iWatt

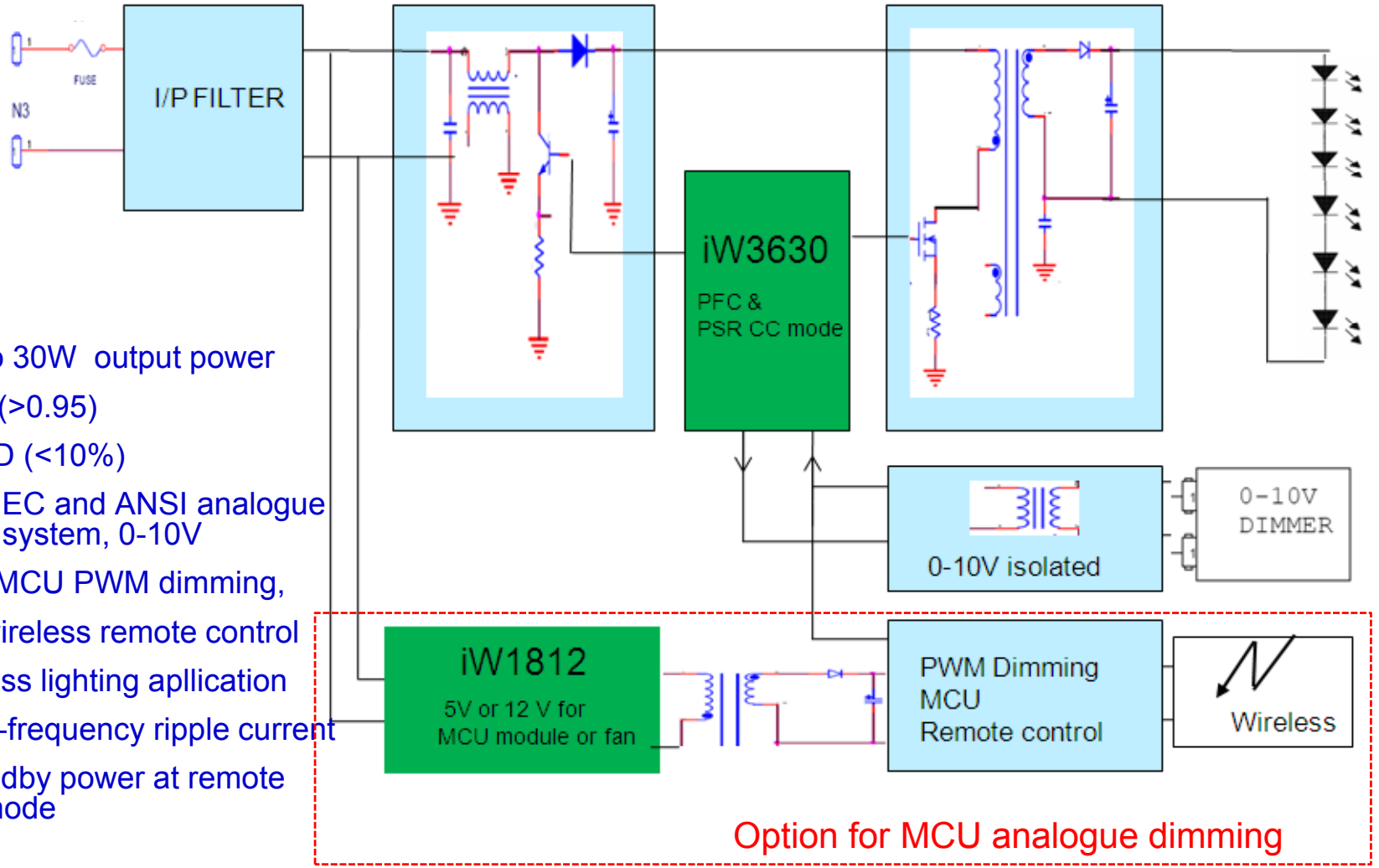
Power Management Simplified Digitally™

iW3630

High Performance 2-Stages AC/DC LED Drivers

Solutions for 0-10V or wireless dimmable LED light
Application for Par lamp & Tube light & Panel light & Down light
High performance on harmonic and flicker less lighting quality

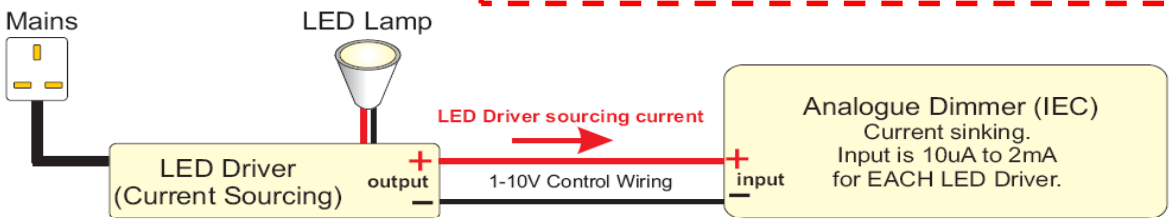
System block and feature



- Upper to 30W output power
- High PF (>0.95)
  Low THD (<10%)
- Support IEC and ANSI analogue dimming system, 0-10V
- Support MCU PWM dimming,
  enable wireless remote control
- Flicker less lighting apllication
  Zero line-frequency ripple current
- Low standby power at remote control mode

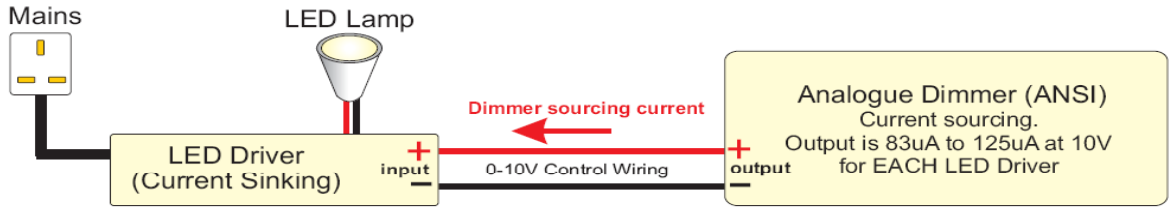
Compatible with IEC and ANSI dimming systems

1-10V Analogue Dimming (Equipment Compliant with IEC60929 Ed 3 Annex E).



Notes:
With no connection to 1-10V terminals, the LED lamp is at MAXIMUM intensity.
LED Driver 1-10V output is SELV# and double insulated from the mains, but the analogue dimmer could degrade this to BASIC insulation*
LED Driver 1-10V output should be ±20V capable (no damage)
LED Driver provides a DC current source to the dimmer. IEC60929 defines this as between 10uA and 2mA per LED Driver.
The LED Driver 1-10V output is voltage limited to slightly above 10V (e.g. 11 volts)
The Analogue Dimmer controls this voltage by sinking the LED Driver control current.
This voltage is controlled by the end user to vary LED lamp intensity.
The following levels are defined in EN60929:
Between 0V and 1V, LED lamp intensity should be at minimum (minimum may or may not mean 'off').
Between 1V and 10V, LED lamp intensity varies from minimum to maximum.
Between 10V and 11V, LED lamp intensity is at maximum.

0-10V Analogue Dimming (Equipment Compliant with ANSI E1.3 - 2001 (R2006)).

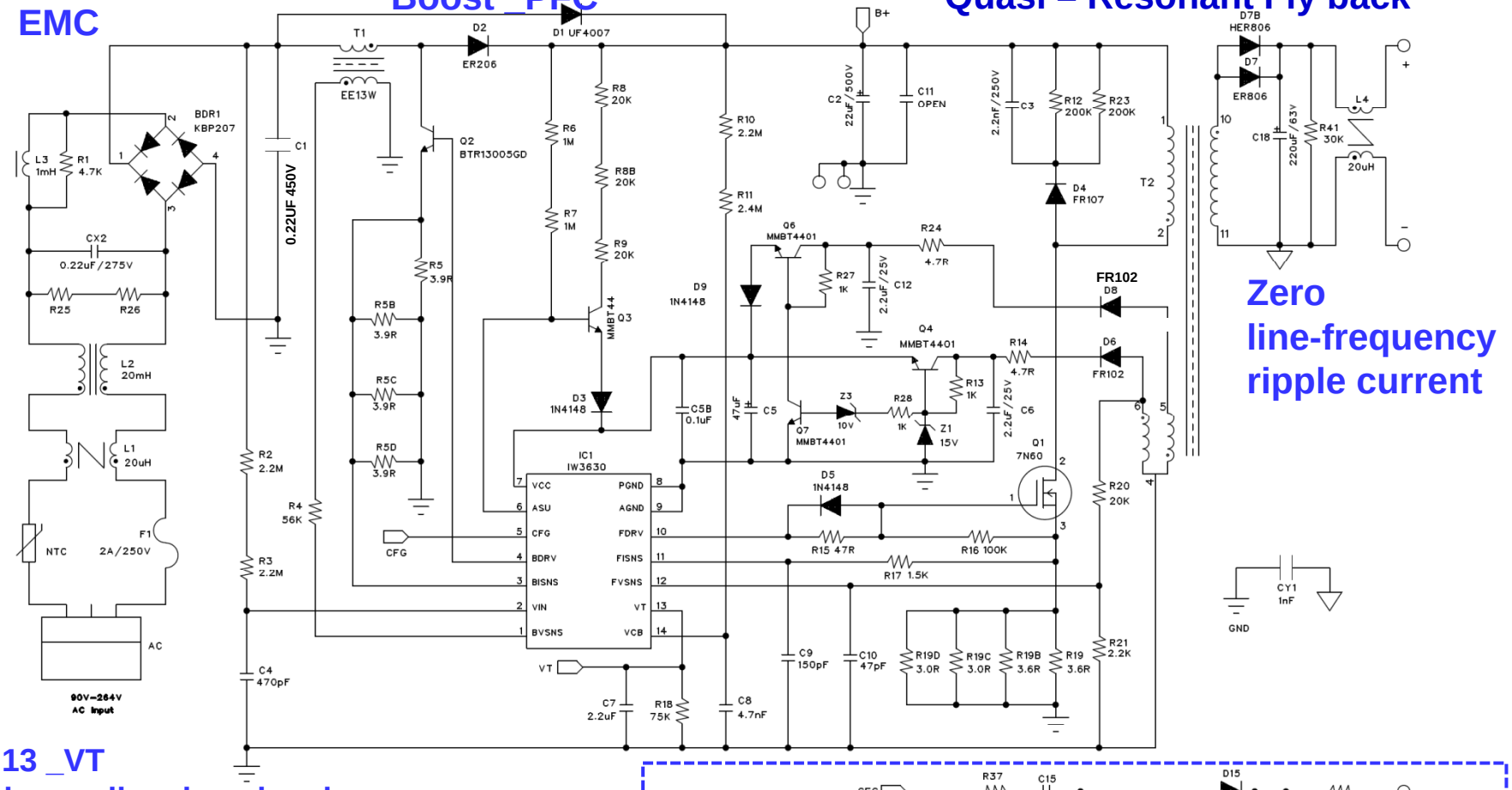


Notes:
With no connection to 0-10V terminals, the LED lamp is at MINIMUM intensity.
LED Driver 0-10V input is SELV# and double insulated from the mains, but the analogue dimmer could degrade this to BASIC insulation*
LED Driver 0-10V input impedance shall be 100k (±20%). This is defined in the ANSI specification
LED Driver 0-10V input should be ±30V capable (no damage)
The Analogue Dimmer provides a variable DC voltage to the LED Driver. This is set by the end user to vary LED lamp intensity.
The following levels are defined in ANSI E1.3 -2001 (R2006):
Between -0.5V and 0.3V LED lamp intensity should be at minimum (Minimum may or may not mean 'off').
Between 0.3V and 9.8V LED lamp intensity varies from minimum to maximum.
Between 9.8V and 30V LED lamp intensity is at maximum.

1. Specification

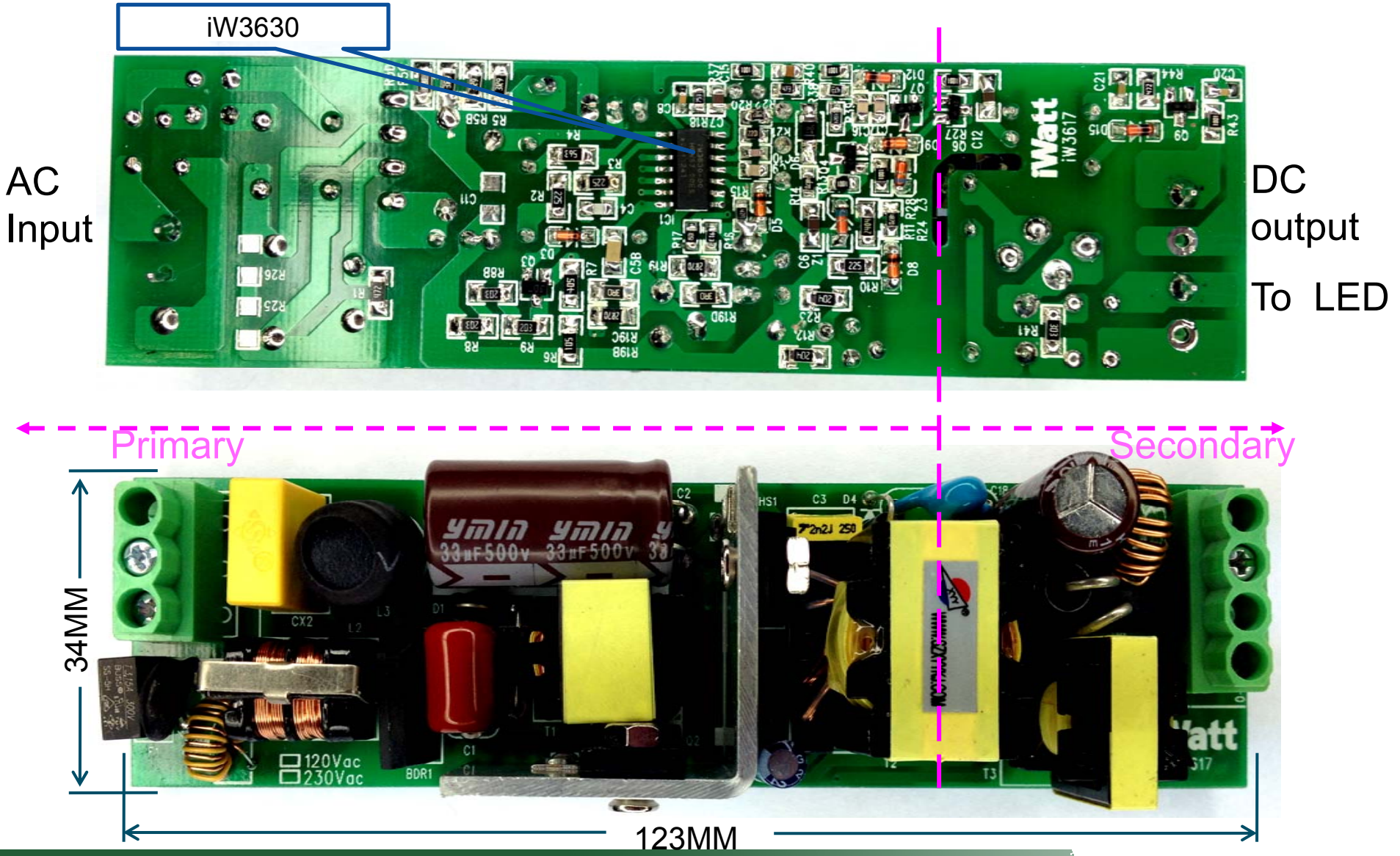
Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	90		264	V_{AC}	2 Wire
Frequency	f_{LINE}	47	50/60	63	Hz	
Output						
Output Voltage	V_{OUT}		55		V	Measured at the end of PCB
Output Current	I_{OUT}		0.7		A	
Output Ripple Current	I_{RIPPLE}		25		mA_{P_P}	Set oscilloscope at 20MHz bandwidth.
Total Output Power						
Continuous Output Power	P_{OUT}		40		W	
Performance Factor	PF	0.9			A	
Active Mode Efficiency	η		86		%	Measured at end of PCB, V_{IN} = 230VAC (T_{AMB} = 25℃).
Environmental						
THD	THD			15	%	
Conducted EMI		Meets CISPR22B / EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Ambient Temperature	T_{AMB}	0		40	° C	Free convection, sea level

2. Schematics for 0-10V dimming system



Pin 13 _VT
Analogue dimming signal
Input range : 0.3-1.5V, clamp at 3.3V
Mapped out as 1-100%
Pin 5_CFG
Output 30KHz, PWM pulse

3. Circuit Board Photograph

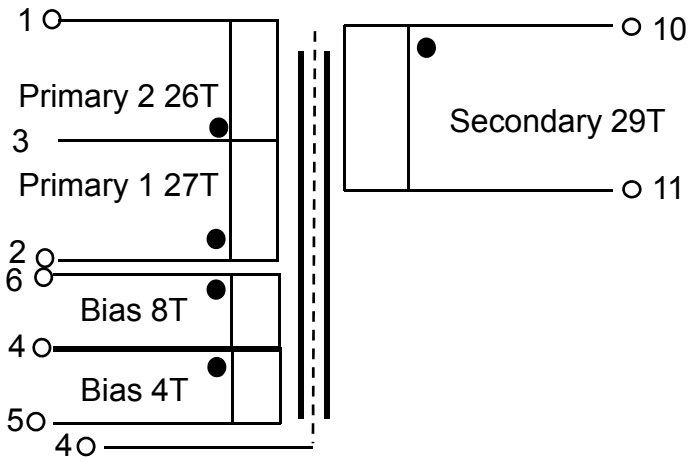


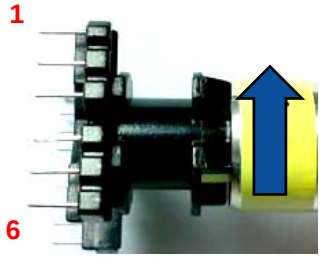
4. BOM __120-277V__28V-50V 700mA

Item	Reference	Description	Qty	Item	Reference	Description	Qty
1	IC1	iW3630-00, Digital PWM Controller,Dimmable, SO-14	1	28	R16	100KΩ,±5%, SMD-1206	2
2	CX1	0.22uF,300V, X2	1	29	R17	1.5KΩ ±5%, SMD-0805	2
3	C1	0.22uF450V,CBB21	1	30	R18	75KΩ ±5%, SMD-0805	1
4	C3	2.2nF,250V	1	31	R19-R19D	3.3Ω ±5%, SMD-0805	1
5	C2	22uF,500V, E-CAP	1				
6	C5	47uF,35V, E-CAP	1	33	R21	2.2KΩ ±1%, SMD-0805	1
7	C18	220uF,63V,E-CAP	1	34	R22,R38	47KΩ ±1%, SMD-0805	1
8	C4	470pF, 25V, X7R, SMD-0805	1	35	R39	120KΩ ±1%, SMD-0805	1
9	C6,C7,C12	2.2uF, 25V, X7R, SMD-0805	2	36	R44	4.7KΩ ±1%, SMD-0805	4
10	C8	4.7nF, 25V, X7R, SMD-0805	1	37	R41	30KΩ ±1%, SMD-1206	1
11	C9	150F,25V, X7R, SMD-0805	1	38	D2	ER206,2A600V	2
12	C10	47pF,50V, X7R, SMD-0805	1	39	F1	T2A250V	1
13	C5B,C16,C20	100NF,50V, X7R, SMD-0805	3	40	BDR1	KBP307	4
14	C15	1uF, 25V, X7R, SMD-0805	1	41	D6 D8	SRGC10DH(FR102),1A,200V, 1206-S	1
15	C17	100PF, 25V, X7R, SMD-0805	1	42	D4,D1	FR107,1A,1000V, S0D-123	2
13	C21	330NF,50V, X7R, SMD-1206	1	43	D7,	ER806,8A,600V,DO-220	1
14	R1	4.7KΩ ±5%, SMD-1206	2	44	D3,D9,D5,D12,D15	LL4148,0.15A,100V,LL-34	1
15	R2,R3	2.2MΩ ±5%, SMD-1206	1	45	Z1	Zener, ZMM15B,15V, LL-34	1
16	R5,R5B,R5C,R5D	3.9Ω ±1%, SMD-1206	1	46	Z2	Zener, ZMM15B,10V, LL-34	1
17	R4	56KΩ±5%, SMD-1206	1	47	Q1	7N60.7A,650V,TO-220	1
18	R6,R7	1MΩ ±5%, SMD-1206	1	48	Q3	MMBTA44, NPN, 400V, SOT-23	1
19	R8,R8B,R9	20KΩ ±5%, SMD-1206	1	49	Q2	3DD13005ED,NPN,4A 700V,T0-220	1
20	R10	2.4MΩ±5%, SMD-1206	2	50	L1,L4	Common Mode Inductor T8*3*3 15uH	2
21	R11	2.2MΩ±5%, SMD-1206	1	51	L2	UU9.5	1
22	R12,R23	200kΩ±5%, SMD-1206	2	52	L3	10*12,0.8mH	1
23	R13,R27,R28,R37,R40,R43	1KΩ±5%, SMD-0805	2	53	T1	EE13W, L=0.6mH	1
24	R14,R24	4.7Ω±5%, SMD-0805	2	54	T2	PQ2020	1
25	R15	47Ω,±5%, SMD-0805	1	50	T3	EE16	1
26	Q4,Q6,Q7,Q9	1N4401	4				1
27	CY1	1NF/275V	1	50			

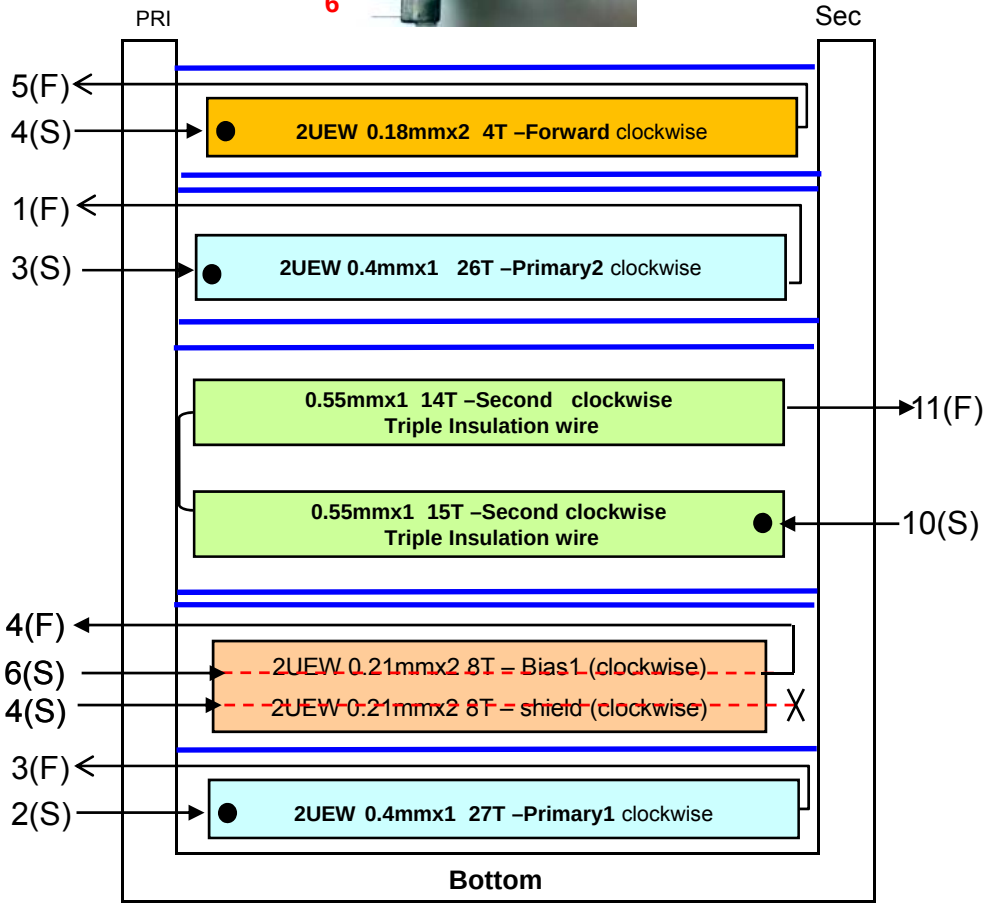
5. Transformer Design(T2)

SCHEMATIC





Rotating direction of winding machine



ELECTRICAL SPECIFICATIONS:

1. Primary Inductance (Lp) = 0.5mH @10KHz
2. Primary Leakage Inductance (Lk)≤ 40uH@10KHz

MATERIALS:

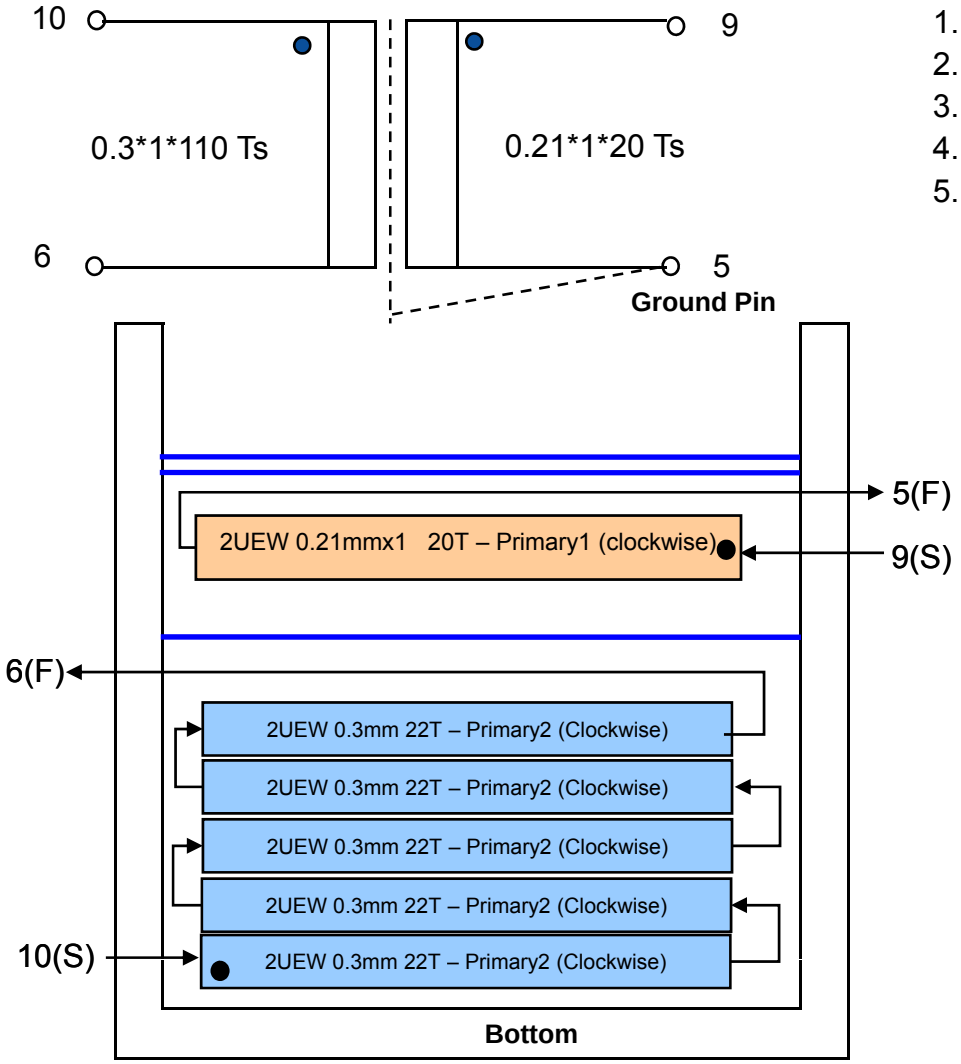
1. Core : PQ2020 (Ferrite Material TDK PC40 or equivalent)
2. Bobbin : PQ2020 Vertical Primary=6, Secondary=8
3. Magnet Wires (Pri) : Type 2-UEW
4. Magnet Wire (Sec) : Triple Insulated Wires
5. Layer Insulation Tape :3M1298 or equivalent.

FINISHED :

1. Core is connected to PRI-GND pin4.
2. Varnish the complete assembly

6. PFC Inductor

SCHEMATIC

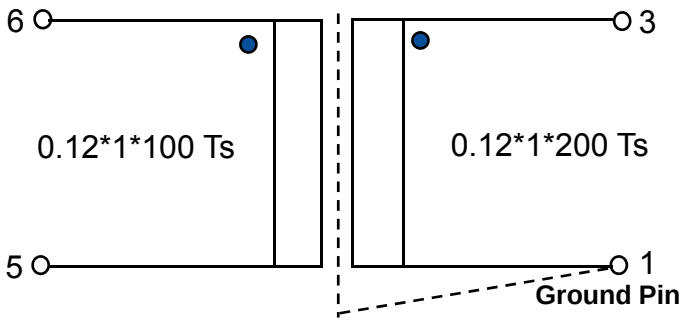


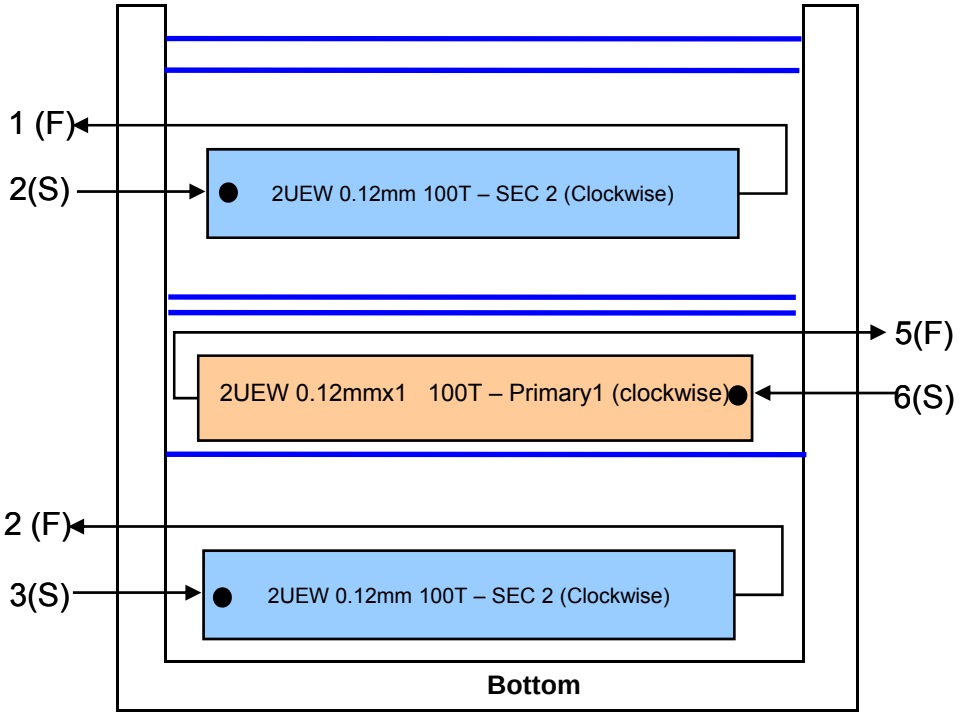
ELECTRICAL SPECIFICATIONS:

1. Inductance (Lp6-10) = 0.6mH @10KHz
2. Core : EE13 W (Ferrite Material TDK PC40 or equivalent)
3. Bobbin : EE13W, Horizontal
4. Ferrite core is connected to Pin 5 after assembling
5. Varnish the complete assembly

7. 0-10V isolated Transformer (T4)

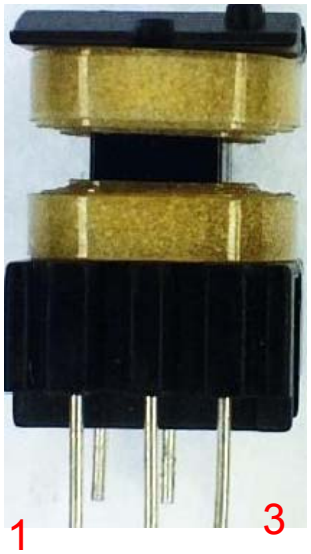
SCHEMATIC





ELECTRICAL SPECIFICATIONS:

1. Core : EE16
   (Ferrite Material TDK PC40 or equivalent)
1. Bobbin : EE16

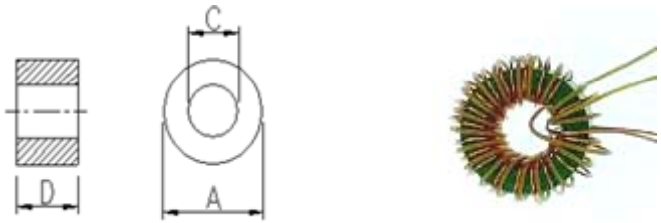


8. Common Mode Inductor L1

Properties of B&F Ferrite - Nickel Zinc (Ni-Zn)

Material	μi	Bms(Gs)	Hc(Oe)	Br(Gs)	Tc(℃)	ρ(Ω-cm)	Frequency (MHz)	αur x 10⁻⁶/℃
B29	800	2900	0.30	1420	150	$1*10^7$	0.1~0.7	25~45

EMI Toroidal Core (T Type)



Dimensions 尺寸 (mm)

Core Size \ Conf.	A	D	C	Fig
T 8.0x4.0x3.0	8.0±0.3	4.0±0.3	3.0±0.2	1,2,3

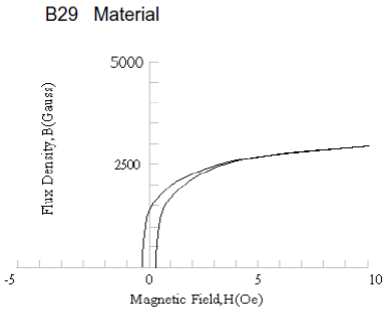
Ferrite core : Ni -Zn T8*4*3

Wire gauge: 0.3mm, 8Turns (Triple Insulated Wire)

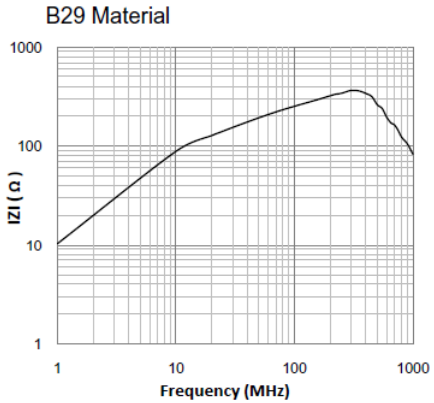
Inductance @10kHz, 1V: 25uH +/10%

DCR: 0.12 OHM +/-20%

Saturation Flux Density (Ni-Zn)



Impedance Vs Frequency Curve (Ni-Zn)



B.F.

Contacts Information

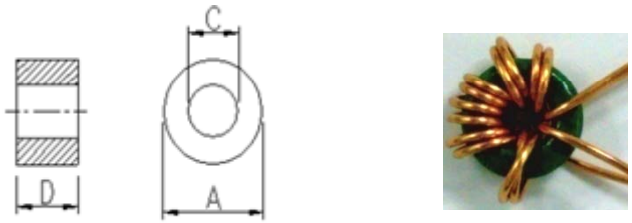
Company Name	:	Bead & Ferrite Electronics (HK) Ltd.
Telephone No.	:	(852) 2601 0833
Fax No.	:	(852) 2693 6202
Email Address	:	bf@bnf.com.hk
Home Page	:	www.bnf.com.hk
Address	:	RM. 16-17, 15/F., Block C, Goldfield Ind. Centre, No.1 Sui Wo Road, Fo Tan, N.T. Hong Kong

9. Common Mode Inductor L4

Properties of B&F Ferrite - Nickel Zinc (Ni-Zn)

Material	μi	Bms(Gs)	Hc(Oe)	Br(Gs)	Tc(℃)	ρ(Ω-cm)	Frequency (MHz)	αur x 10⁻⁶/℃
B29	800	2900	0.30	1420	150	$1*10^7$	0.1~0.7	25~45

EMI Toroidal Core (T Type)



Dimensions 尺寸 (mm)

Core Size \ Conf.	A	D	C	Fig
T 8.0x4.0x3.0	8.0±0.3	4.0±0.3	3.0±0.2	1,2,3

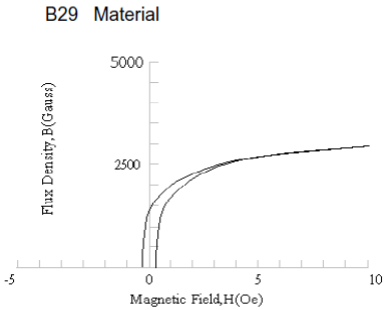
Ferrite core : Ni -Zn T8*4*3

Wire gauge: 0.45mm, 6Turns

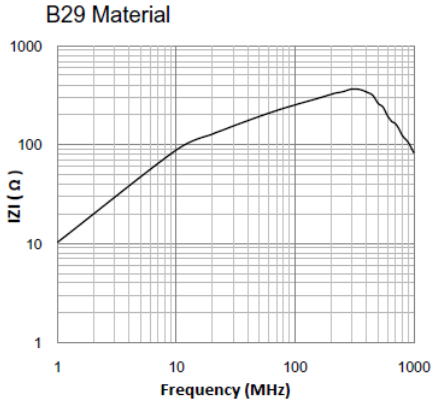
Inductance @10kHz, 1V: 17uH +/-10%

DCR: 0.1 OHM +/-20%

Saturation Flux Density (Ni-Zn)



Impedance Vs Frequency Curve (Ni-Zn)



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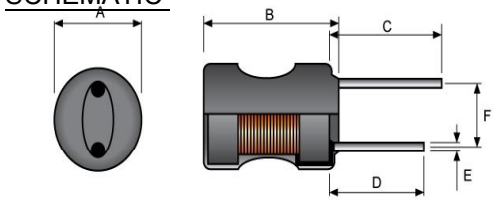
10. EMI Inductor

1. Differential Mode Inductor L3

SCHEMATIC



Ferrite core size : AxB 10x12mm

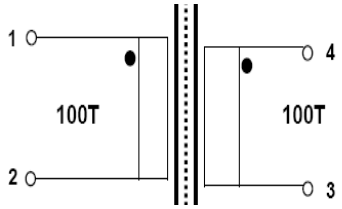
Wire gauge: 0.4mm, 140 Turns

Inductance @10kHz, 1V: 0.8mH +/-10%

DCR: 1.4 OHM +/-20%

2.Common Choke L2 for EMI

SCHEMATIC



Ferrite core : UU9.5 u>=10k
Wire gauge: 0.3mm, 100Turns
Inductance @10kHz, 1V: 25mH +/-20%
DCR: 1.2OHM +/-20%

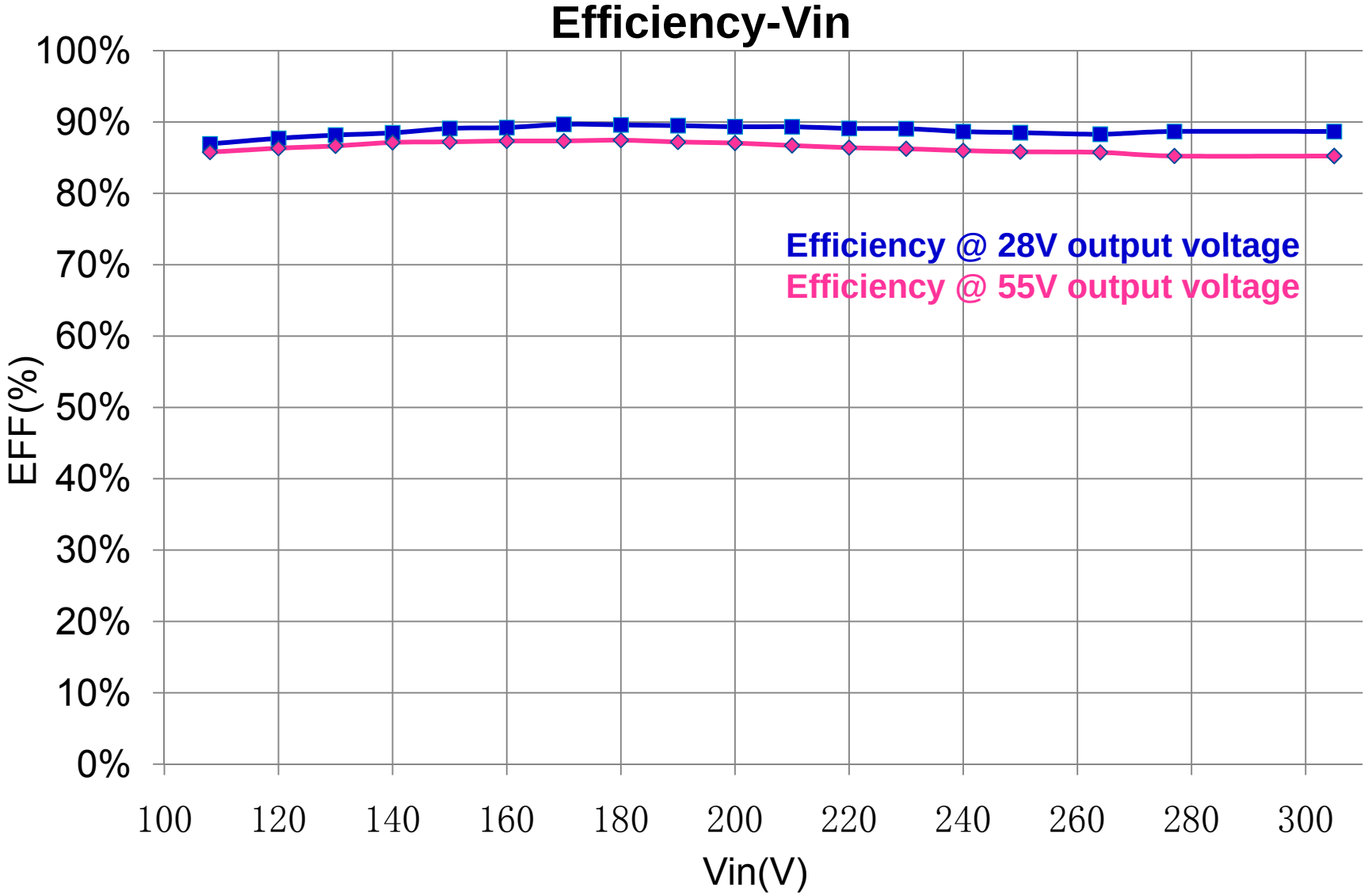
11. Regulation, Ripple and Efficiency Measurement(55V)

Vin (V)	Pin (W)	Vout (V)	Iout (mA)	Ripple(PK) (mA)	efficiency	PF	THD (%)
108	45.53	55.38	704	23.0	85.63%	0.999	4.60
120	44.85	55.38	704	23.0	86.93%	0.999	4.30
130	44.45	55.38	704	23.0	87.71%	0.999	3.05
140	44.22	55.38	704	23.0	88.17%	0.998	3.32
150	44.06	55.38	704	23.0	88.49%	0.997	3.33
160	43.88	55.38	706	21.0	89.10%	0.997	4.76
170	43.82	55.38	706	21.0	89.22%	0.997	4.23
180	43.72	55.38	708	21.0	89.68%	0.997	4.47
190	43.76	55.38	708	21.0	89.60%	0.996	4.50
200	43.81	55.38	708	21.0	89.50%	0.996	4.70
210	43.89	55.38	708	21.0	89.33%	0.991	4.30
220	43.95	55.38	709	21.0	89.34%	0.988	4.60
230	44.07	55.38	709	19.0	89.10%	0.988	4.30
240	44.21	55.38	711	19.0	89.06%	0.988	5.20
250	44.41	55.38	711	19.0	88.66%	0.986	5.70
264	44.55	55.38	712	19.0	88.51%	0.988	5.80
277	44.66	55.38	712	19.0	88.29%	0.986	6.20
305	44.47	55.38	712	19.0	88.67%	0.971	7.90

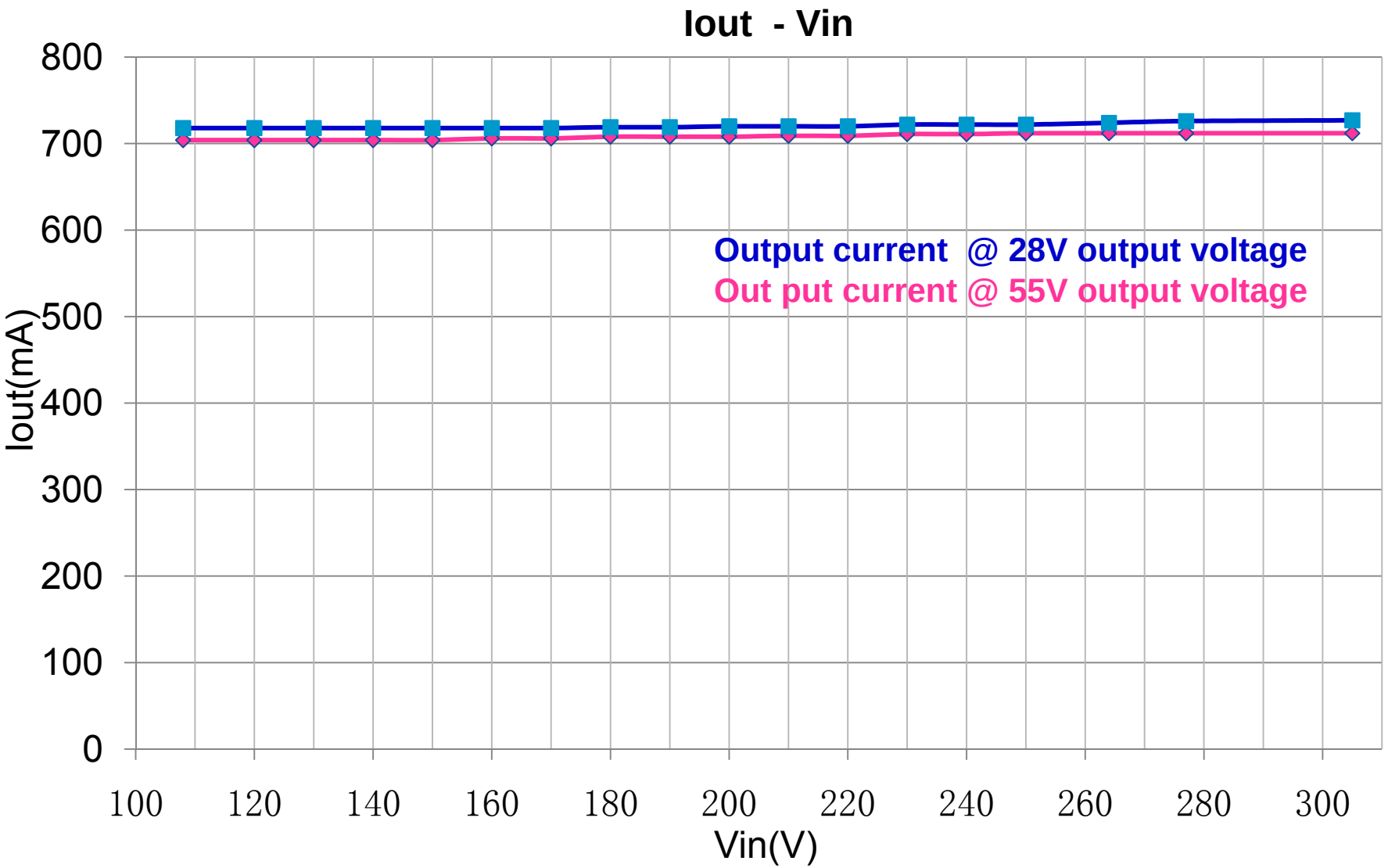
12. Regulation, Ripple and Efficiency Measurement(28V)

Vin (V)	Pin (W)	Vout (V)	Iout (mA)	Ripple(PK) (mA)	efficiency	PF	THD (%)
108	23.52	28.10	718	23.0	85.78%	0.999	5.20
120	23.33	28.05	718	23.0	86.33%	0.998	5.70
130	23.20	28.00	718	23.0	86.66%	0.997	3.05
140	23.07	28.00	718	23.0	87.14%	0.996	3.32
150	23.05	28.00	718	23.0	87.22%	0.995	3.33
160	23.05	28.00	719	21.0	87.34%	0.993	4.71
170	23.05	28.00	719	21.0	87.34%	0.992	4.23
180	23.05	28.00	720	21.0	87.46%	0.992	4.47
190	23.12	28.00	720	21.0	87.20%	0.990	4.42
200	23.16	28.00	720	21.0	87.05%	0.989	4.67
210	23.25	28.00	720	21.0	86.71%	0.987	4.65
220	23.33	28.00	720	21.0	86.41%	0.985	4.30
230	23.44	28.00	722	19.0	86.25%	0.983	4.40
240	23.51	28.00	722	19.0	85.99%	0.980	4.67
250	23.62	28.00	724	19.0	85.83%	0.978	4.72
264	23.71	28.00	726	19.0	85.74%	0.972	6.20
277	23.88	28.00	727	19.0	85.24%	0.966	8.50
305	23.88	28.00	727	19.0	85.24%	0.934	14.20

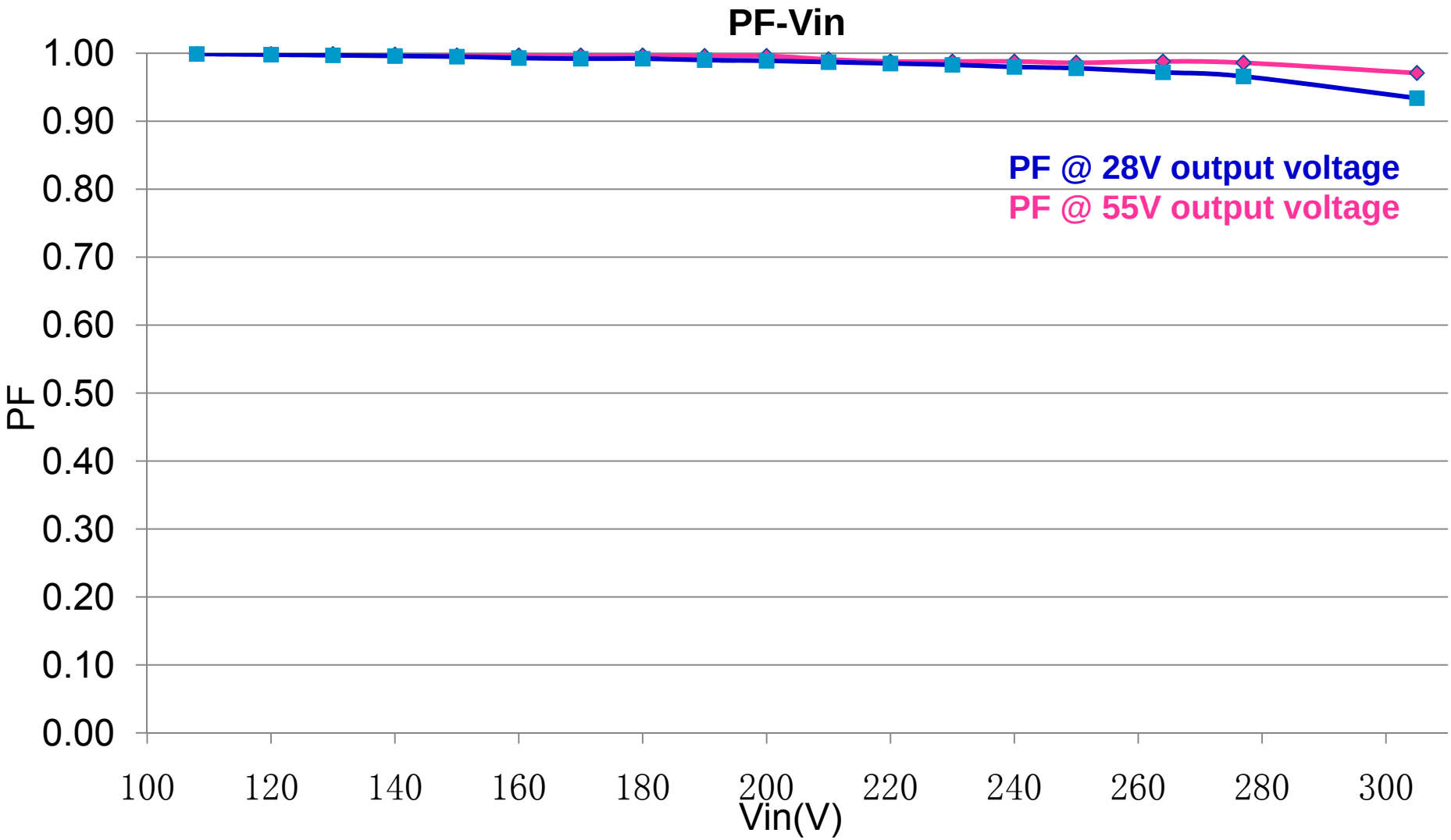
13. Variable Input Vs. Efficiency Measurement (55V)



14. Line regulation at 55V and 28V output

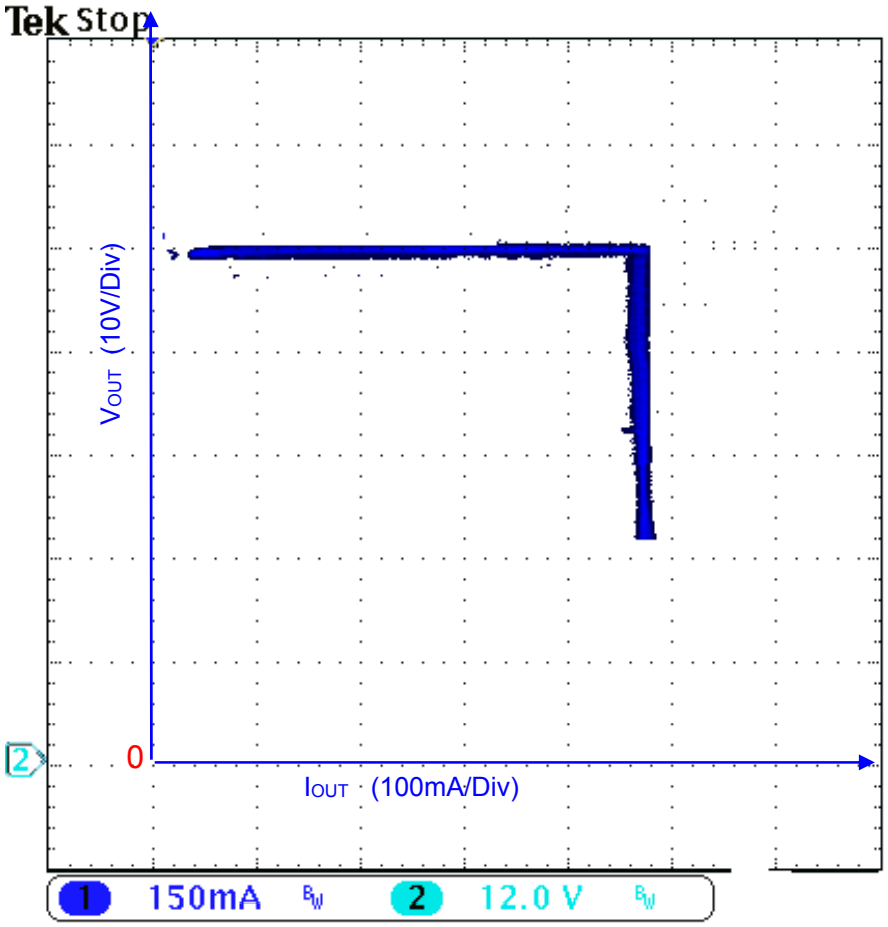


15. Variable Input Vs. PF (55V and 28V)

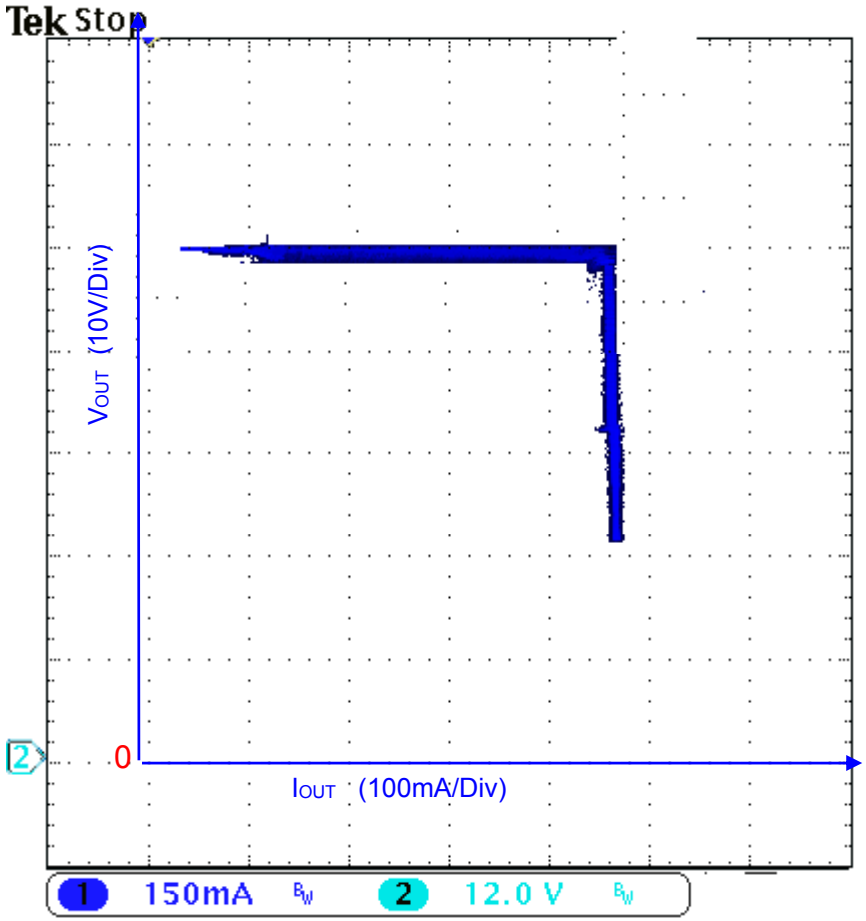


16. Output VI Characteristics(CV Mode)

V_{IN}=120Vac/60Hz

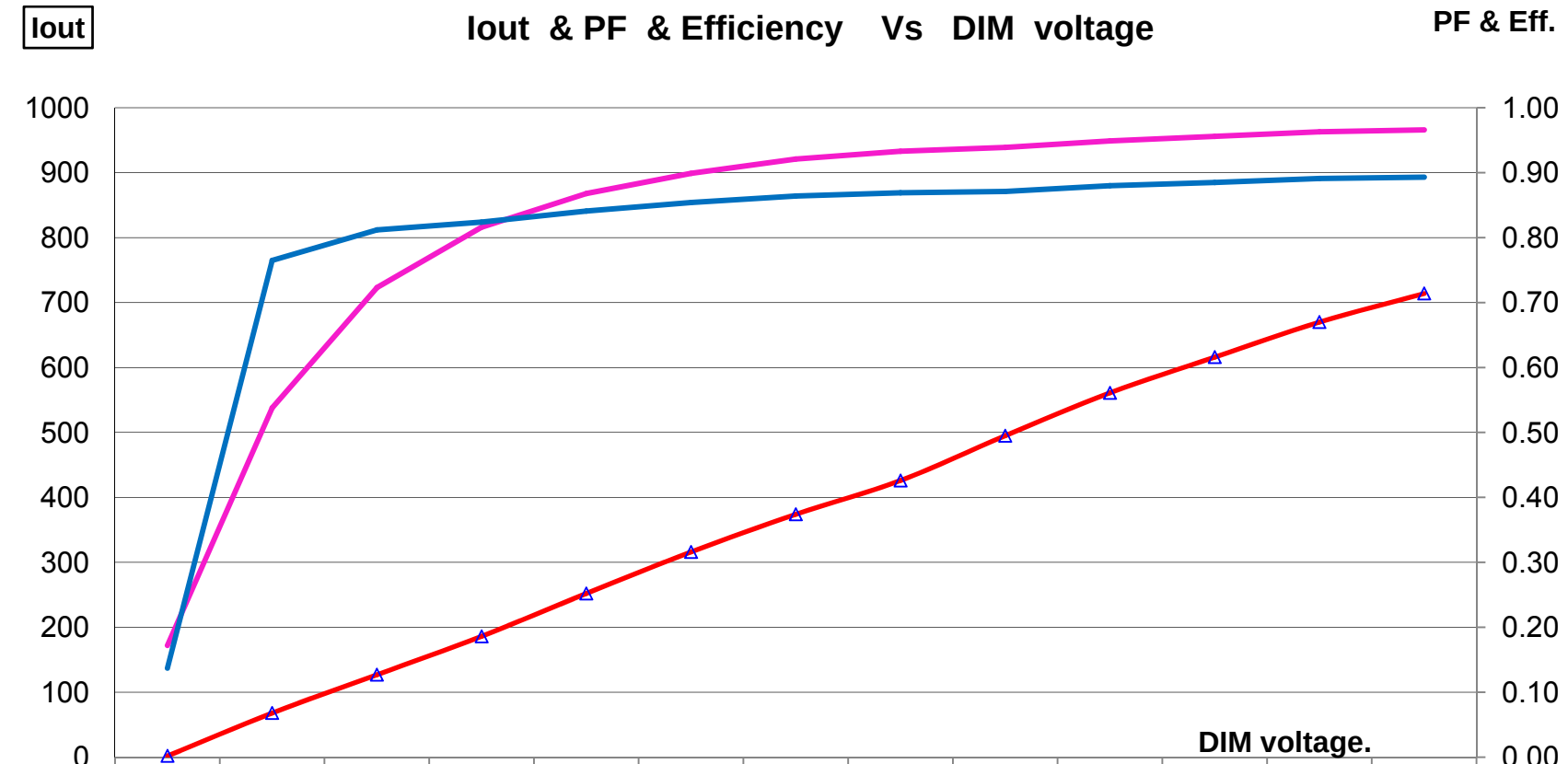


V_{IN}=277Vac/50Hz



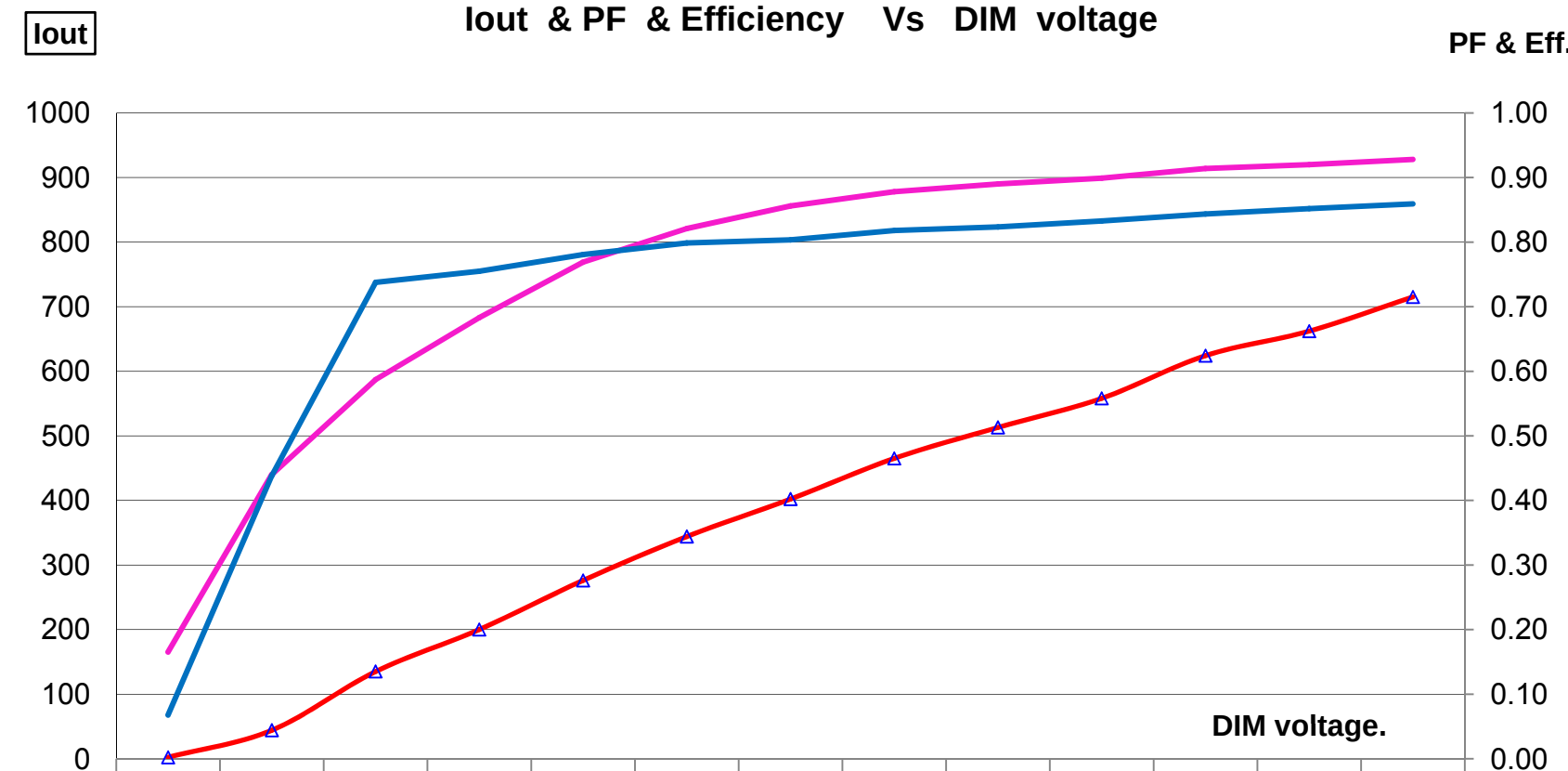
* Note: Output voltage is monitored at end of PCB

17. Variable Input Vs. PF Measurement(55V@Vin305)



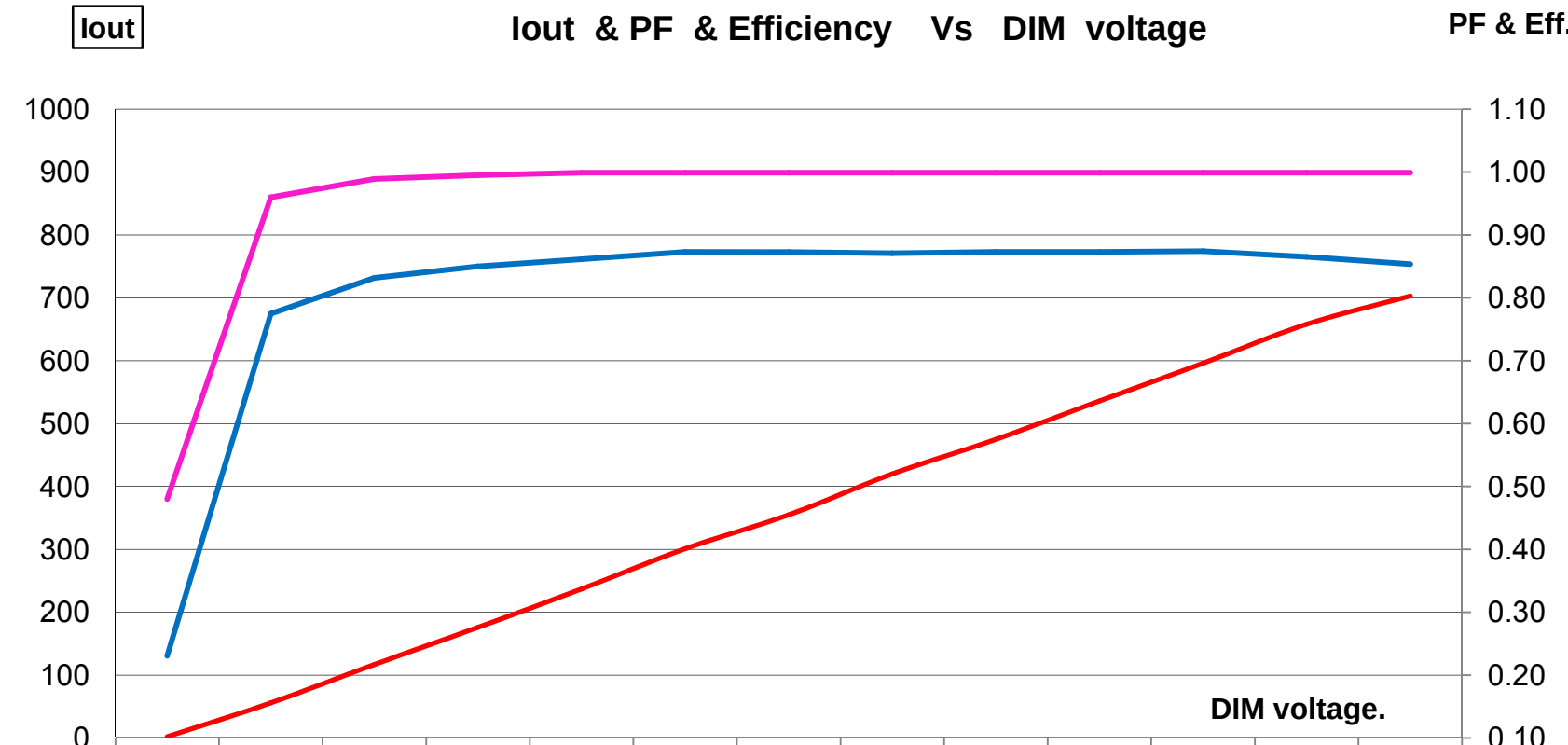
	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.8
Iout	2	68	127	186	252	316	374	426	495	561	616	670	714
PF	0.17	0.54	0.72	0.82	0.87	0.90	0.92	0.93	0.94	0.95	0.96	0.96	0.97
Eff	0.14	0.77	0.81	0.82	0.84	0.85	0.86	0.87	0.87	0.88	0.89	0.89	0.89

18. Variable Input Vs. PF Measurement(28V@Vin305)



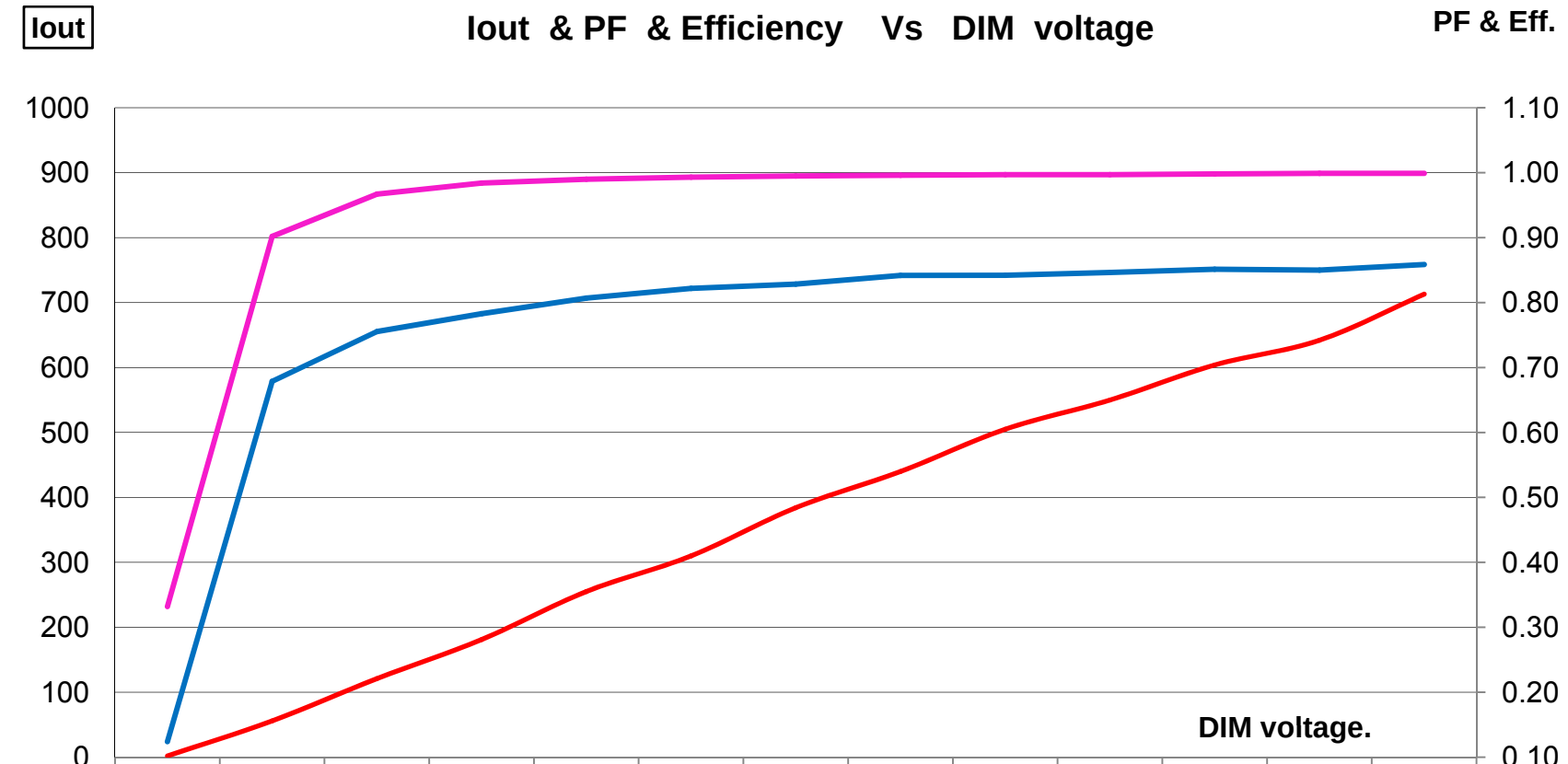
	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.8
Iout	2	44	135	200	276	344	402	465	513	558	624	662	715
PF	0.17	0.44	0.59	0.68	0.77	0.82	0.86	0.88	0.89	0.90	0.91	0.92	0.93
Eff	0.07	0.44	0.74	0.75	0.78	0.80	0.80	0.82	0.82	0.83	0.84	0.85	0.86

19. Variable Input Vs. PF Measurement (55V~Vin108)



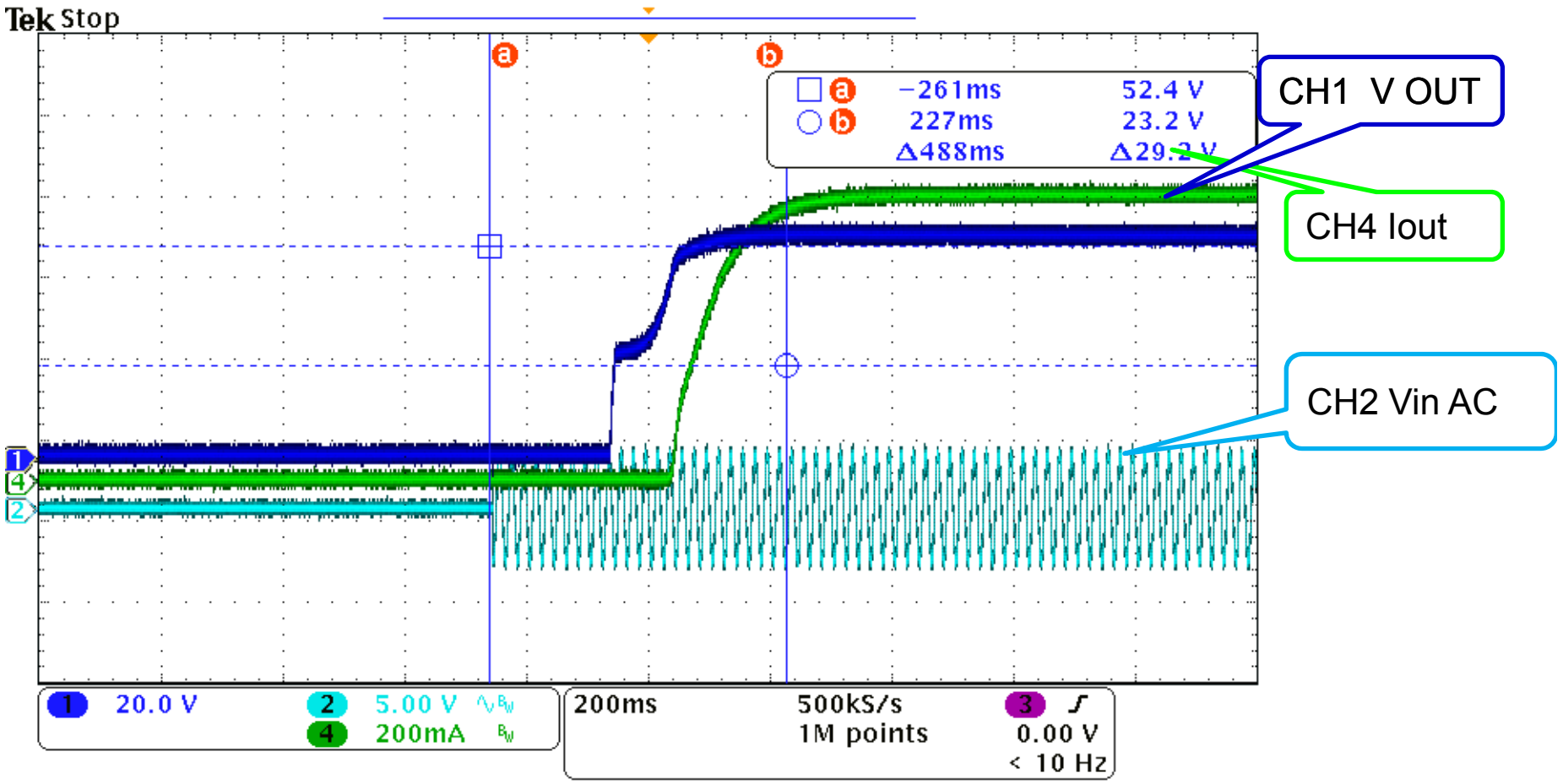
	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.8
Iout	2	56	117	176	237	301	355	420	475	536	596	658	703
PF	0.48	0.96	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Eff	0.23	0.77	0.83	0.85	0.86	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.85

20. Variable Input Vs. PF Measurement (28V@Vin108)



	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.3	1.4	1.8
Iout	2	56	121	181	255	310	384	440	505	550	604	642	713
PF	0.33	0.90	0.97	0.98	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Eff	0.12	0.68	0.76	0.78	0.81	0.82	0.83	0.84	0.84	0.85	0.85	0.85	0.86

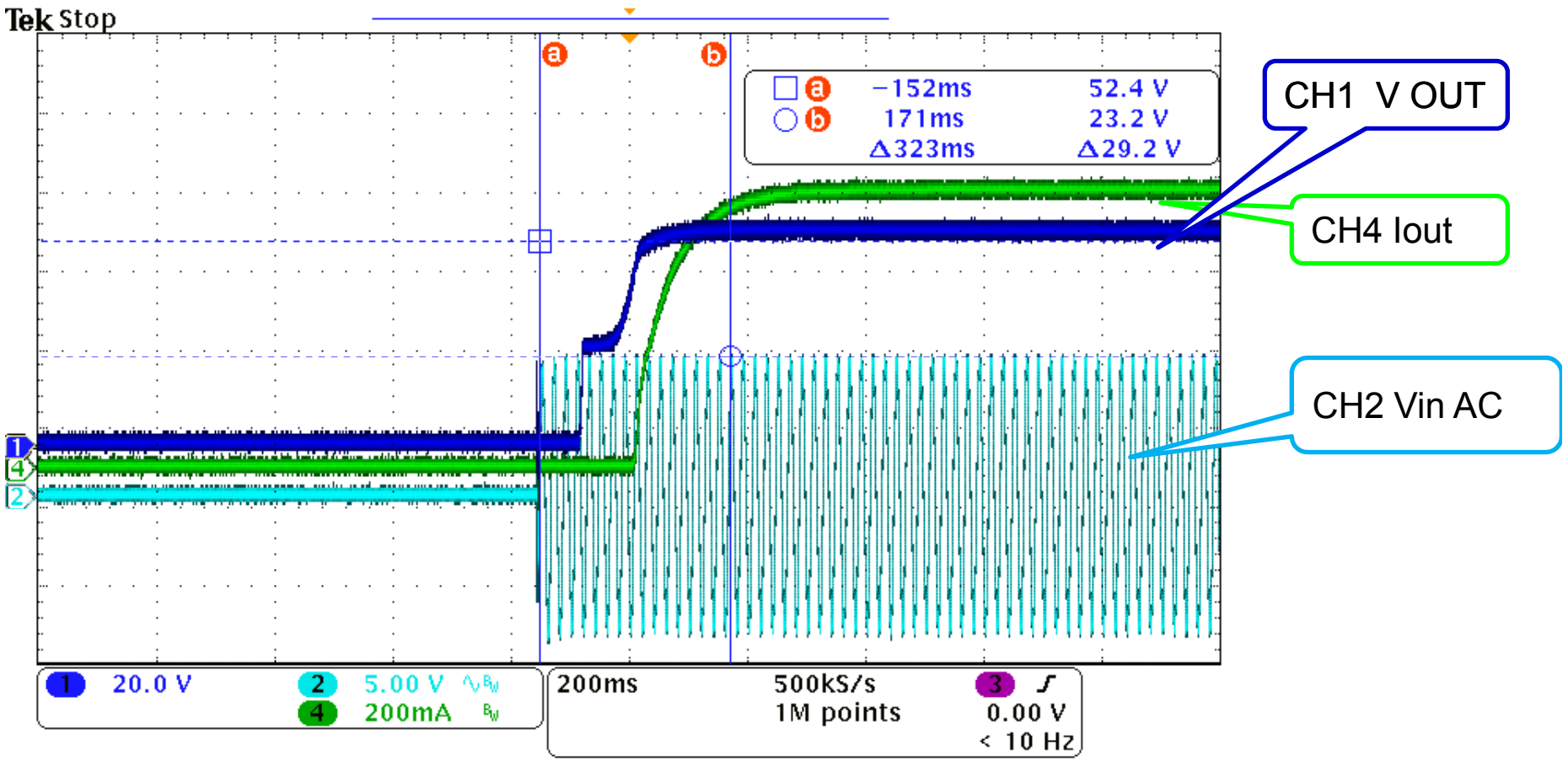
21. Turn-on Delay Time and Output current overshoot



Vin 108V_{AC} , Full Load

T_{ST_DELAY}=488mS

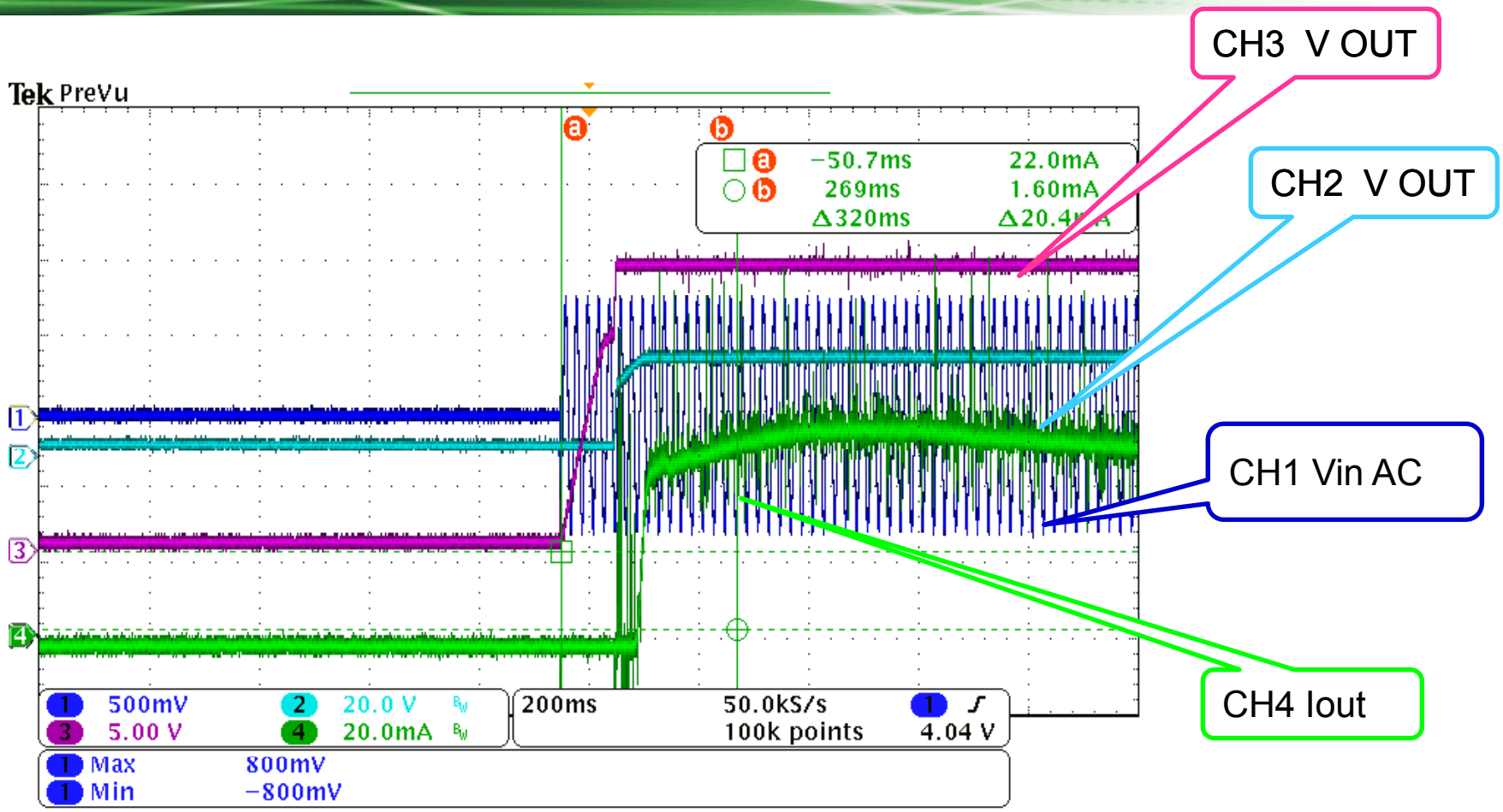
22. Turn-on Delay Time and Output current overshoot



Vin 305V_{AC}, Full Load

T_{ST_DELAY}=323mS

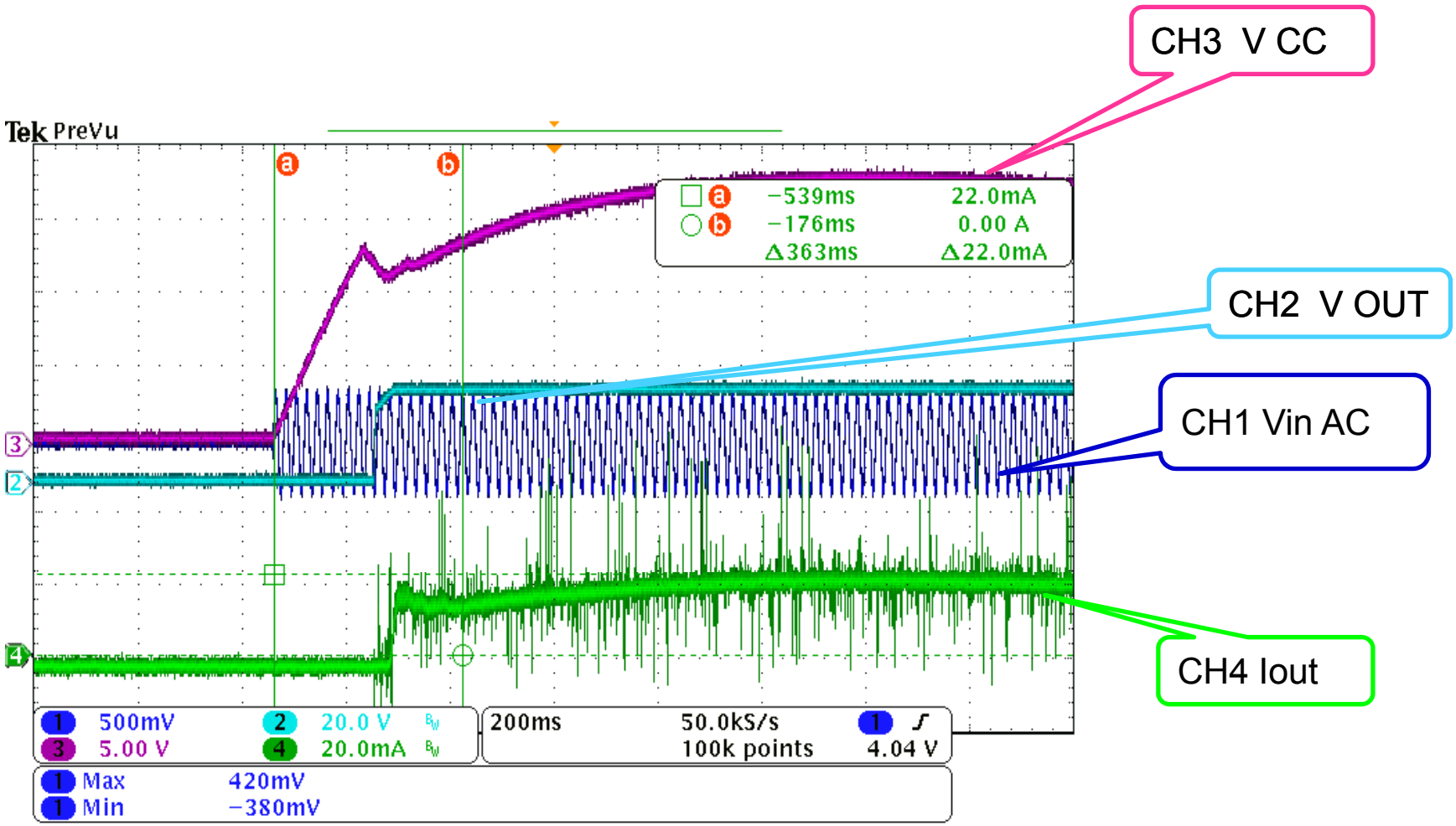
23. Turn-on Delay Time and Output current overshoot



Vout 28V Vin 305V_{AC}, MIN Load

T_{ST_DELAY}=320mS

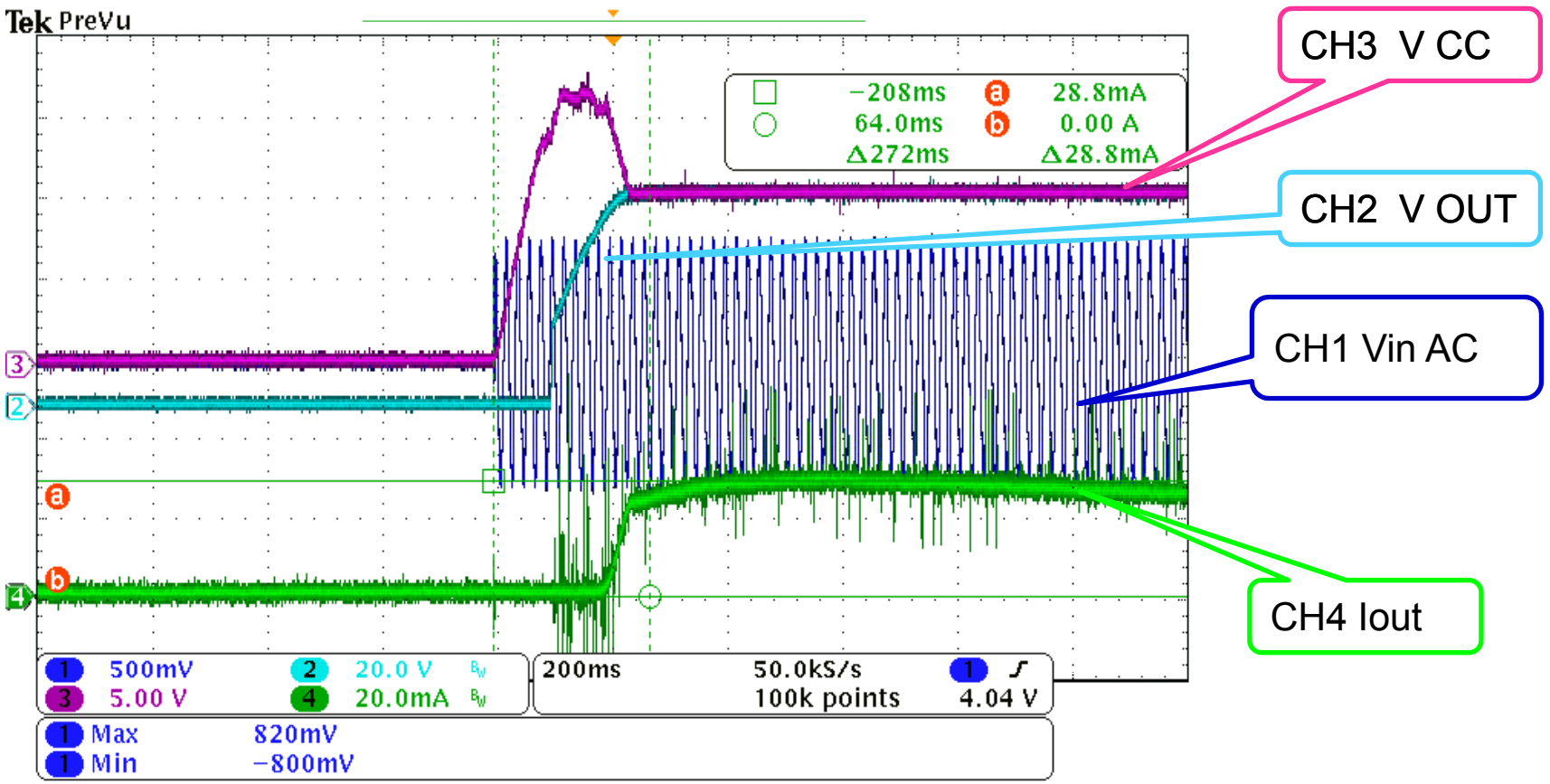
24. Turn-on Delay Time and Output current overshoot



VOUT 28V VIN 108V_{AC},MIN Load

T_{ST_DELAY}=363mS

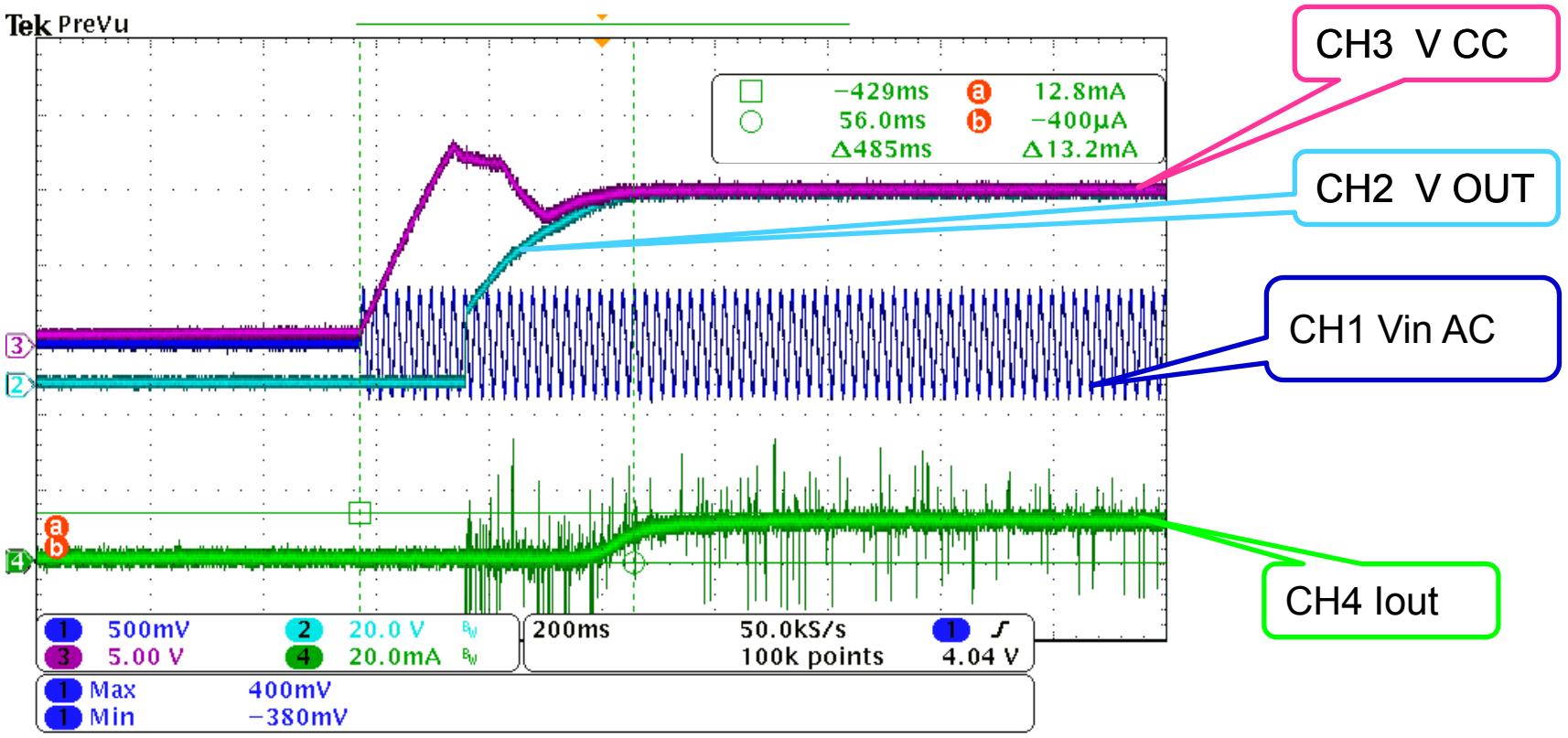
25. Turn-on Delay Time and Output current overshoot



Vout 50V _ Vin 305V_{AC}, Minimum Load

T_{ST_DELAY}=272mS

26. Turn-on Delay Time and Output current overshoot

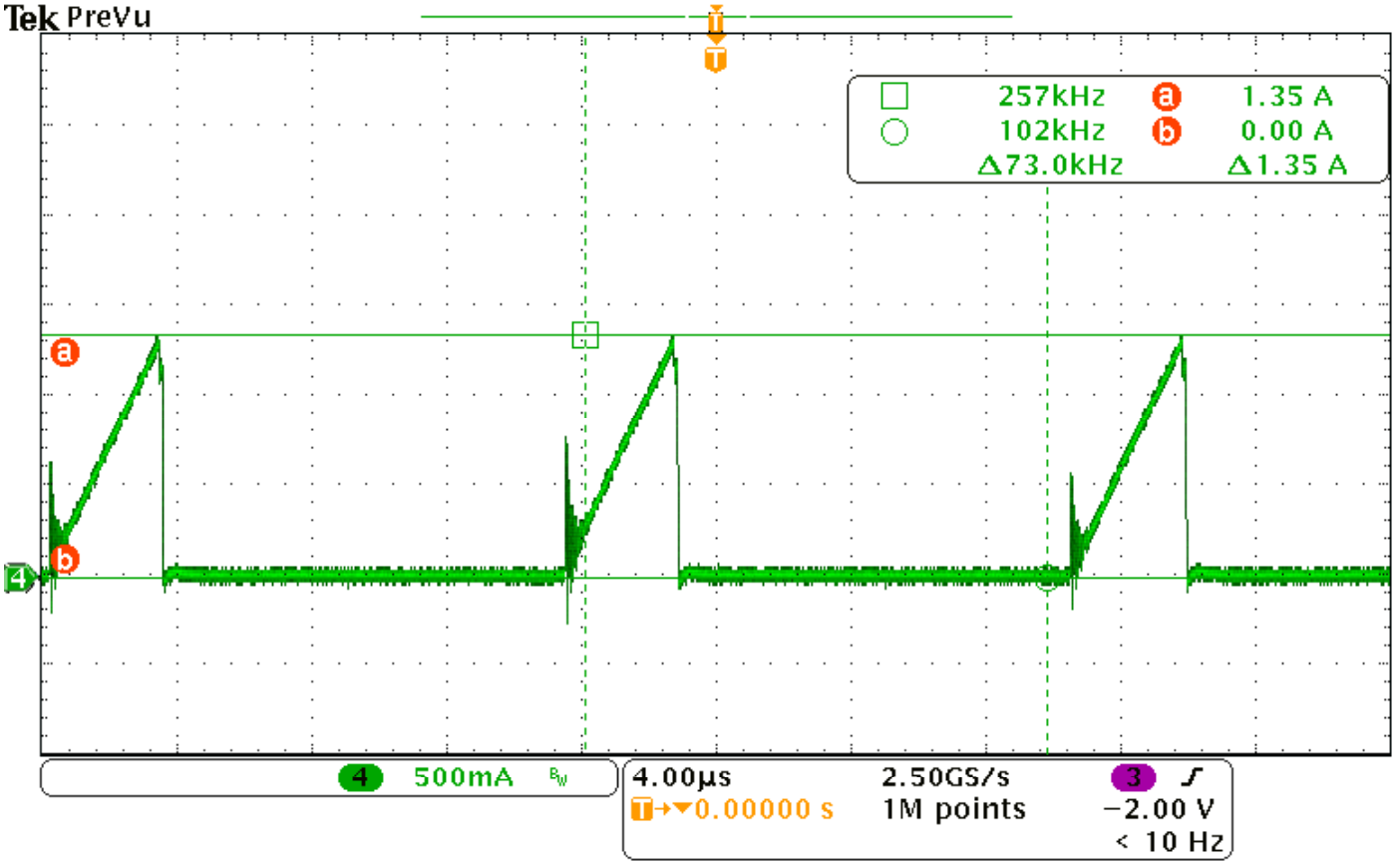


Vout 50V __AC108V$_{AC}$__Minimun Load

T_{ST_DELAY}=485mS

27. Transformer Flux Density

(Np=53Ts, Lm=0.5mH, Ae=64mm^2-PQ2016)



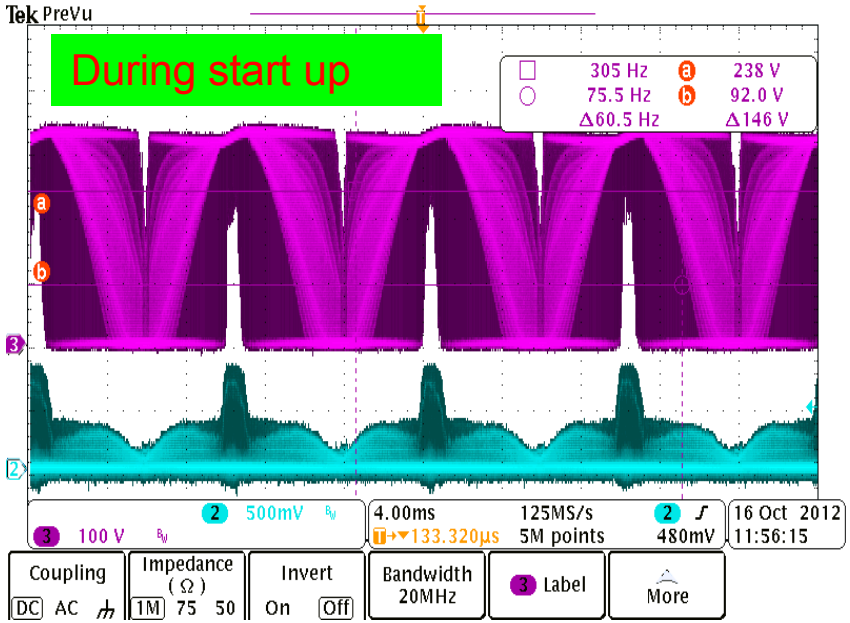
$B_{MAX} = I_{PRI} * L_{PRI} / (N_P * A_e)$

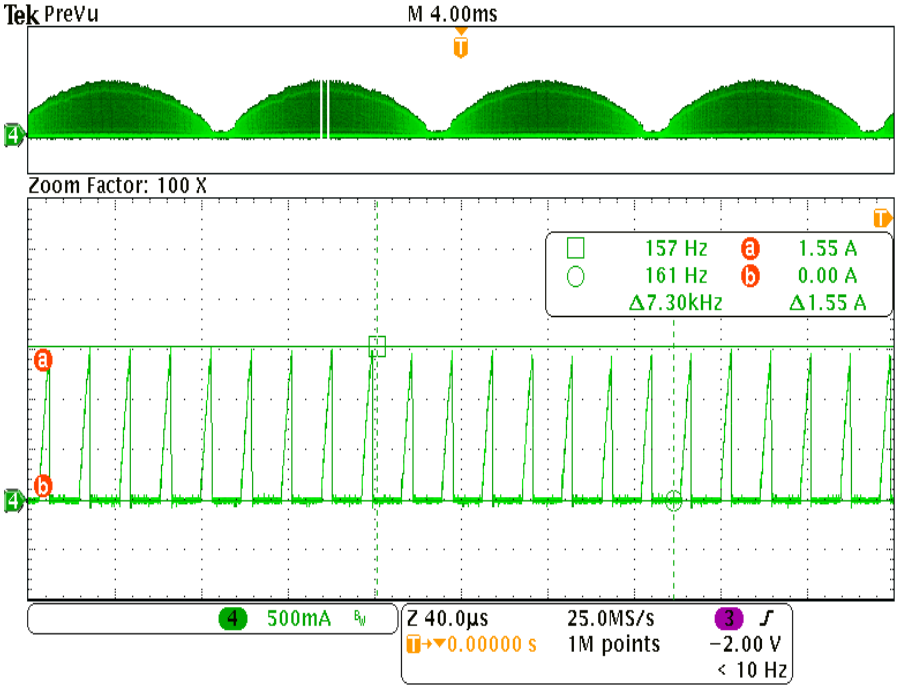
=(1350*0.5)/(53*64)

=0.199Tesla

28. PF Flux Density

(Np=110Ts, Lm=0.6mH, Ae=32mm²-EE13W)





Turn-on I_{PRI} is monitored at 108Vac and *0.7A* load

I_{PRI}=1.78A

$$B_{MAX} = I_{PRI} * L_{PRI} / (N_P * A_e)$$

$$=(1780*0.6)/(110*32)$$

=0.303Tesla

I_{PRI} is monitored at 108Vac and *0.7A* load

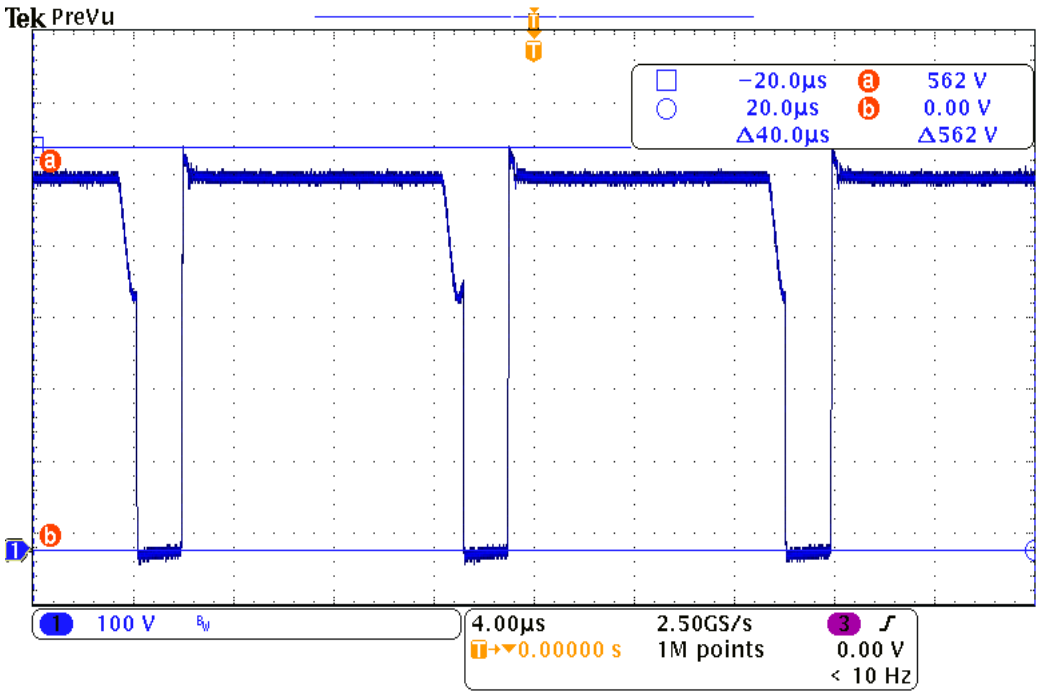
I_{PRI}=1.55A

$$B_{MAX} = I_{PRI} * L_{PRI} / (N_P * A_e)$$

$$=(1550*0.6)/(110*32)$$

=0.264Tesla

29. Q1 MOSFET V_{DS} Waveform



Test Condition:

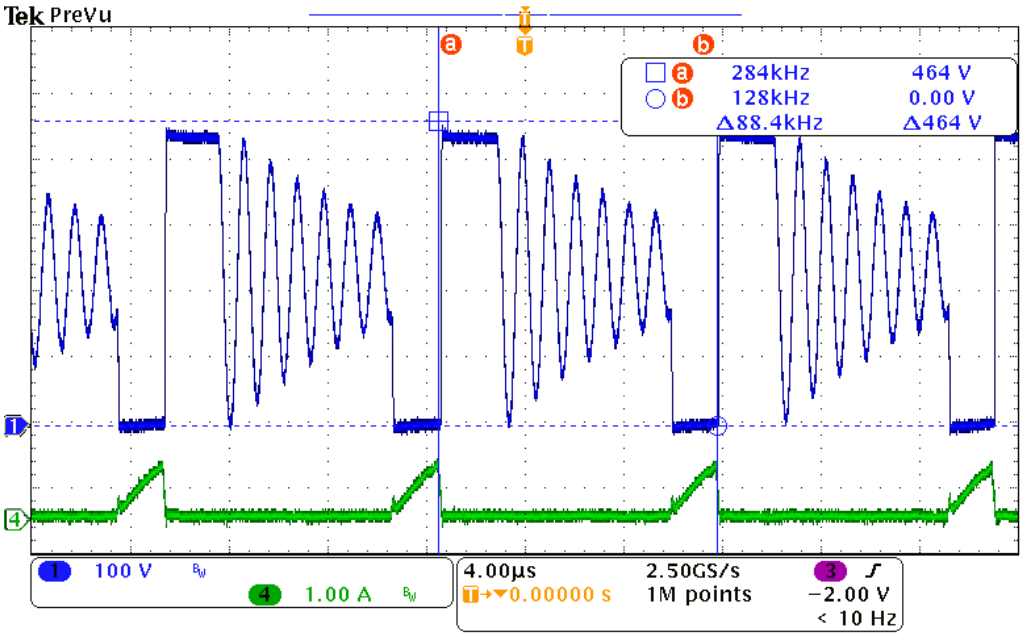
V_{IN}=305VAC, V_{OUT}=55V

Result:

V_{DS_MAX}=564V

Remark: Mosfet Spec__7A 650V

30. Q2 BJT(BTR13005GD) V_{CE} Waveform



Test Condition:

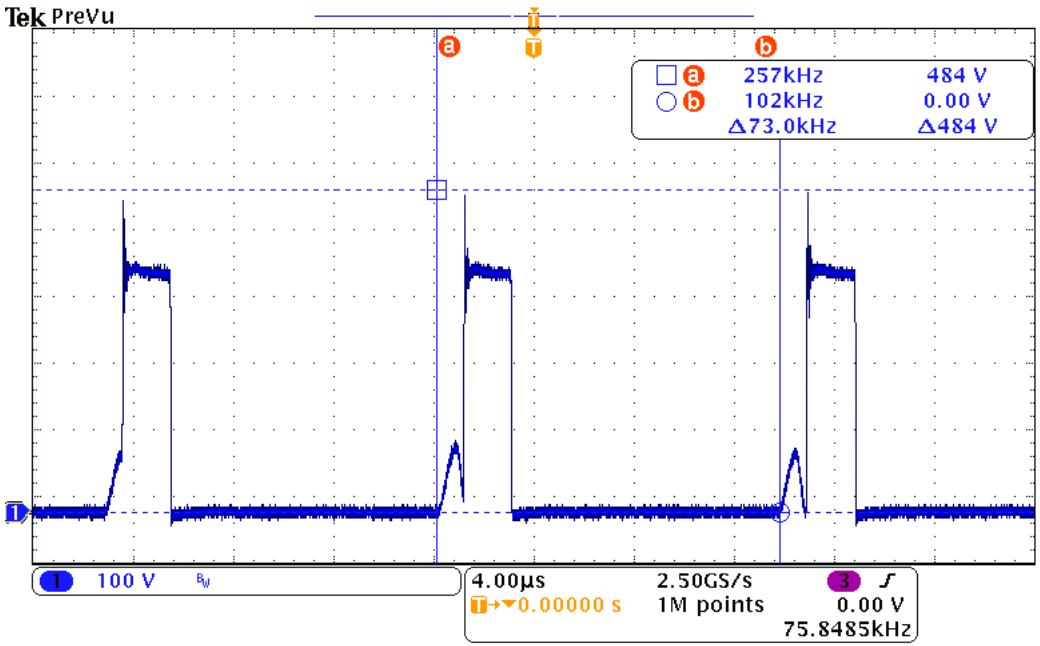
V_{IN}=305VAC, V_{OUT}=55V

Result:

V_{DS_MAX}=464V

Remark: Spec__4A 700V

31. Output Diode Waveform



Test Condition:

V_{IN}=305VAC, V_{OUT}=55V

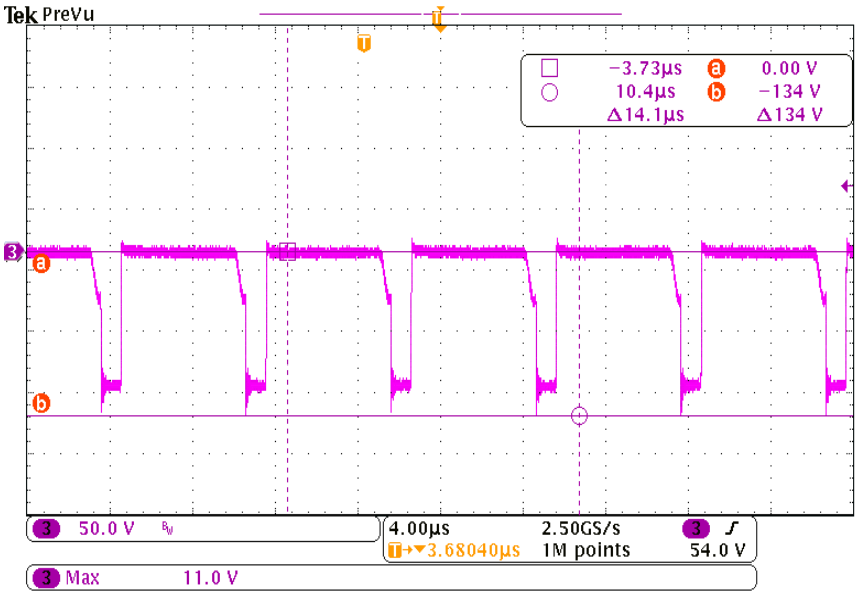
Result:

V_{RRM_MAX}=484V

Remark: Diode Spec__8A 600V

32. Vcc Diode waveform

Vcc_Forward winding diode



Test Condition:

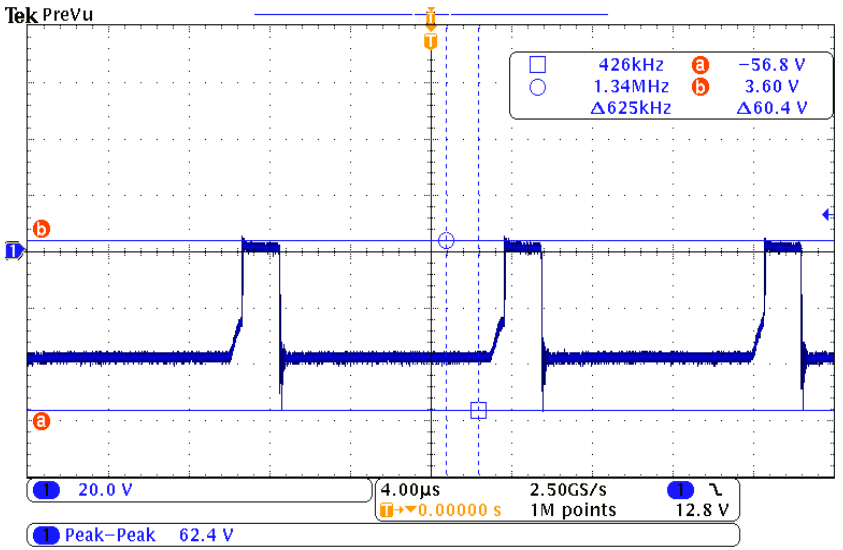
V_{IN}=305VAC, V_{OUT}=55V

Result:

V_{RRM_MAX}=134V

Remark:FR102_ Diode Spec__1A 200V

Vcc_Flyback winding diode



Test Condition:

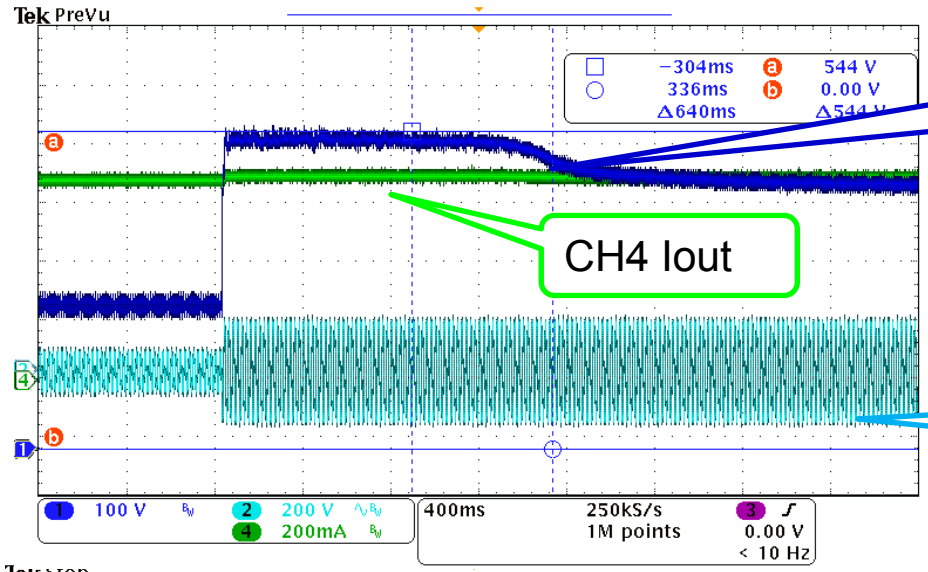
V_{IN}=305VAC, V_{OUT}=55V

Result:

V_{RRM_MAX}=60.4V

Remark:1N4148_ Diode Spec__0.2A 75V

33. AC line transient , Overshoot voltage on bulk-cap



Bulk-Cap Voltage

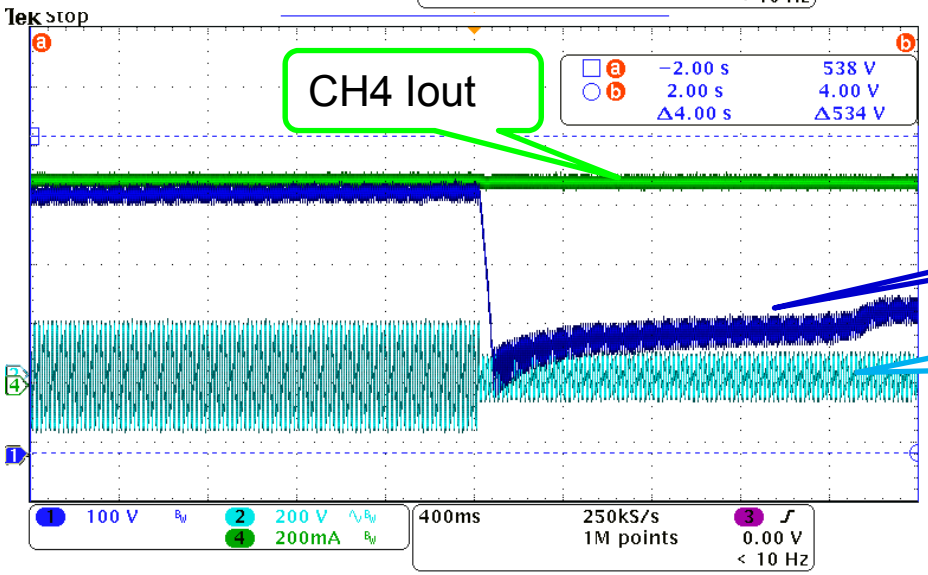
CH4 Iout

CH3 Vin AC

108V to 305V_{AC},Full Load

The bulk cap voltage is

544max



CH4 Iout

CH3 VCC

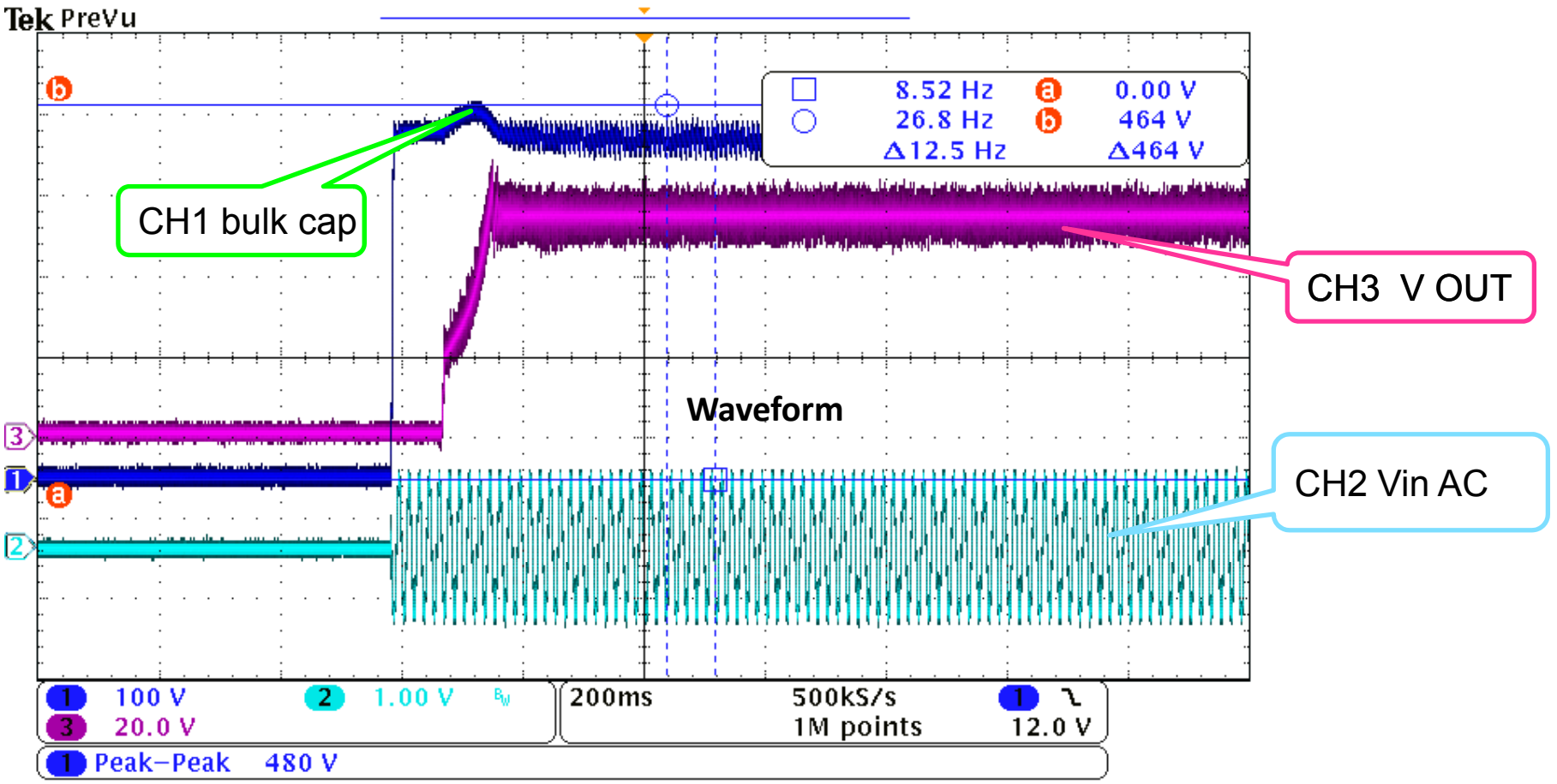
CH1 Vin AC

305V to 108V_{AC},Full Load

The bulk cap voltage is

227Vmax

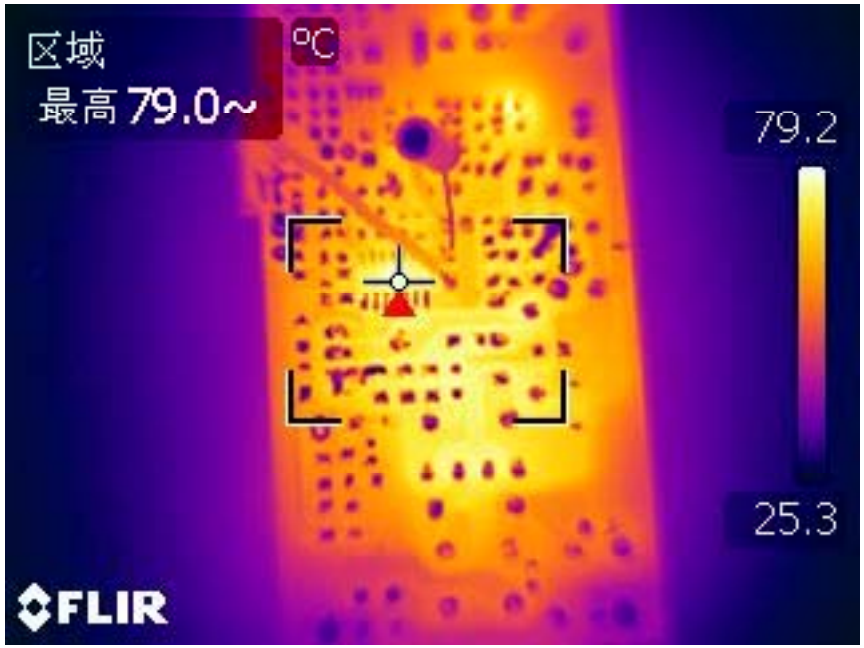
34. Power-on overshoot voltage on bulk cap

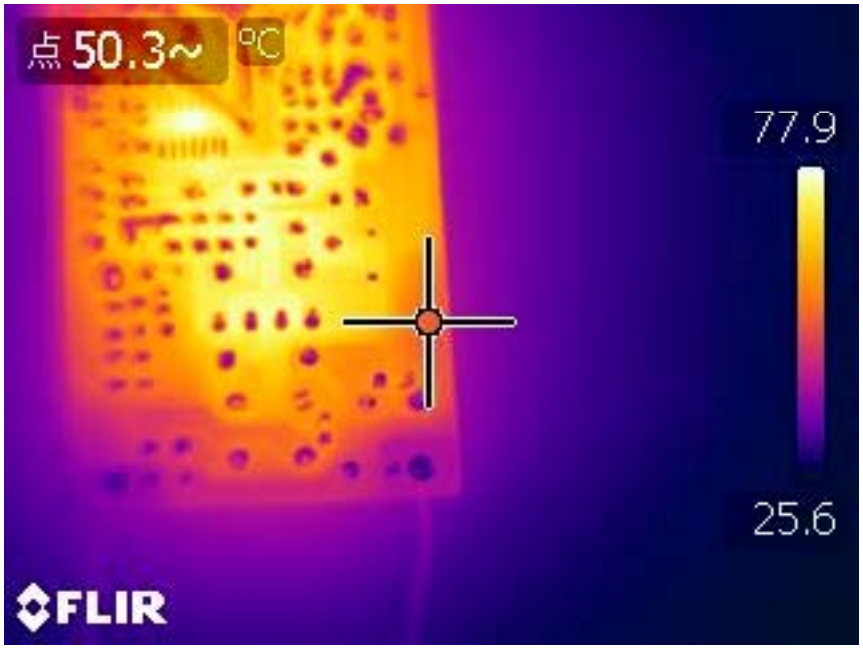


Vout 50V Vin 305V_{AC}

V bulk=464V

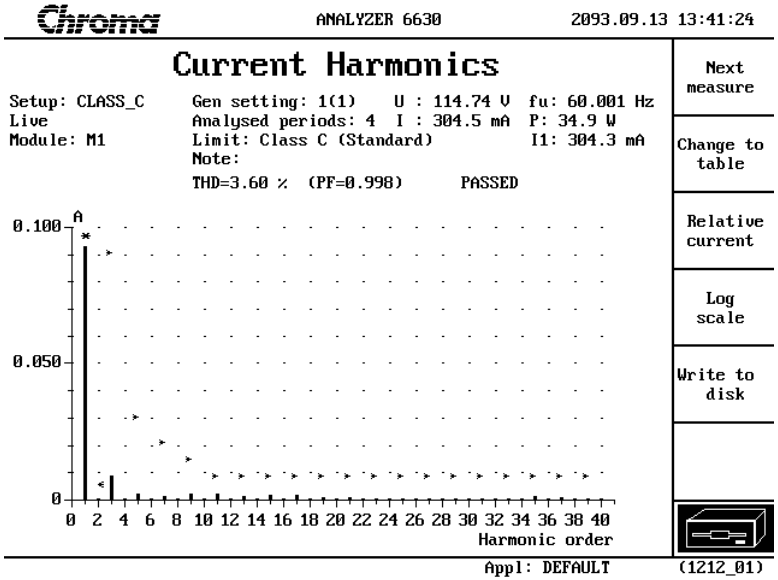
35. i W3630 thermal test

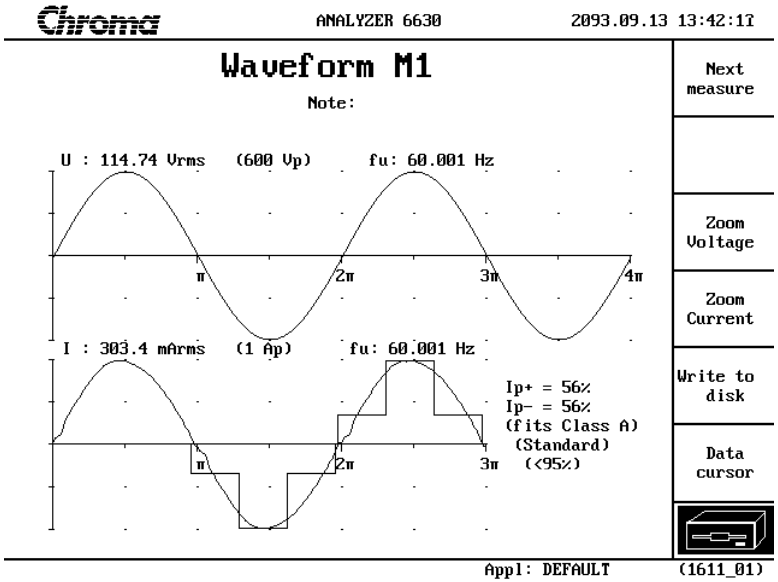




Input:108Vac
Output:55V700mA(Maximum output)
V cc@IC:13.2V Icc@IC:19mA
IC:79C
PCB:50.3C

36.Harmonic and current waveform





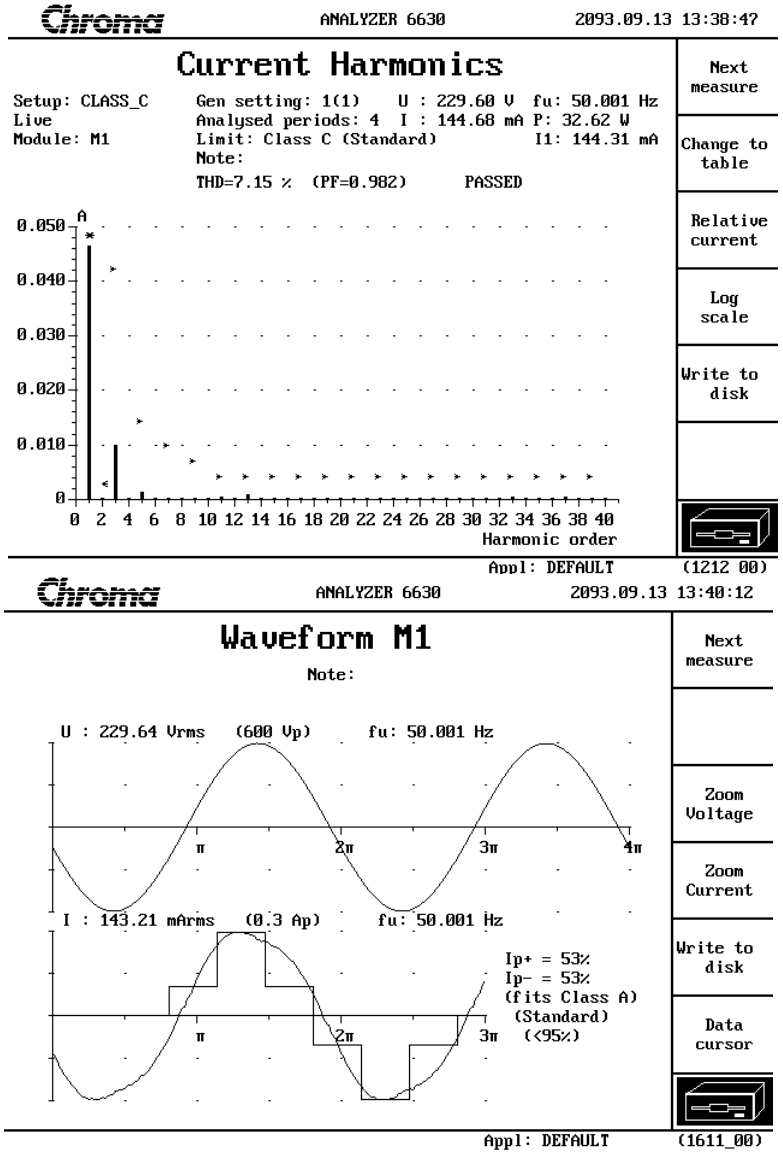
Harmonics current @115Vac

THD=3.6%

AC current waveform @115Vac

PF=0.998

37.Harmonic and current waveform



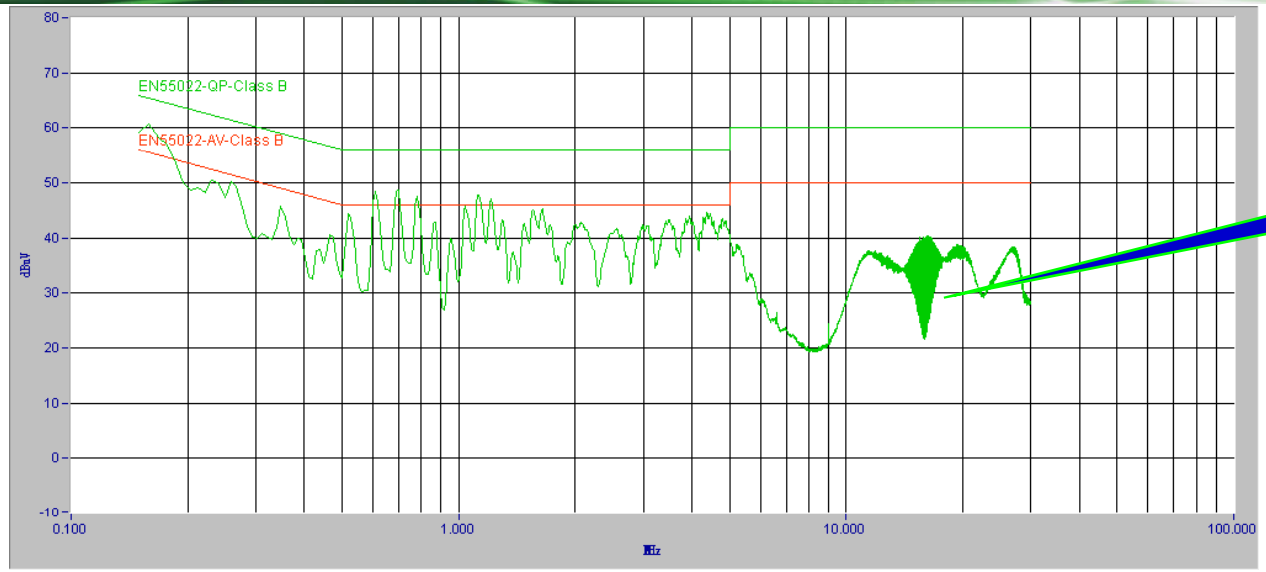
Harmonics current @230Vac

THD=7.15%

AC current waveform @230Vac

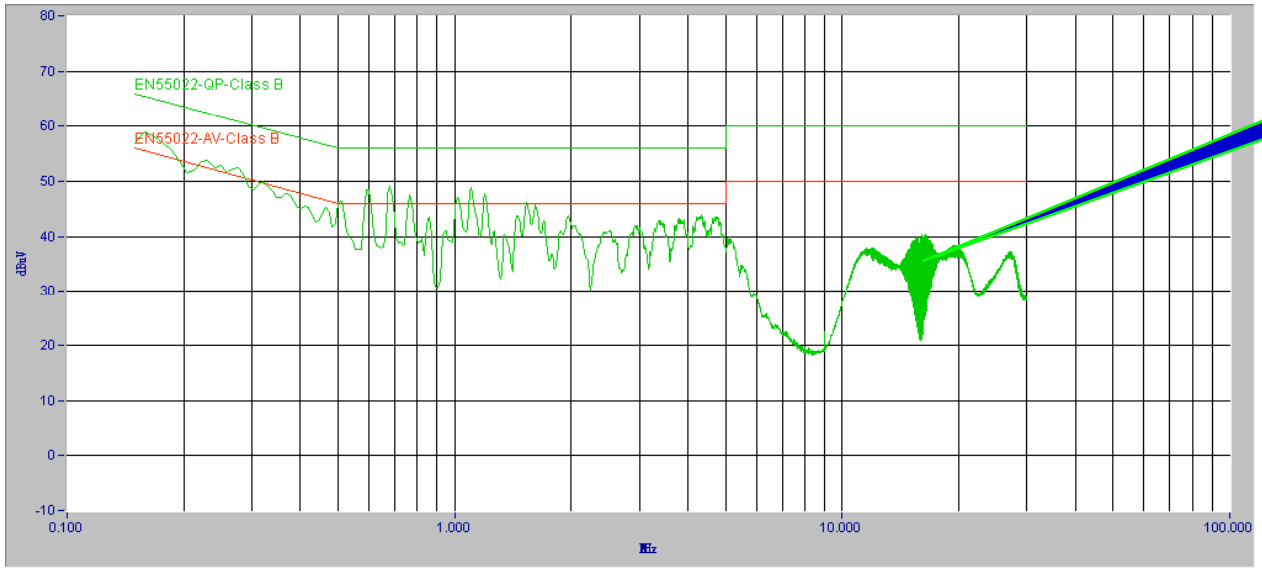
PF=0.982

38. Conducted EMI (Full Load)



QP Scan
QP Limit line

Input=230VAC
L line QP



QP Scan
QP Limit line

Input=230VAC
N line QP