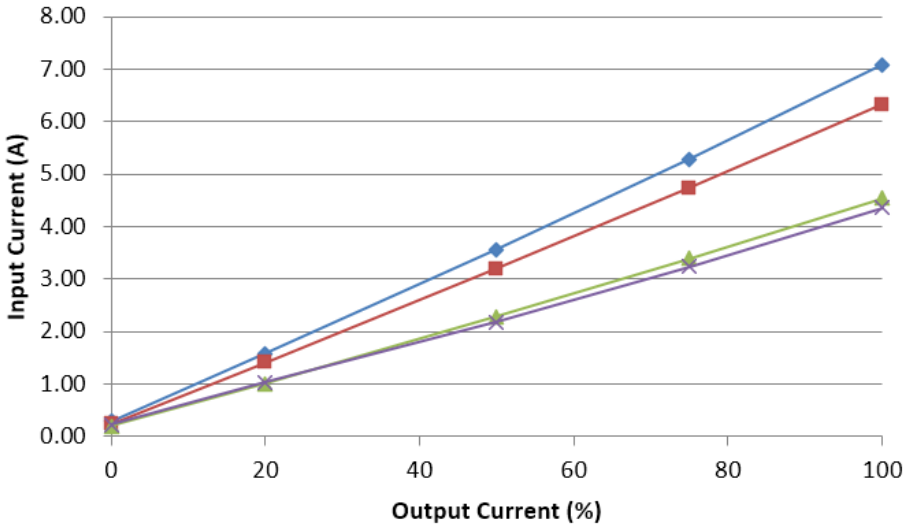


(3) Input current vs. Output current

Conditions: Vin : 85Vac
: 110Vac
: 230Vac
: 264Vac
Ta : 25°C

MU4FSDL-5SBS-12SBS-24SBS-48SBS

Vin	Input Current				
	Iout: 0%	Iout: 25%	Iout: 50%	Iout: 75%	Iout: 100%
85Vac	0.29A	1.58A	3.57A	5.29A	7.09A
115Vac	0.24A	1.41A	3.20A	4.74A	6.33A
230Vac	0.20A	1.01A	2.29A	3.40A	4.54A
264Vac	0.22A	1.04A	2.18A	3.24A	4.36A

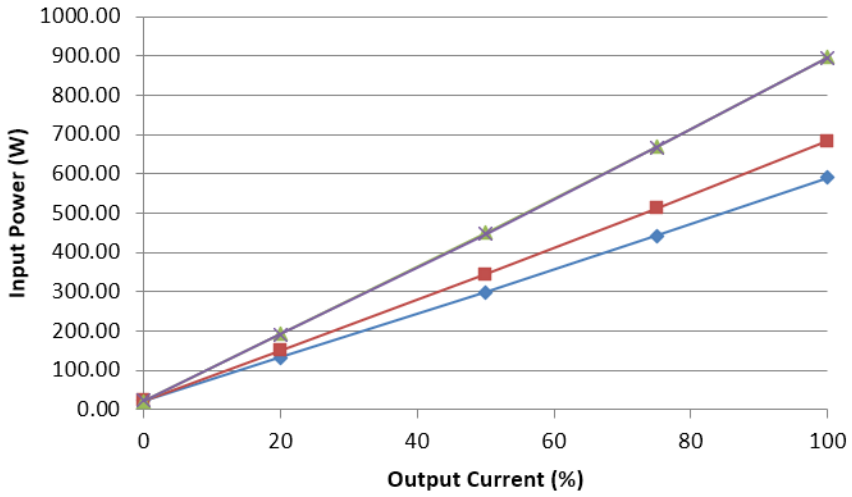


(4) Input power vs. Output current

Conditions: Vin : 85Vac
: 110Vac
: 230Vac
: 264Vac
Ta : 25°C

MU4FSDL-5SBS-12SBS-24SBS-48SBS

Vin	Input Power				
	Iout: 0%	Iout: 25%	Iout: 50%	Iout: 75%	Iout: 100%
85Vac	22.5W	132.5W	299.1W	443.0W	591.4W
115Vac	23.1W	151.1W	345.2W	512.4W	684.1W
230Vac	22.0W	192.2W	449.9W	668.7W	897.5W
264Vac	22.9W	191.6W	447.8W	666.6W	895.4W

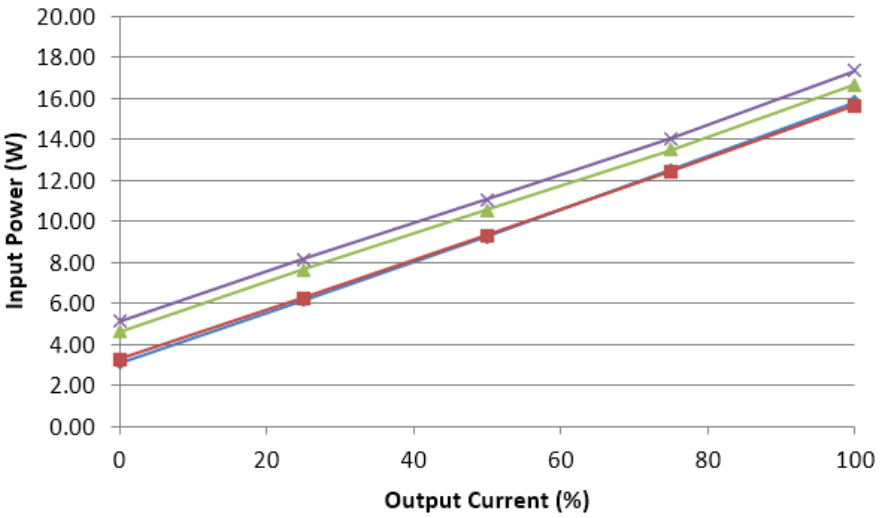


(5) Input power vs. Output current (Unit inhibited)

Conditions: Vin : 85Vac
: 115Vac
: 230Vac
: 264Vac
Ta : 25°C

MU4FSDL-T5H-5SBSL-12SBSL-24SBSL-48SBSL

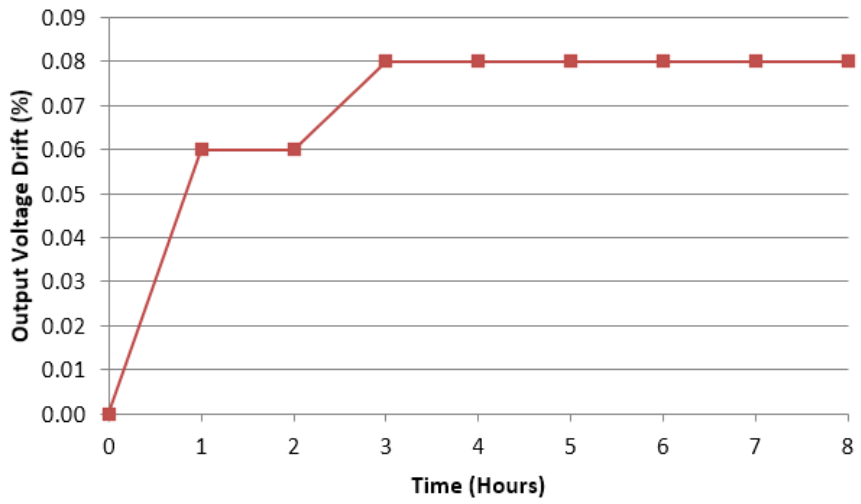
Vin	Input Power				
	Iout: 0%	Iout: 25%	Iout: 50%	Iout: 75%	Iout: 100%
85Vac	3.1W	6.1W	9.2W	12.5W	15.8W
115Vac	3.3W	6.3W	9.3W	12.4W	15.6W
230Vac	4.6W	7.6W	10.6W	13.5W	16.7W
264Vac	5.1W	8.1W	11.1W	14.0W	17.4W



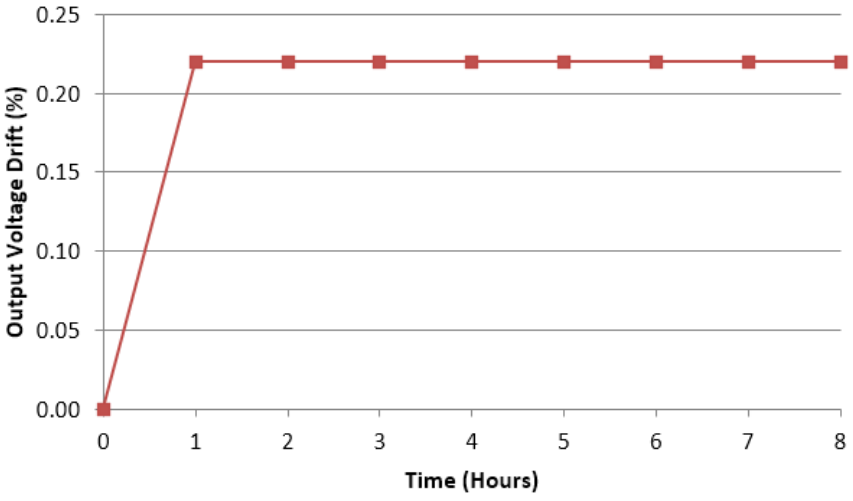
2.2 Warm up voltage drift characteristics

Conditions: Vin: 230Vac
Iout: 100%
Ta: 25°C

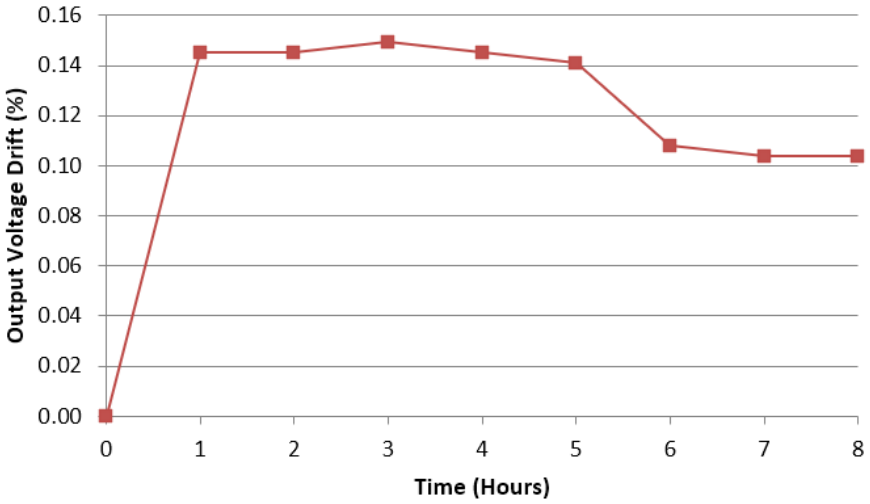
5V SBS Module



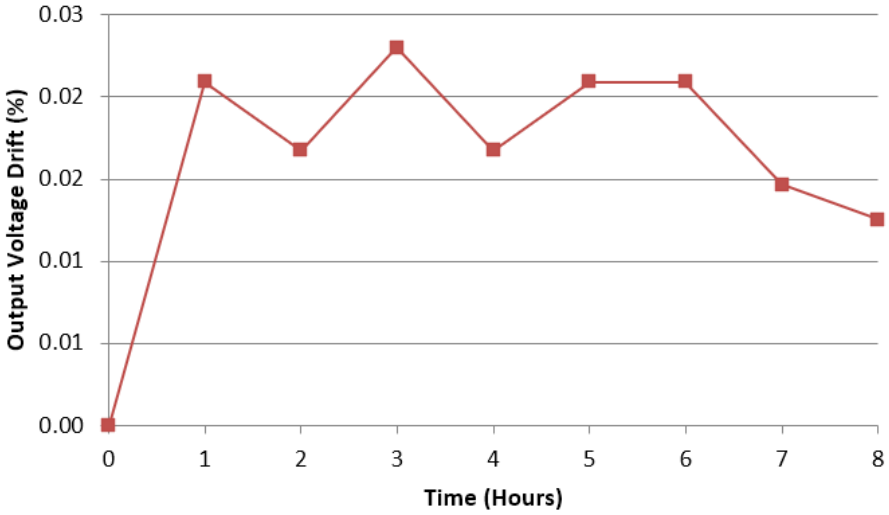
12V SBS Module



24V SBS Module



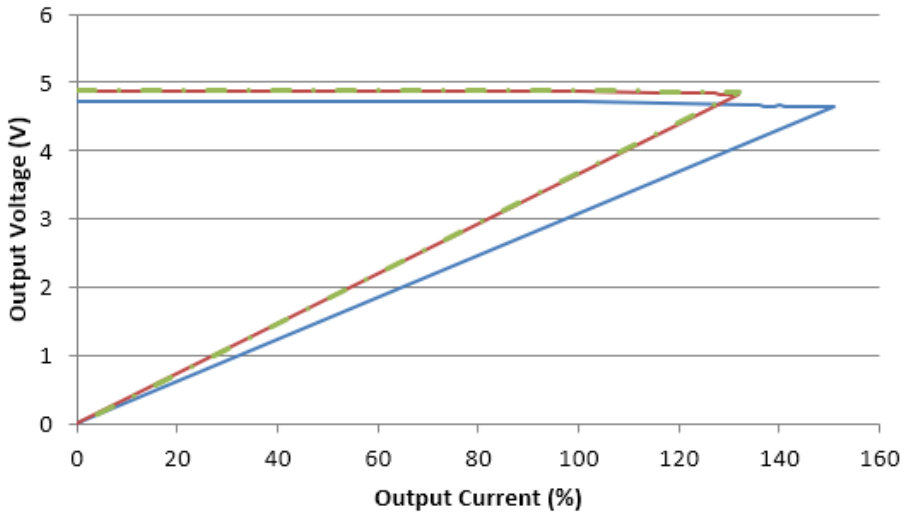
48V SBS Module



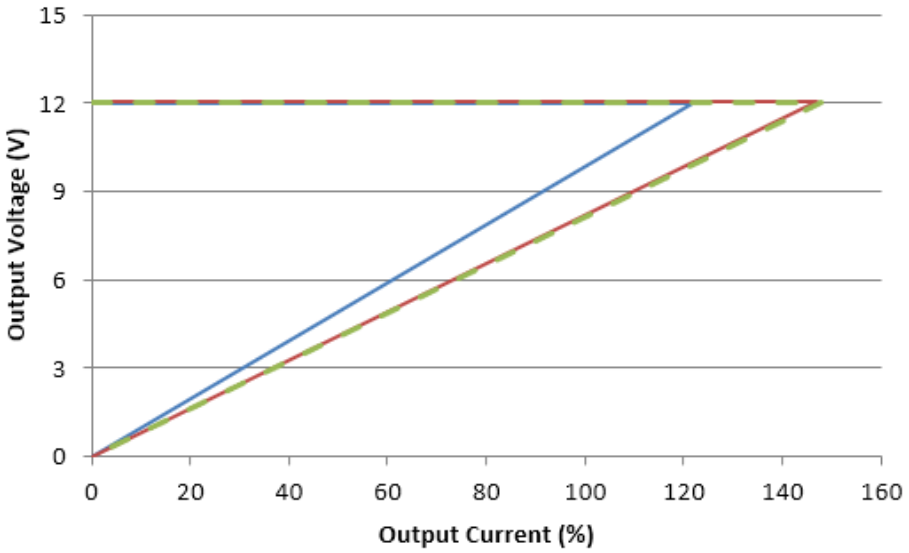
2.3 Over current protection (OCP) characteristics

Conditions: Vin: 110Vac
Ta: -30°C
25°C
60°C

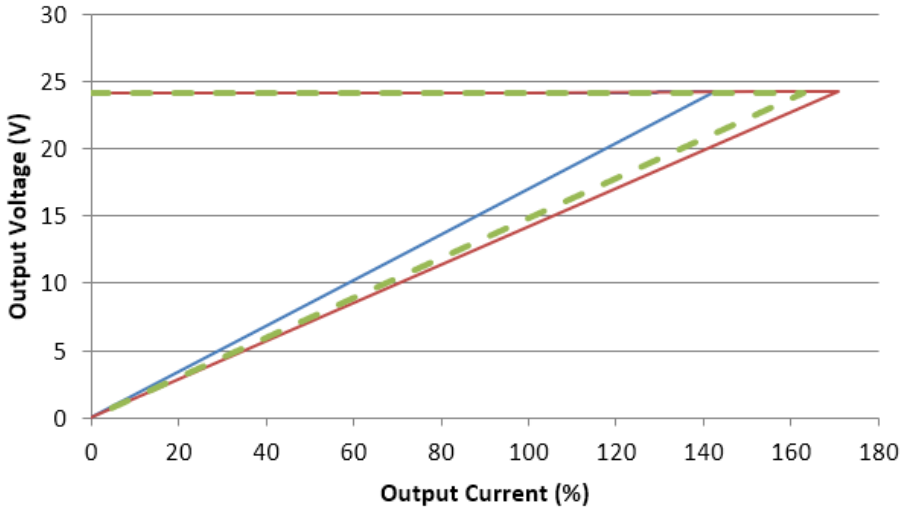
5V SBS Module



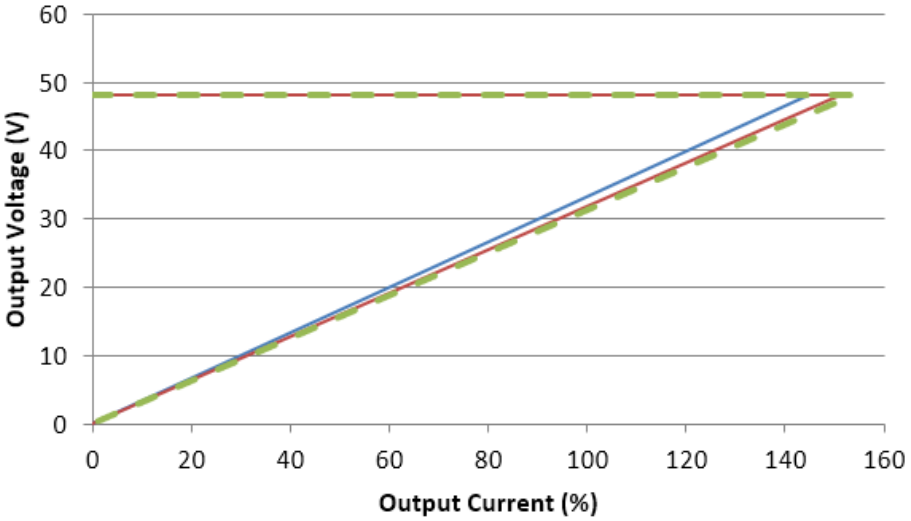
12V SBS Module



24V SBS Module



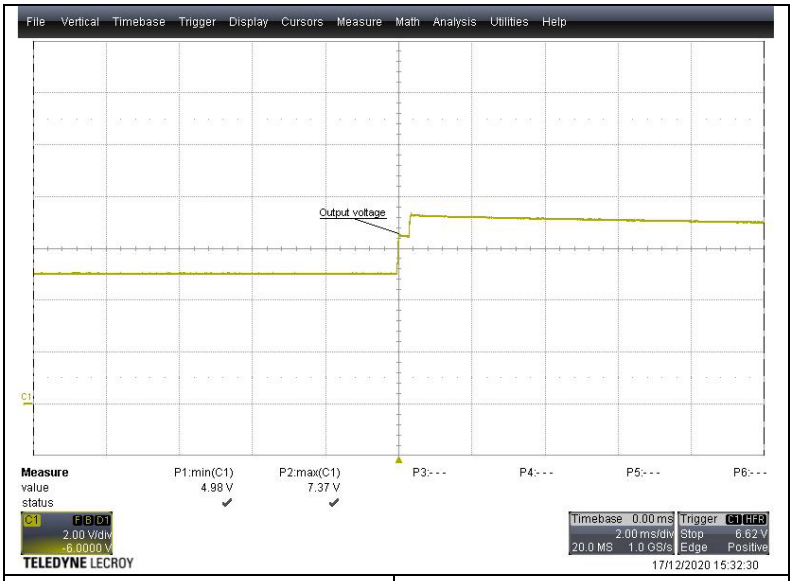
48V SBS Module



2.4 Over voltage protection (OVP) characteristics

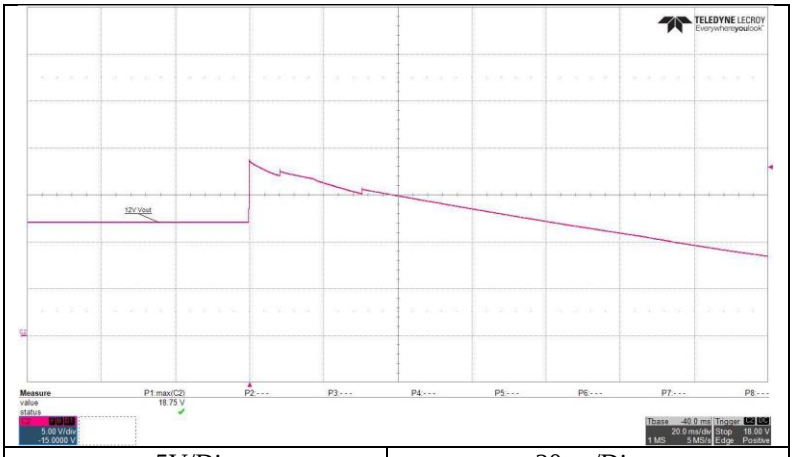
Conditions: Vin: 90Vac
Iout: 0%
Ta: 25°C

5V SBS Module



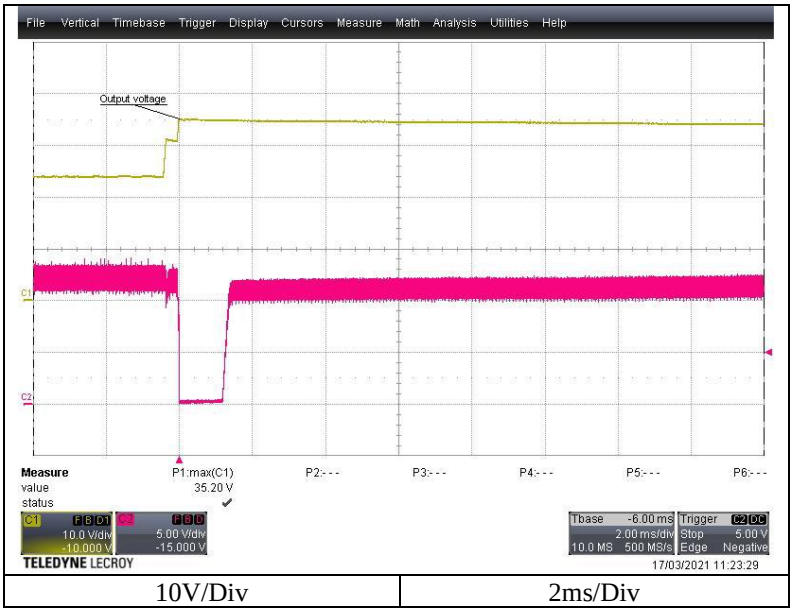
2V/Div	2ms/Div

12V SBS Module



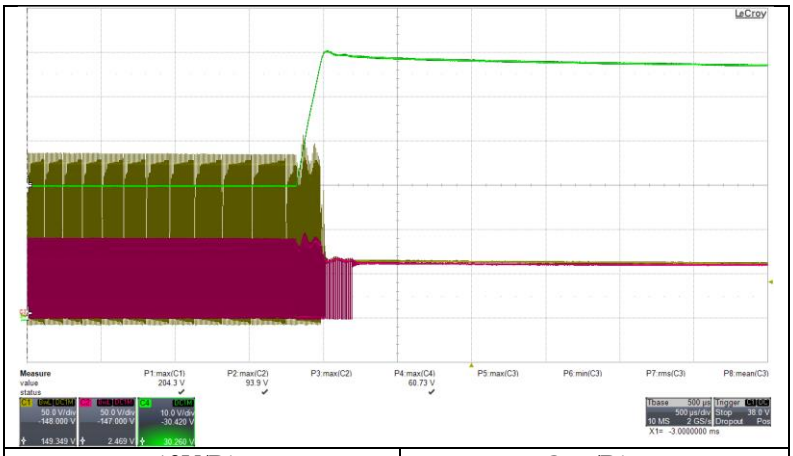
5V/Div	20ms/Div

24V SBS Module



10V/Div	2ms/Div

48V SBS Module

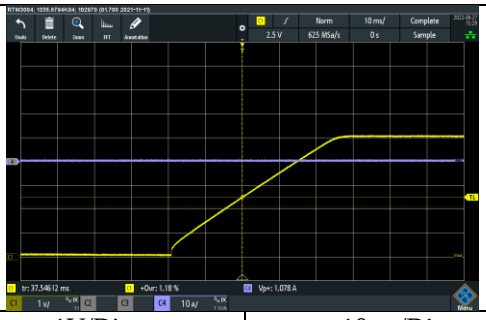
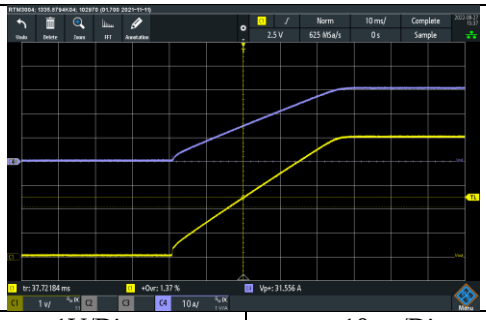
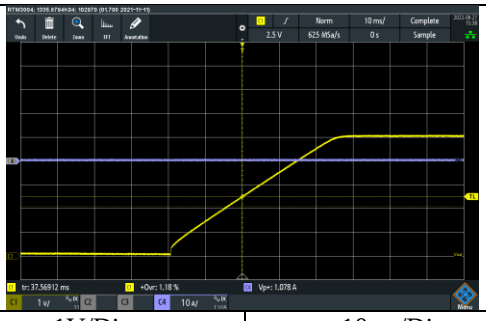
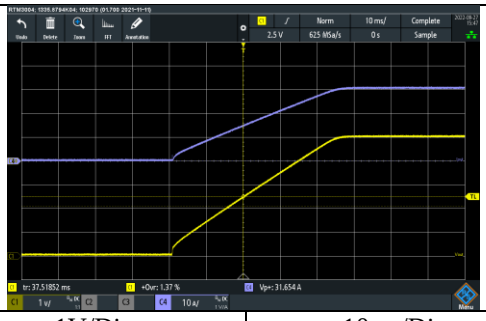
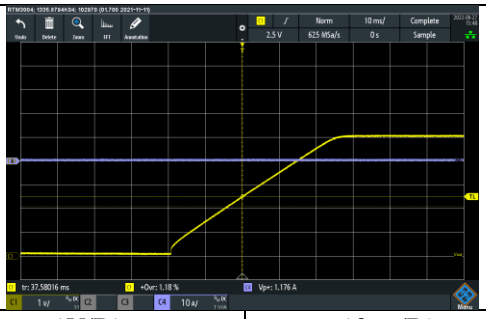
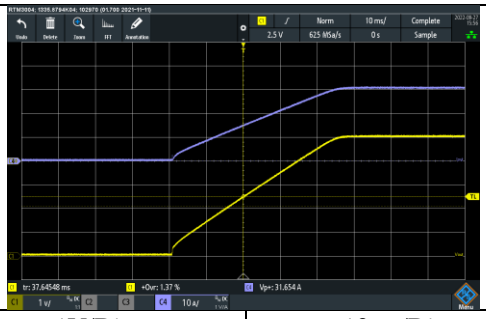
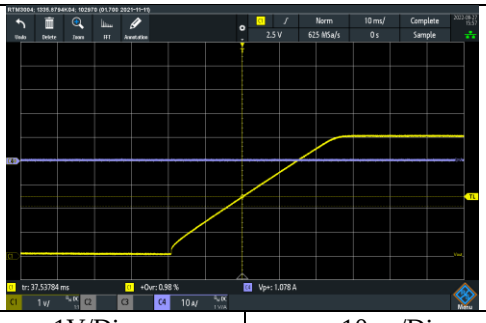


10V/Div	2ms/Div

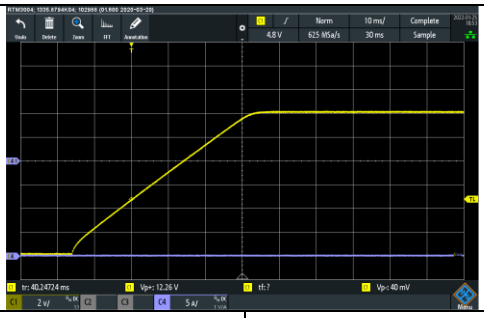
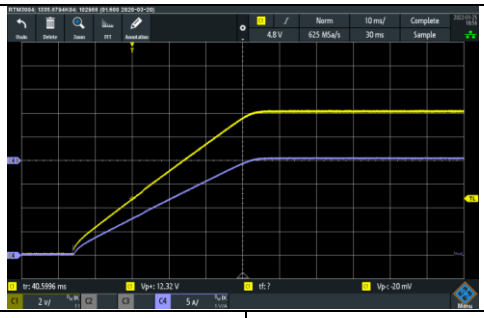
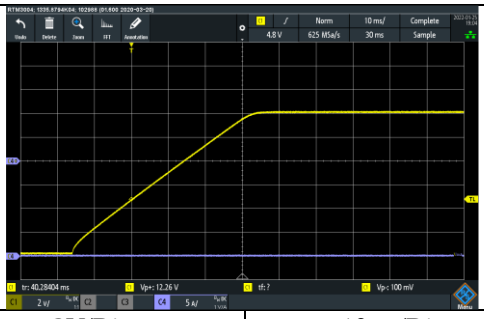
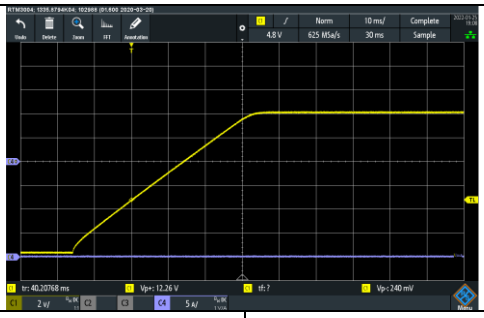
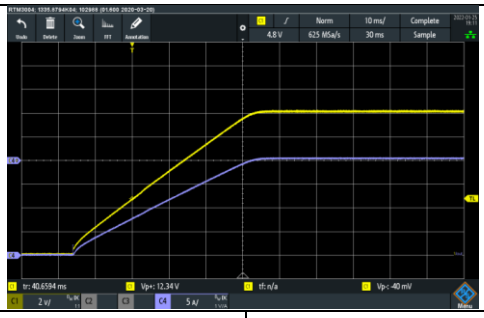
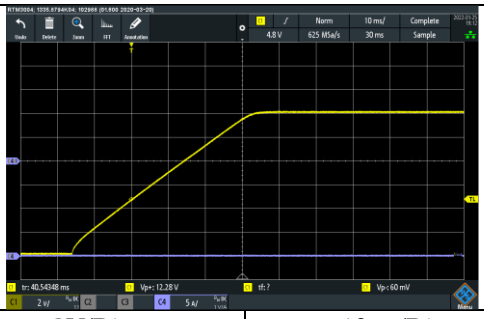
2.5 Output rise characteristics

Conditions: Vin: 85Vac
: 110Vac
: 230Vac
: 264Vac
Ta: 25°C
Iout: 0%
: 100%

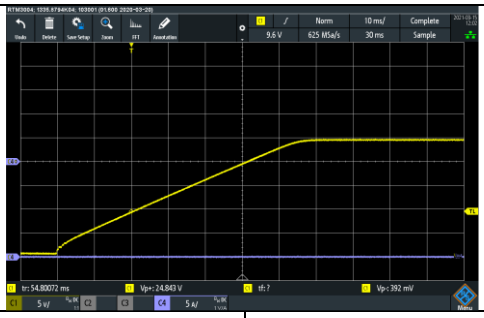
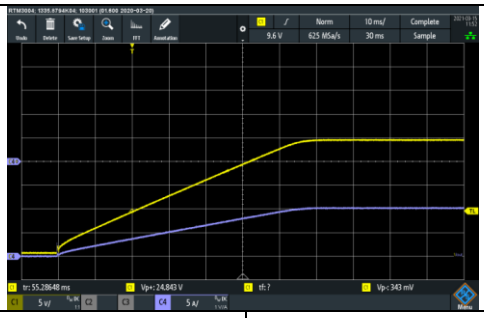
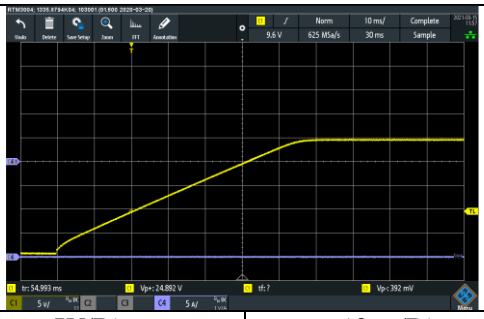
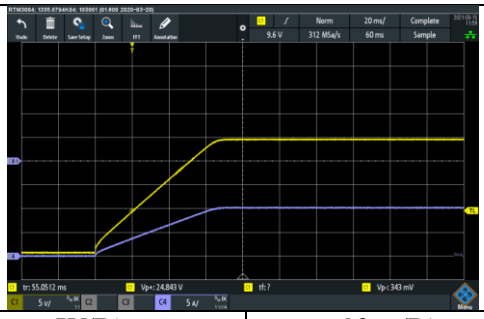
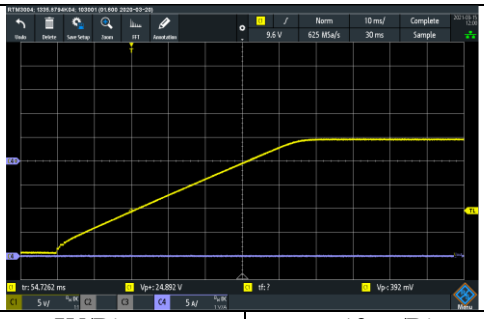
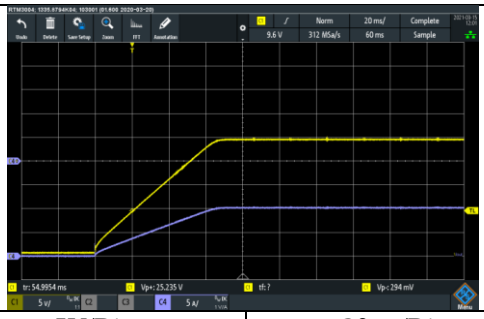
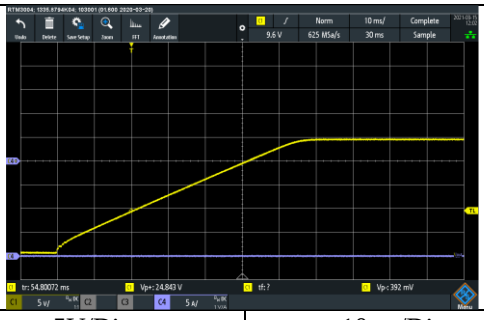
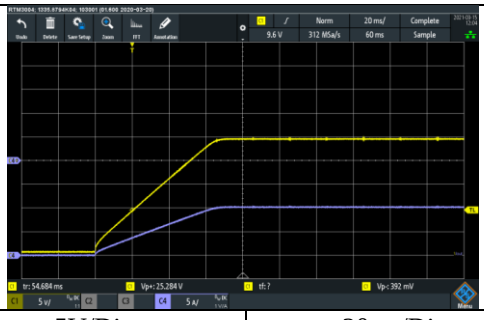
5V SBS Module

85V 0%		85V 100%	
			
1V/Div	10ms/Div	1V/Div	10ms/Div
110V 0%		110V 100%	
			
1V/Div	10ms/Div	1V/Div	10ms/Div
230V 0%		230V 100%	
			
1V/Div	10ms/Div	1V/Div	10ms/Div
264V 0%		264V 100%	
			
1V/Div	10ms/Div	1V/Div	10ms/Div

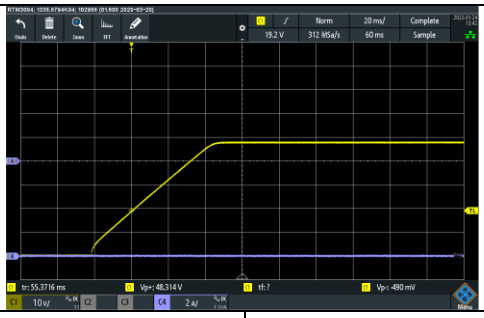
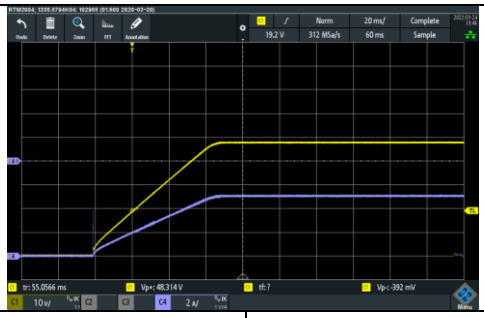
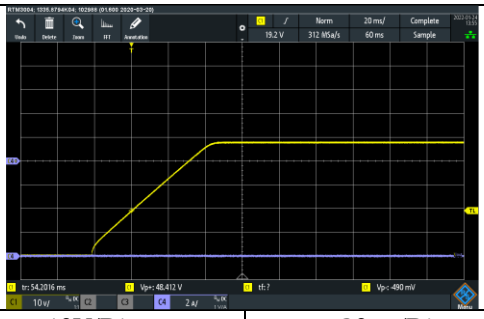
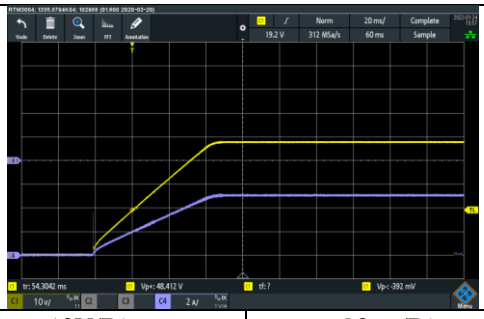
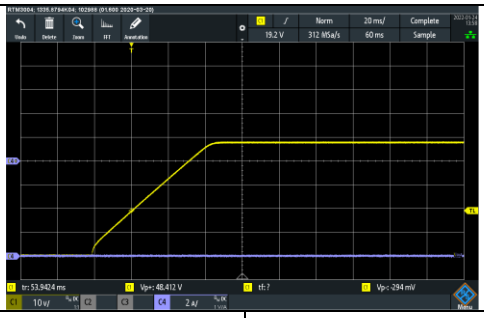
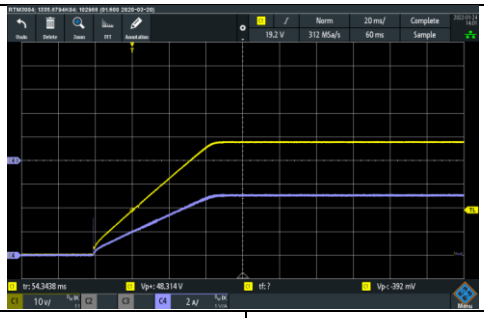
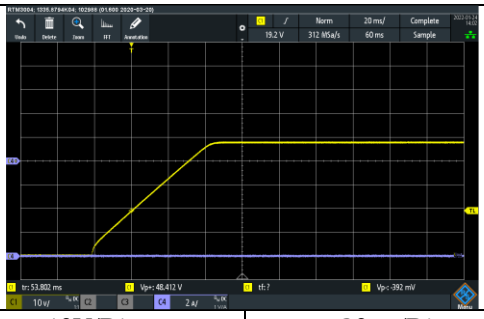
12V SBS Module

85V 0%		85V 100%	
			
2V/Div	10ms/Div	2V/Div	10ms/Div
110V 0%		110V 100%	
			
2V/Div	10ms/Div	2V/Div	10ms/Div
230V 0%		230V 100%	
			
2V/Div	10ms/Div	2V/Div	10ms/Div
264V 0%		264V 100%	
			
2V/Div	10ms/Div	2V/Div	10ms/Div

24V SBS Module

85V 0%		85V 100%	
			
5V/Div	10ms/Div	5V/Div	10ms/Div
110V 0%		110V 100%	
			
5V/Div	10ms/Div	5V/Div	20ms/Div
230V 0%		230V 100%	
			
5V/Div	10ms/Div	5V/Div	20ms/Div
264V 0%		264V 100%	
			
5V/Div	10ms/Div	5V/Div	20ms/Div

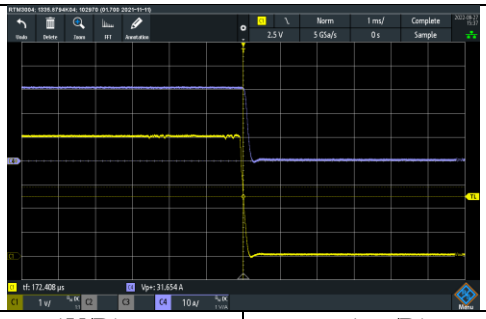
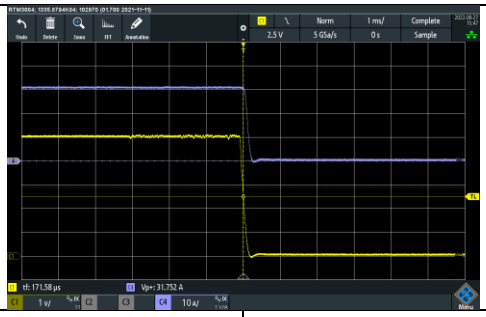
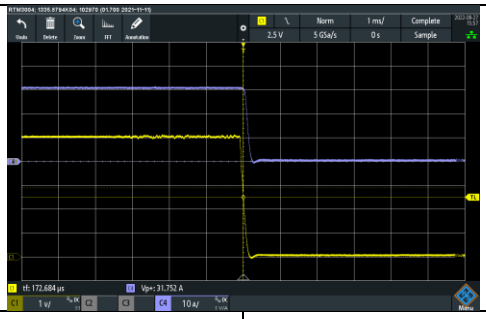
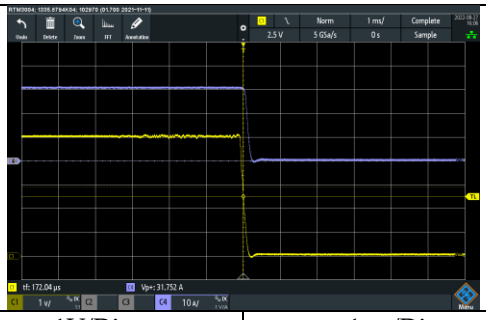
48SBS Module

85V 0%		85V 100%	
			
10V/Div	20ms/Div	10V/Div	20ms/Div
115V 0%		115V 100%	
			
10V/Div	20ms/Div	10V/Div	20ms/Div
230V 0%		230V 100%	
			
10V/Div	20ms/Div	10V/Div	20ms/Div
264V 0%		264V 100%	
			
10V/Div	20ms/Div	10V/Div	50ms/Div

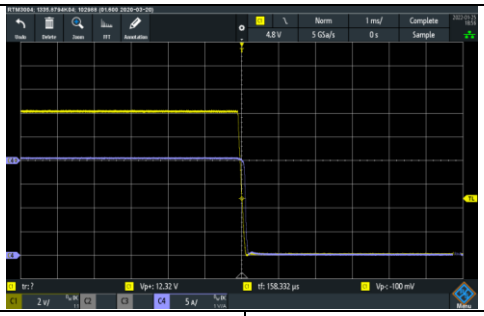
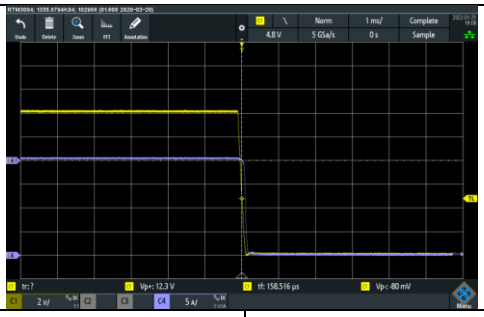
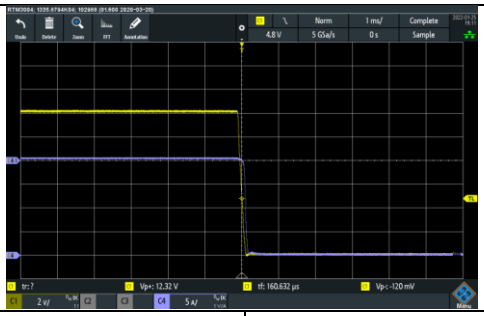
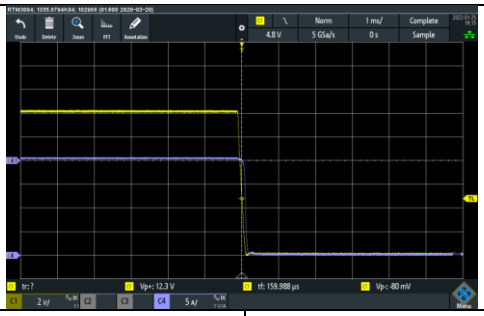
2.6 Output Fall Characteristics

Conditions: Vin: 85Vac
: 110Vac
: 230Vac
: 264Vac
Ta: 25°C
Iout: 100%

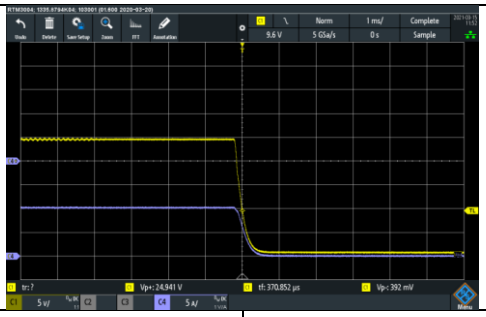
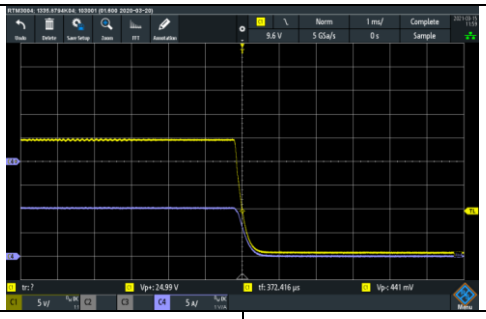
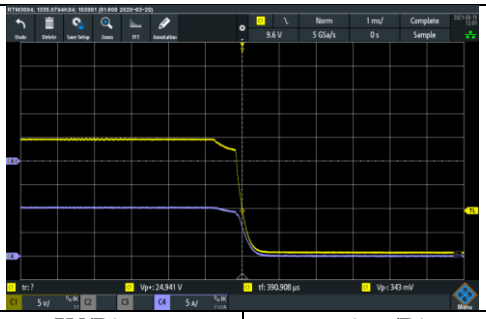
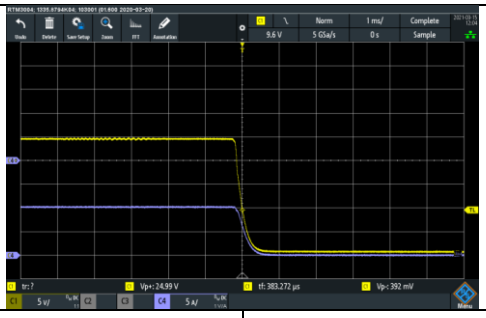
5V SBS Module

85V 100%	
	
1V/Div	1ms/Div
110V 100%	
	
1V/Div	1ms/Div
230V 100%	
	
1V/Div	1ms/Div
264V 100%	
	
1V/Div	1ms/Div

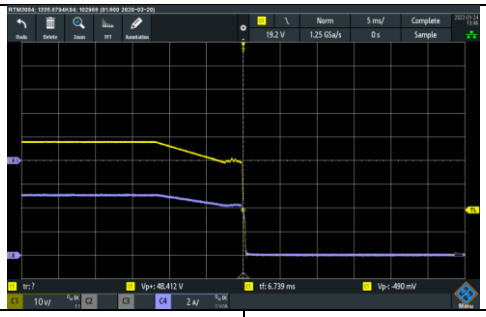
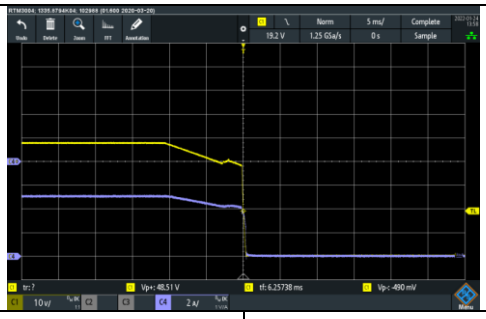
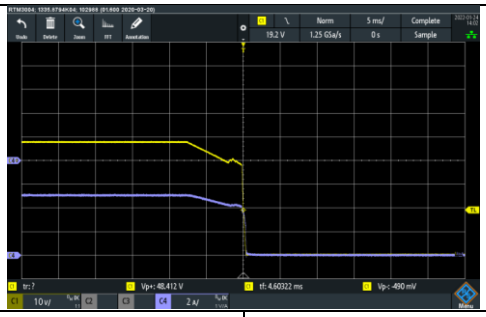
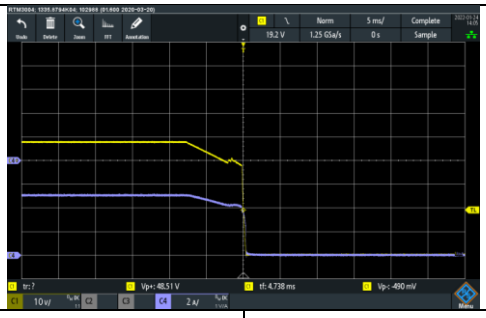
12V SBS Module Iout: 100%

85V 100%	
	
2V/Div	1ms/Div
110V 100%	
	
2V/Div	1ms/Div
230V 100%	
	
2V/Div	1ms/Div
264V 100%	
	
2V/Div	1ms/Div

24V SBS Module

85V 100%	
	
5V/Div	1ms/Div
110V 100%	
	
5V/Div	1ms/Div
230V 100%	
	
5V/Div	1ms/Div
264V 100%	
	
5V/Div	1ms/Div

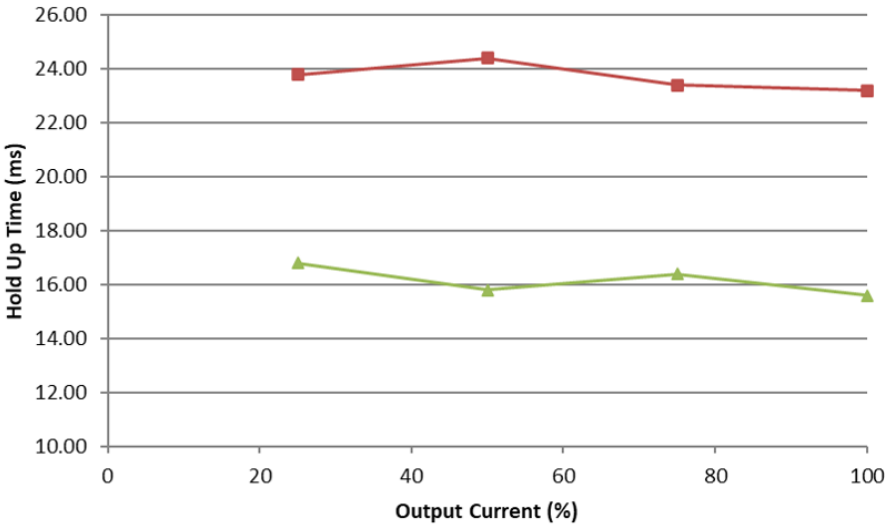
48SBS Module

85V 100%	
	
10V/Div	5ms/Div
115V 100%	
	
10V/Div	5ms/Div
230V 100%	
	
10V/Div	5ms/Div
264V 100%	
	
10V/Div	5ms/Div

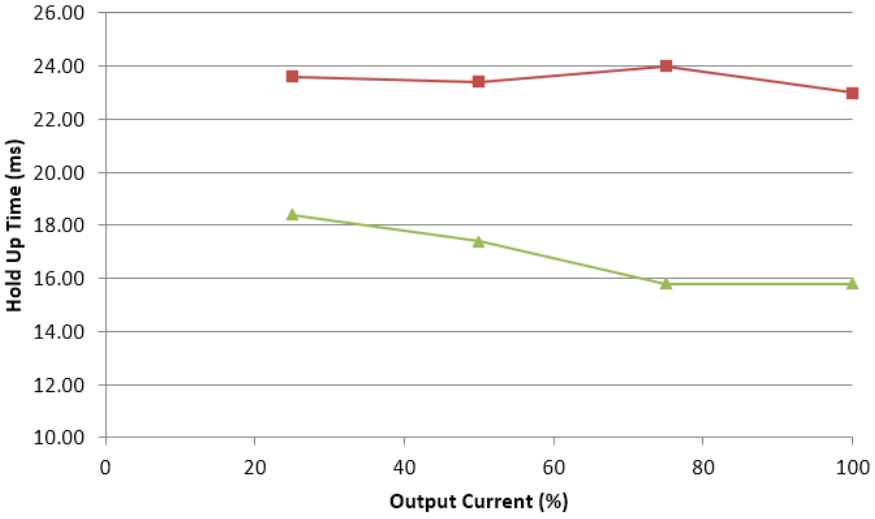
2.7 Hold up time characteristics

Conditions: Vin: 100Vac
: 264Vac
Ta: 25°C

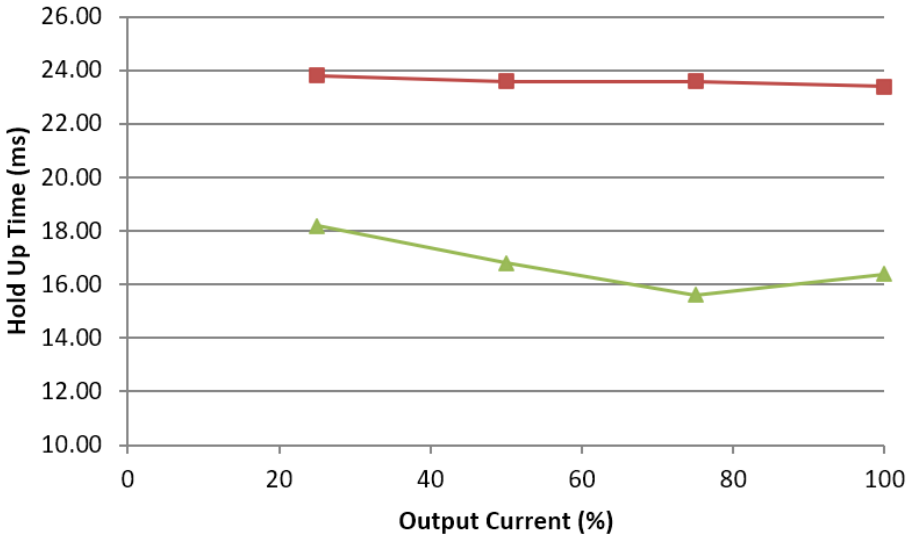
5V SBS Module



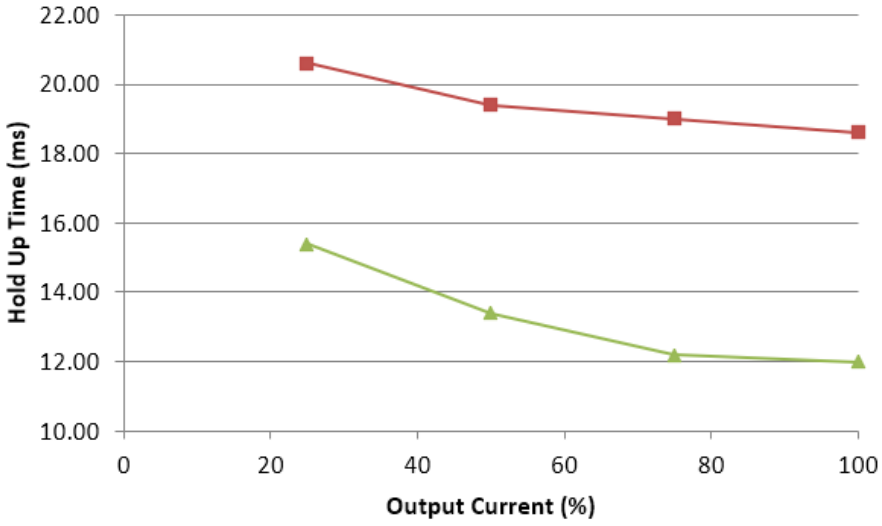
12V SBS Module



24V SBS Module



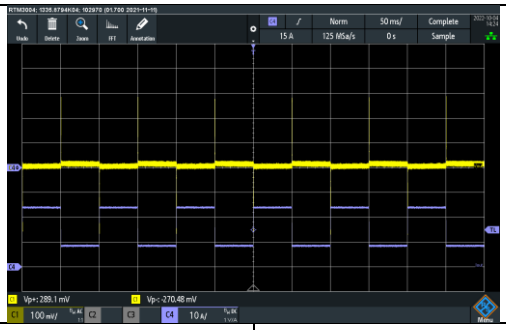
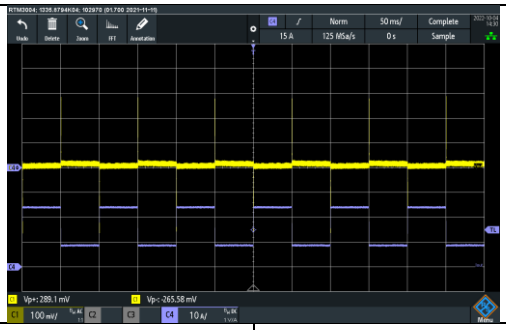
48SBS Module



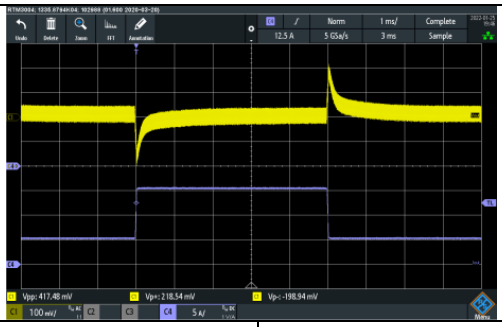
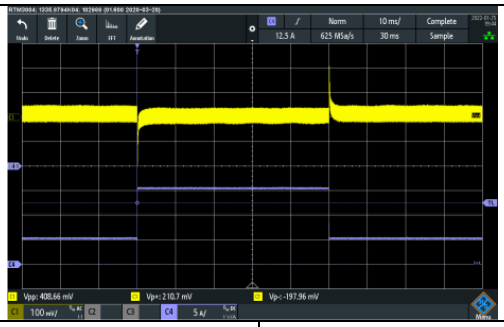
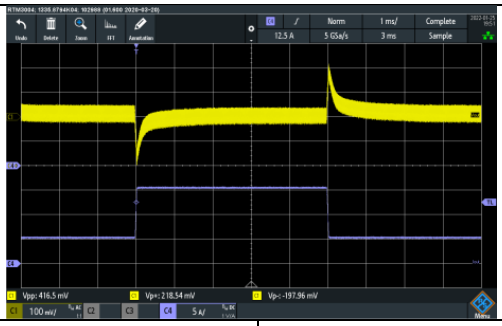
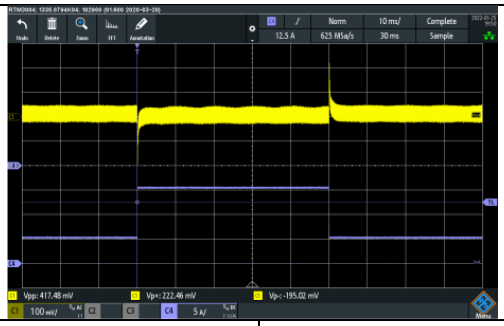
2.8 Dynamic load response characteristics

Conditions: Vin: 85Vac;
:264Vac
Ta: 25°C
Iout: 25%↔75%
(tr = tf = 50μS)
f :100Hz
:10Hz

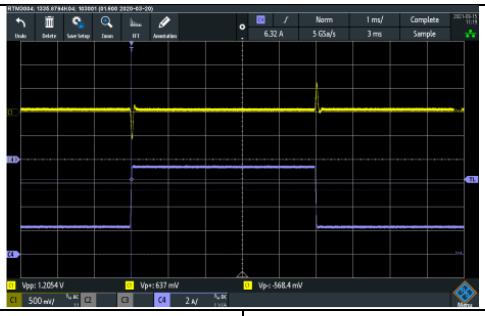
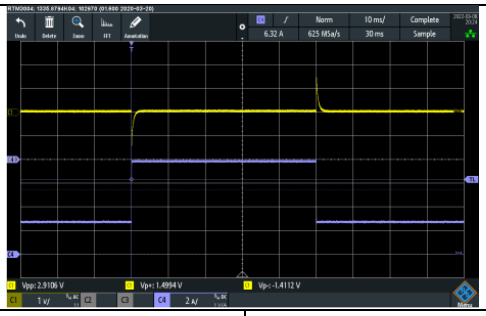
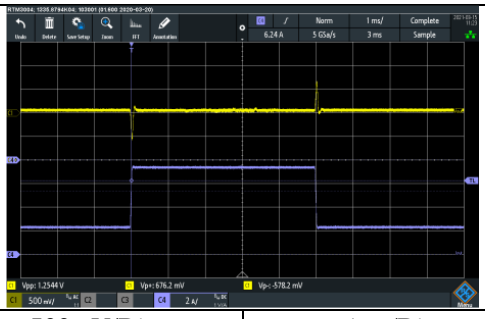
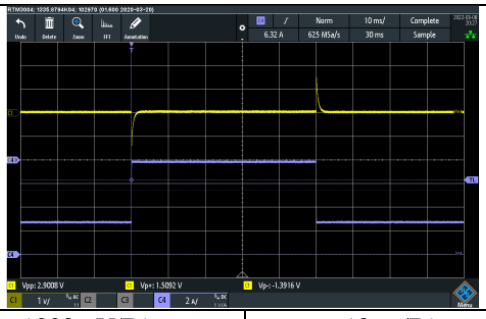
5V SBS Module

85V 100Hz		85V 10Hz	
			
100mV/Div	5ms/Div	100mV/Div	50ms/Div
+5.4% (deviation)	-5.8% (deviation)	+5.4% (deviation)	-5.8% (deviation)
264V 100Hz		264V 10Hz	
			
100mV/Div	50ms/Div	100mV/Div	50ms/Div
+5.3% (deviation)	-5.9% (deviation)	+5.3% (deviation)	-5.8% (deviation)

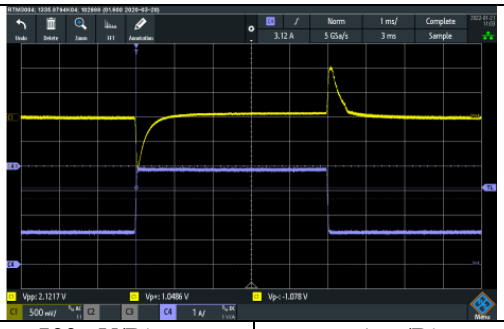
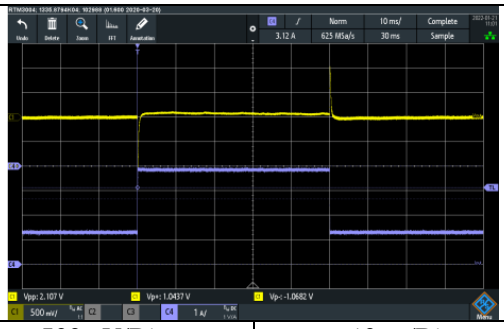
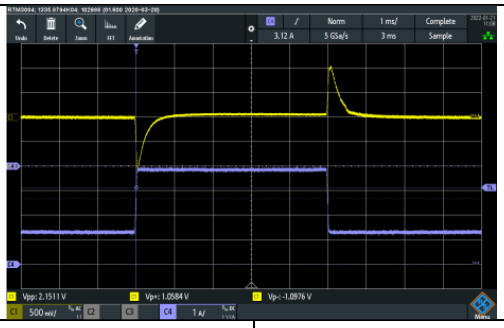
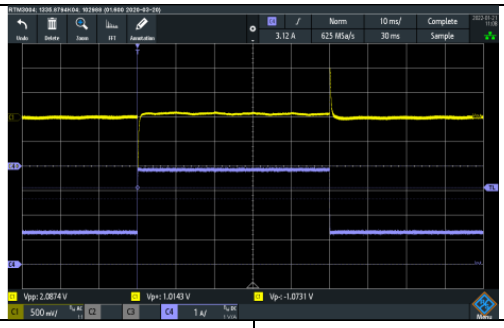
12V SBS Module

85V 100Hz		85V 10Hz	
			
100mV/Div	1ms/Div	100mV/Div	10ms/Div
+1.82% (deviation)	-1.66% (deviation)	+1.76% (deviation)	-1.65% (deviation)
264V 100Hz		264V 10Hz	
			
100mV/Div	1ms/Div	100mV/Div	10ms/Div
+1.82% (deviation)	-1.65% (deviation)	+1.85% (deviation)	-1.63% (deviation)

24V SBS Module

85V 100Hz		85V 10Hz	
			
500mV/Div	1ms/Div	1000mV/Div	10ms/Div
+2.65% (deviation)	-2.37% (deviation)	+6.25% (deviation)	-5.82% (deviation)
264V 100Hz		264V 10Hz	
			
500mV/Div	1ms/Div	1000mV/Div	10ms/Div
+2.82% (deviation)	-24.1% (deviation)	+6.29% (deviation)	-5.80% (deviation)

48SBS Module

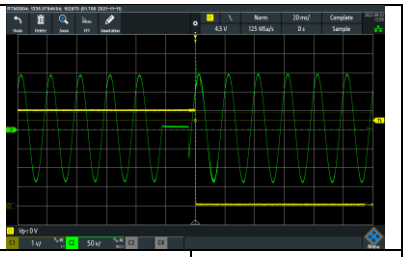
85V 100Hz		85V 10Hz	
			
500mV/Div	1ms/Div	500mV/Div	10ms/Div
+2.18% (deviation)	-2.25% (deviation)	+2.17% (deviation)	-2.22% (deviation)
264V 100Hz		264V 10Hz	
			
500mV/Div	1ms/Div	500mV/Div	10ms/Div
+2.21% (deviation)	-2.29% (deviation)	+2.11% (deviation)	-2.24% (deviation)

2.9 Response to brownout characteristics

Conditions: Vin: 110Vac
Iout: 100%
Ta: 25°C

5V SBS Module

Performance parameters: A - The shortest interruption time for the output to drop below the regulation band
B – The interruption time for the output to drop down to 20 – 40 % of nominal
C – The interruption time for the output to drop down to <20% of nominal

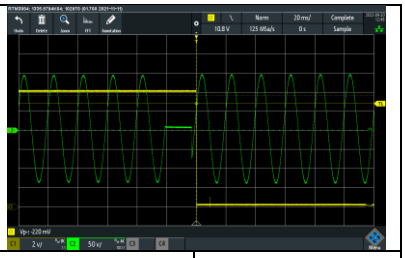
Not witnessed at this resolution		Not witnessed at this resolution			
V/DIV	mS/Div	V/DIV	mS/Div	1V/DIV	20mS/Div
A		B		C	

Conditions: Vin: 230Vac
Iout: 100%
Ta: 25°C

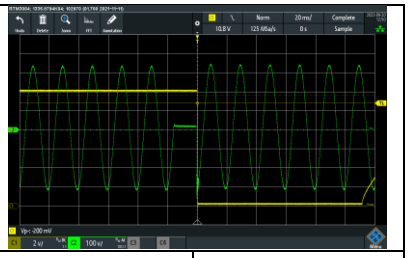
Not witnessed at this resolution		Not witnessed at this resolution			
V/DIV	mS/Div	V/DIV	mS/DIV	1V/DIV	20mS/Div
A		B		C	

Conditions: Vin: 230Vac
Iout: 100%
Ta: 25°C

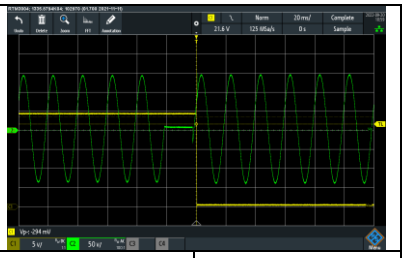
12V SBS Module

Not witnessed at this resolution		Not witnessed at this resolution			
V/DIV	mS/Div	V/DIV	mS/Div	2V/DIV	20mS/Div
A		B		C	

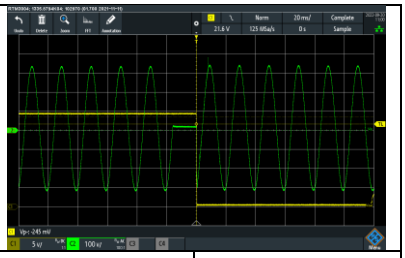
Conditions: Vin: 230Vac
Iout: 100%
Ta: 25°C

Not witnessed at this resolution		Not witnessed at this resolution			
V/DIV	mS/Div	V/DIV	mS/Div	2V/DIV	20mS/Div
A		B		C	

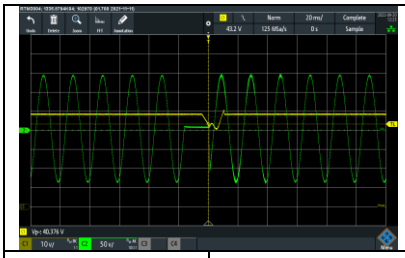
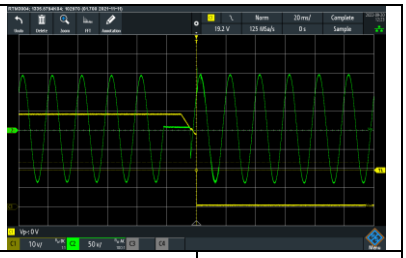
24V SBS Module

Not witnessed at this resolution		Not witnessed at this resolution			
V/DIV	mS/Div	V/DIV	mS/Div	5V/DIV	20mS/Div
A		B		C	

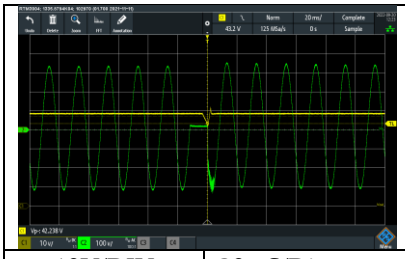
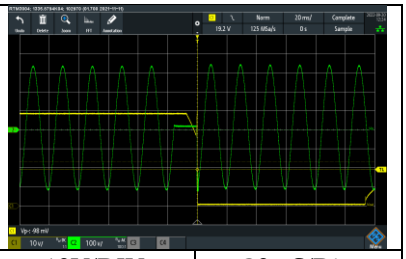
Conditions: Vin: 230Vac
Iout: 100%
Ta: 25°C

Not witnessed at this resolution		Not witnessed at this resolution			
V/DIV	mS/Div	V/DIV	mS/Div	5V/DIV	20mS/Div
A		B		C	

48SBS Module

		Not witnessed at this resolution			
10V/DIV	20mS/Div	V/DIV	mS/Div	10V/DIV	20mS/Div
A		B		C	

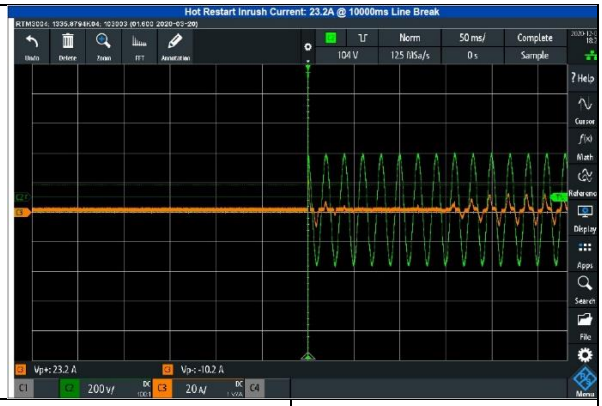
Conditions: Vin: 230Vac
Iout: 100%
Ta: 25°C

		Not witnessed at this resolution			
10V/DIV	20mS/Div	V/DIV	mS/Div	10V/DIV	20mS/Div
A		B		C	

2.10 Inrush Current Waveform

Conditions: Vin: 264Vac
Iout: 100%
Ta: 25°C

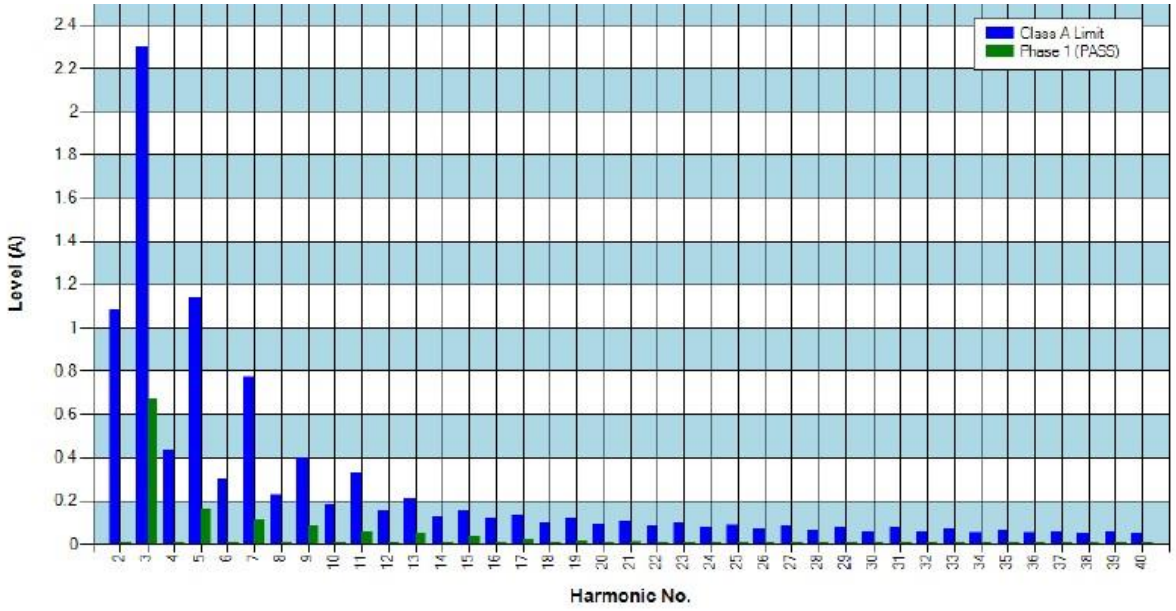
MU4FSDL-5V-12V-24V-48V

<table>
<tr><td colspan="2"> 
</td><td colspan="2"> 
</td></tr>
<tr><td>20A/Div</td><td>5ms/Div</td><td>20A/Div</td><td>50ms/Div</td></tr>
<tr><td colspan="2">Switch on phase angle 0°</td><td colspan="2">Switch on phase angle 90°</td></tr>
</table>

2.11 Input current harmonics

Conditions: Vin: 110Vac
Iout: 100%
Ta: 25°C

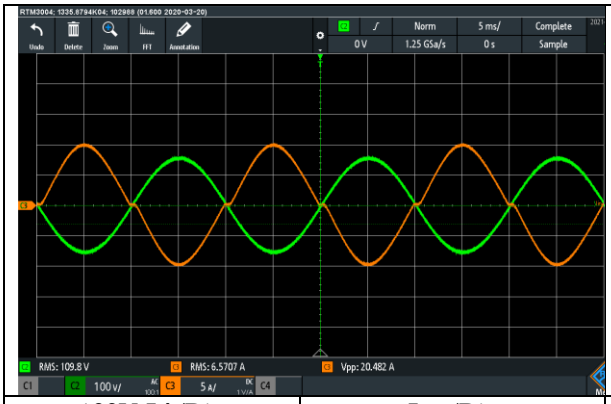
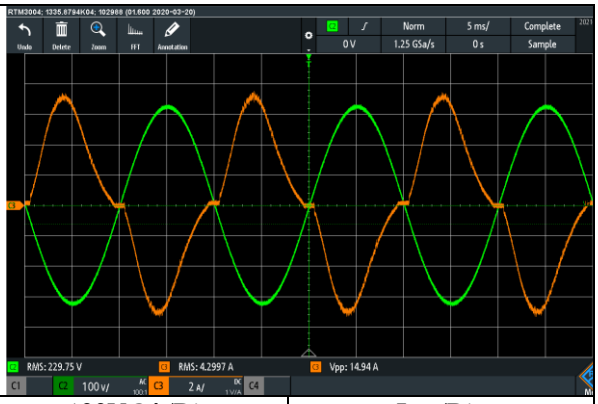
MU4FSDL-T5H-5SBSJ-12SBSJ-24SBSJ-48SBSJ



2.12 Input current waveform

Conditions: Iout: 100%
Ta: 25°C

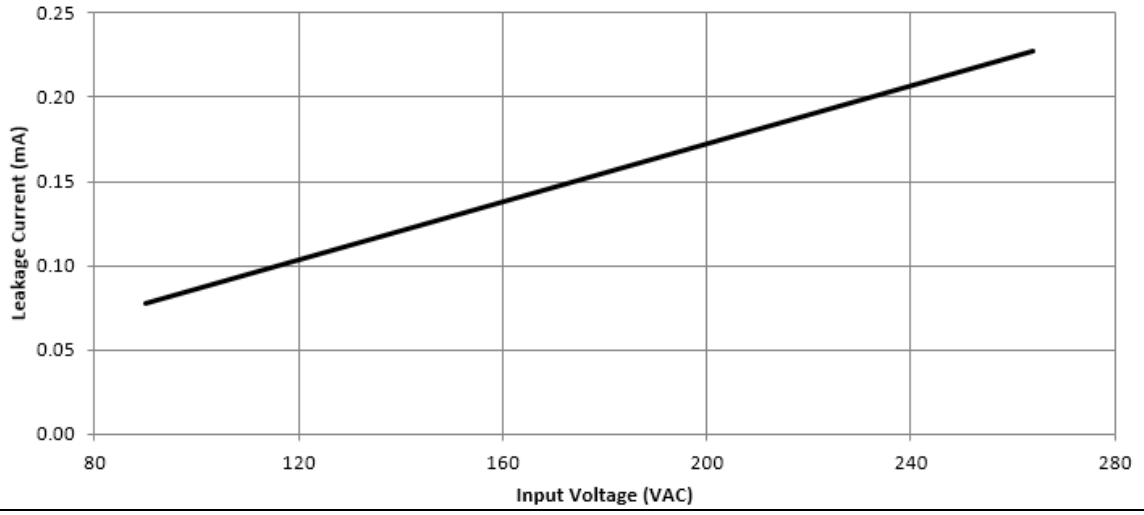
MU4FSDL-Q5H-5SBSJ-12SBSJ-24SBSJ-48SBSJ

<table>
<tr><td colspan="2">  </td><td colspan="2">  </td></tr>
<tr><td>100V 5A/Div</td><td>5ms/Div</td><td>100V 2A/Div</td><td>5ms/Div</td></tr>
<tr><td colspan="2">Vin: 110V</td><td colspan="2">Vin: 230V</td></tr>
</table>

2.13 Leakage current characteristics

Conditions : Iout: 100%
Ta: 25°C

MU4FSDL-5SBS-12SBS-24SBS-48SBS

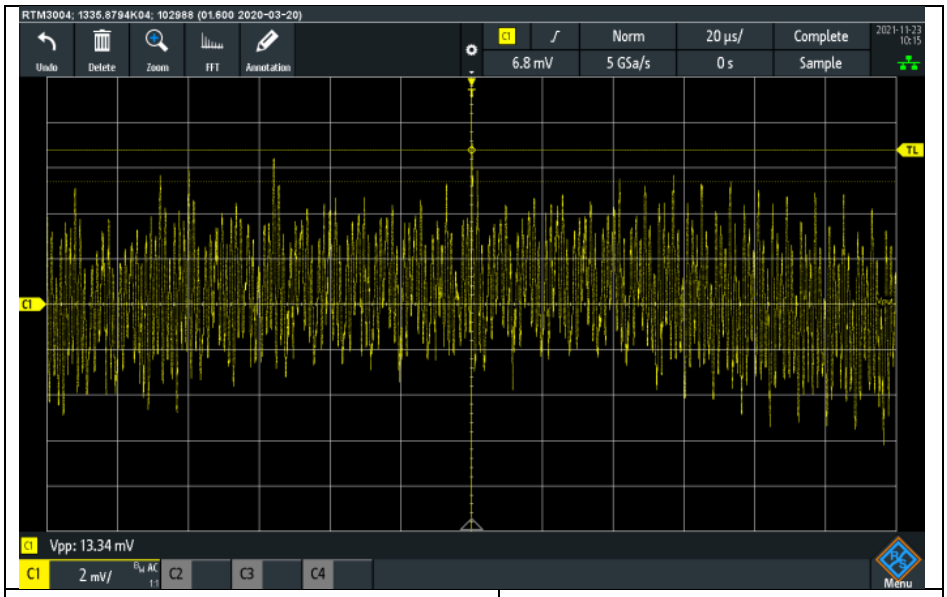


Frequency: 63Hz

2.14 Output ripple and noise waveform

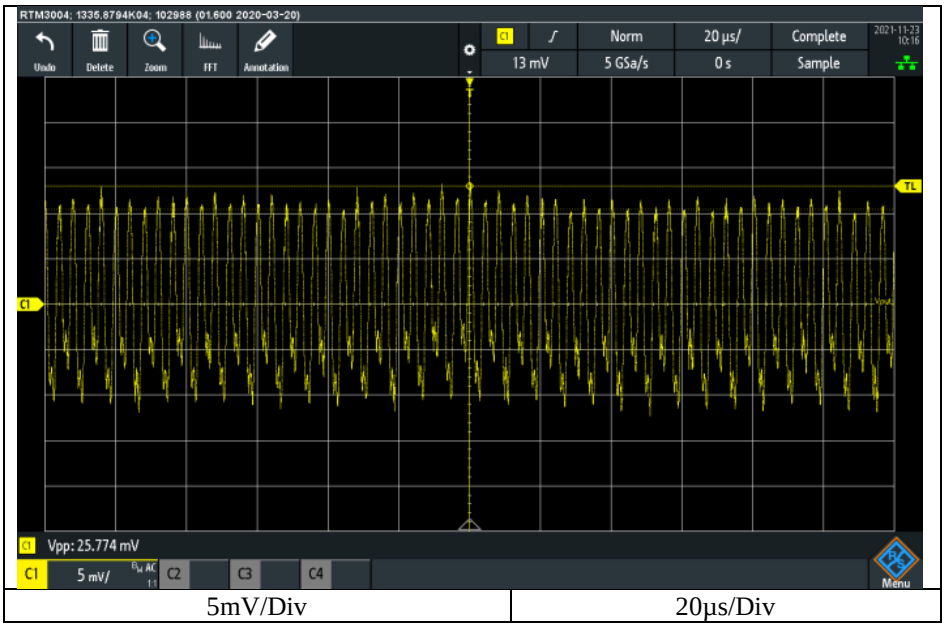
Conditions: Vin: 100Vac
Iout: 0%
Ta: 25°C

5V SBS Module



2mV/Div	20µs/Div

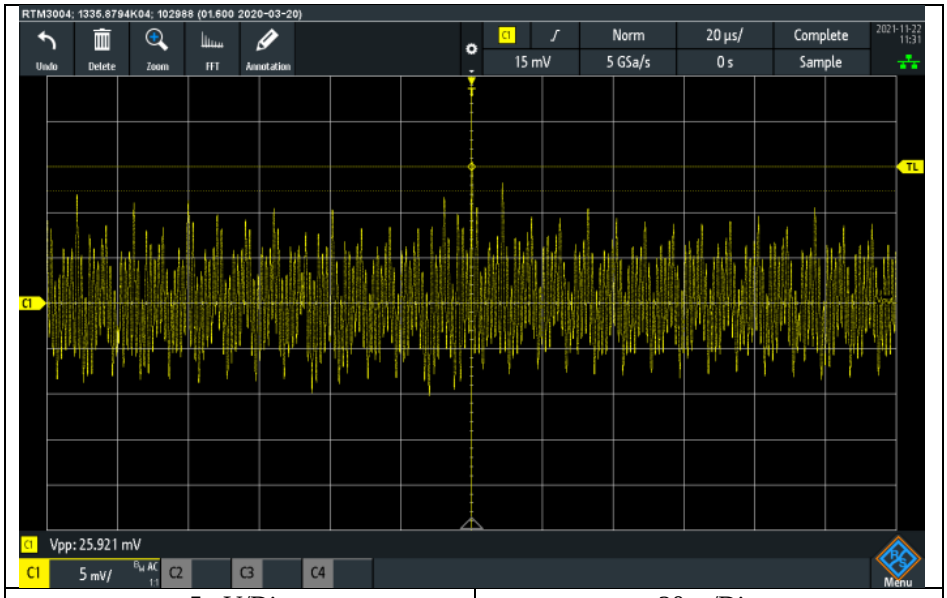
Conditions: Vin: 100Vac
Iout: 100%
Ta: 25°C



5mV/Div	20µs/Div

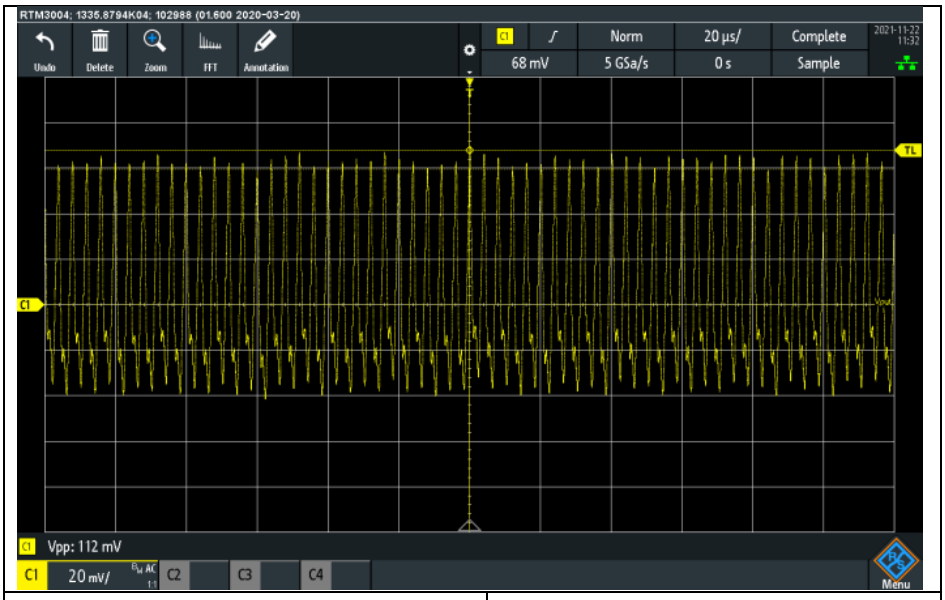
Conditions: Vin: 100Vac
Iout: 0%
Ta: 25°C

12V SBS Module



5mV/Div	20µs/Div

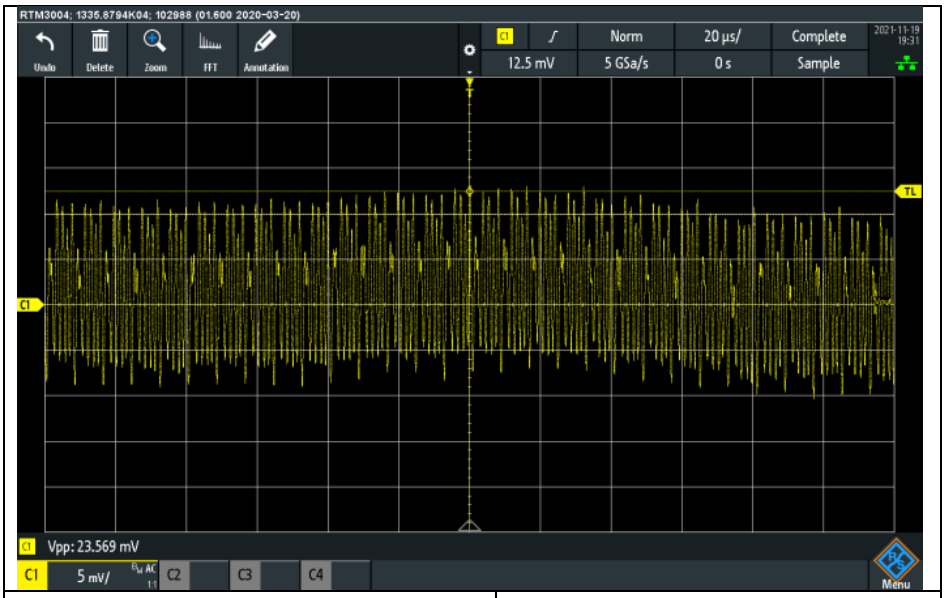
Conditions: Vin: 100Vac
Iout: 100%
Ta: 25°C



20mV/Div	20µs/Div

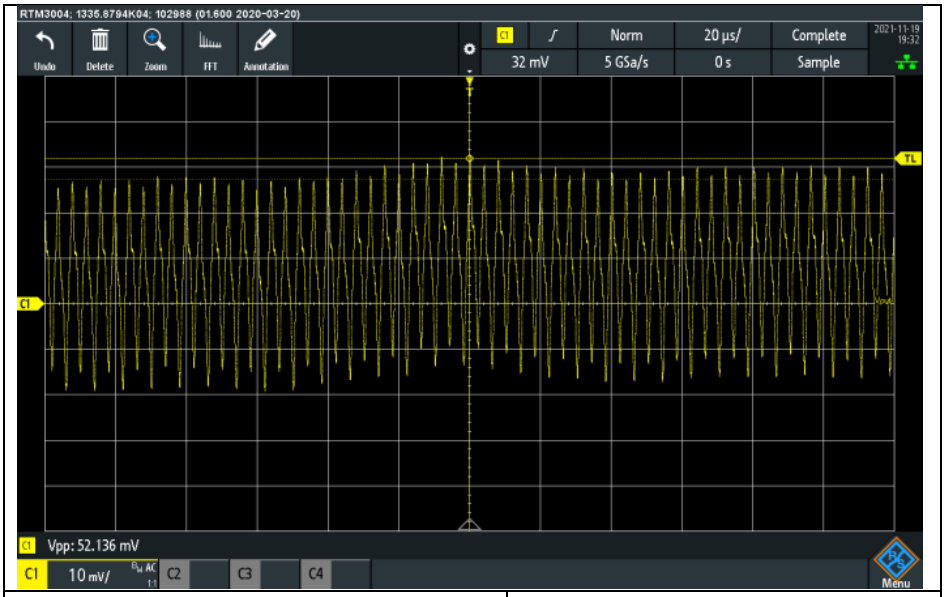
Conditions: Vin: 100Vac
Iout: 0%
Ta: 25°C

24V SBS Module



5mV/Div	20µs/Div

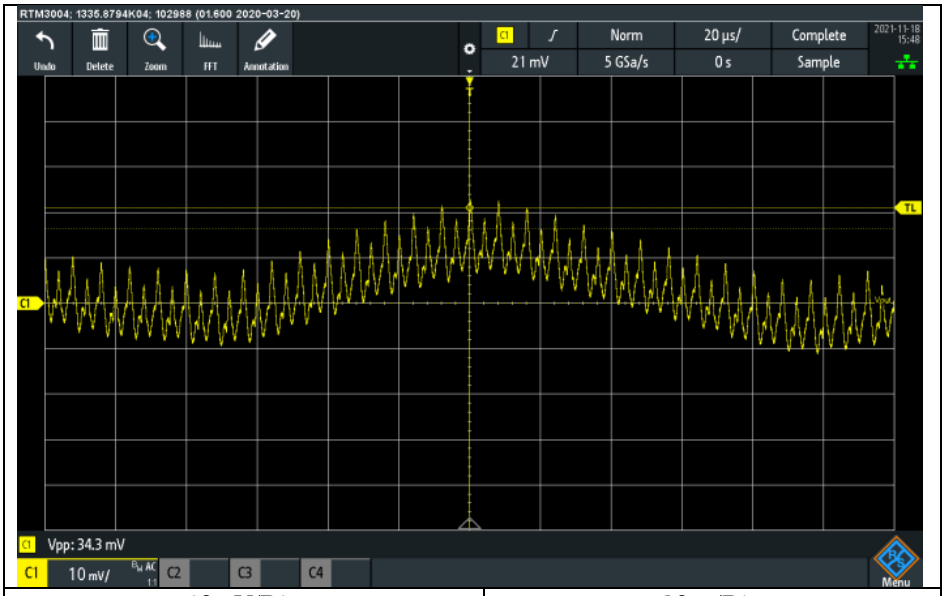
Conditions: Vin: 100Vac
Iout: 100%
Ta: 25°C



10mV/Div	20µs/Div

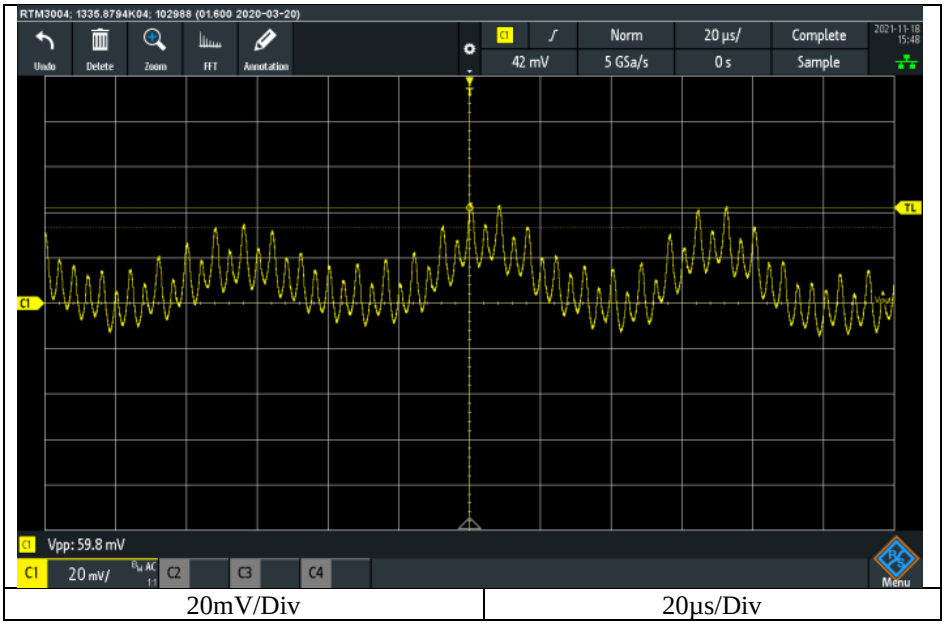
Conditions: Vin: 100Vac
Iout: 0%
Ta: 25°C

48SBS Module



10mV/Div	20µs/Div

Conditions: Vin: 100Vac
Iout: 100%
Ta: 25°C



20mV/Div	20µs/Div

2.15 Electro-Magnetic Interference characteristics

Conducted Emissions

Conditions: Vin: 230Vac
Iout: 100%
Ta: 25°C
QP Limit:
AVE Limit:

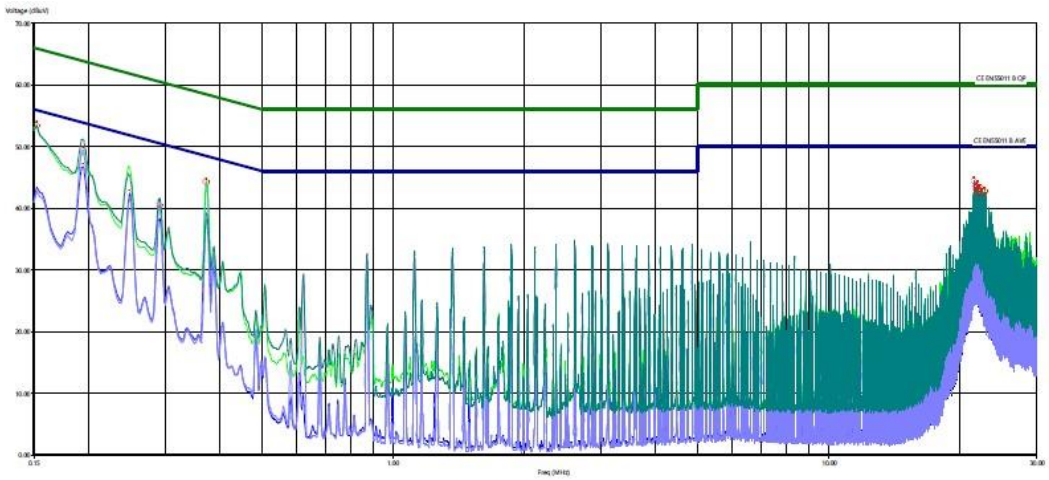
MU4FSDL-Q5H-5SBSL-12SBSL-24SBSL-48SBSL

Live

Point A (0.37MHz)		
Ref Data	Limit (dbµV)	Measure (dBµV)
QP	58.44	39.25
AVE	48.44	38.15

Neutral

Point B (0.37MHz)		
Ref Data	Limit (dBµV)	Measure (dBµV)
QP	58.44	44.40
AVE	48.44	44.13



2.16 Electro-Magnetic Interference characteristics

Radiated Emissions

Conditions: Vin: 230Vac
Iout: 100%
Ta: 25°C
Horizontal:
Vertical:

MU4FSDL-Q5H-5SBSL-12SBSL-24SBSL-48SBSL

Point A (219MHz)		
Ref Data	Limit (dBµV)	Measure (dBµV)
QP	40	31.04