Z$^+$800 H.V Series

EVALUATION

DATA

DWG No.: IA798-53-01		
APPD	CHK	DWG
⟋ 2/10/14	Kami S. Oct-2-14	MICHAEL C. 1.06.2014

TDK-Lambda

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TERMINOLOGY USED
Definition

Vin	Input voltage
Vout	Output voltage
Iin	Input current
Iout	Output current
Ta	Ambient temperature
f	Frequency
C.V	Constant voltage mode
C.C	Constant current mode

TDK-Lambda

1. EVALUATION METHOD

1.1 Circuit used for determination

(1) Steady state data
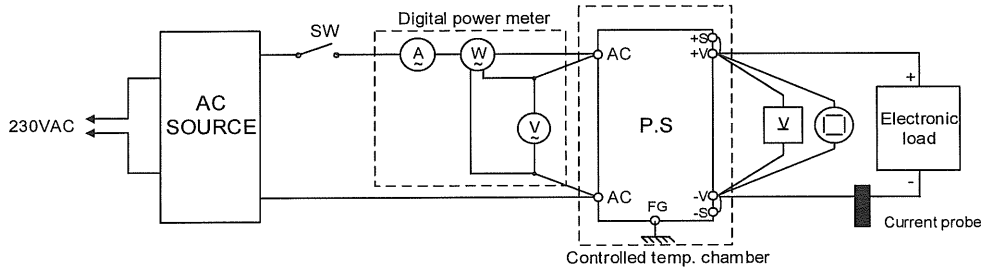
(2) Warm up voltage drift characteristics same as Steady state data

(3) Warm up current drift characteristics same as Steady state data

(4) Over voltage protection (OVP) characteristics
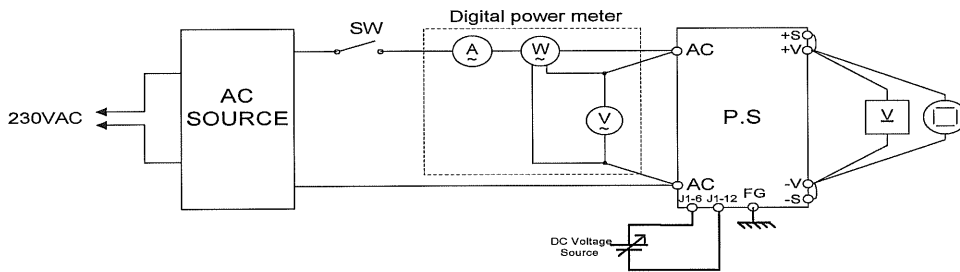
(5) Output voltage rise/fall characteristics same as Steady state data

(6) Output current rise/fall characteristics
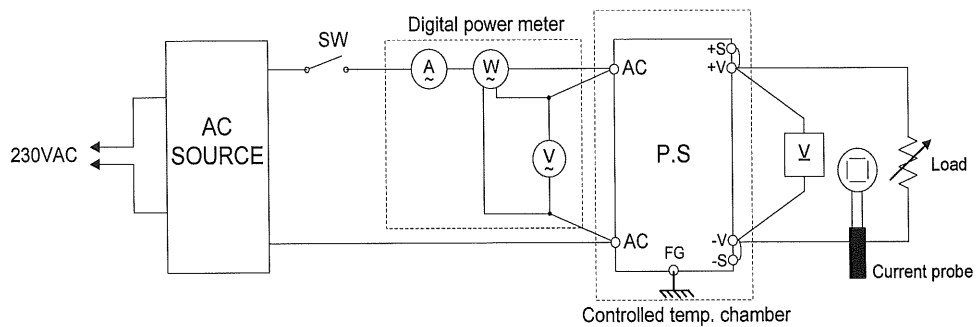
1.1 Circuit used for determination

(7) Dynamic line voltage and current response characteristics
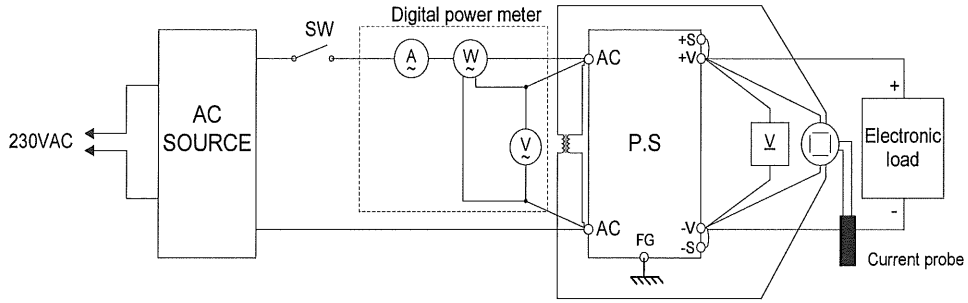
(8) Dynamic load voltage and current response characteristics
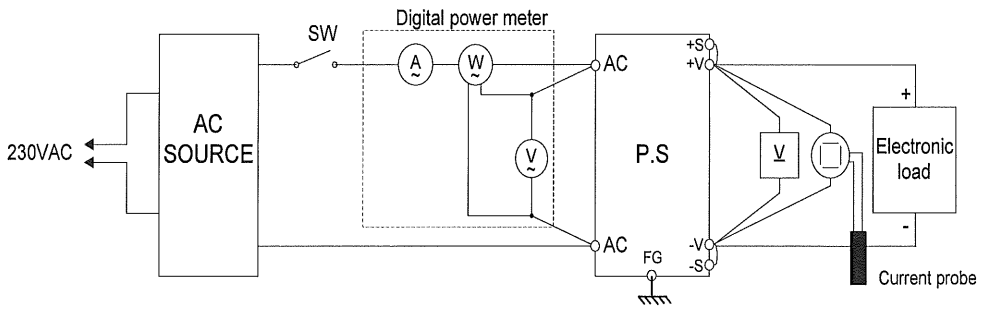
Constant Voltage mode

Output current waveform
Iout 0% <---> 100%
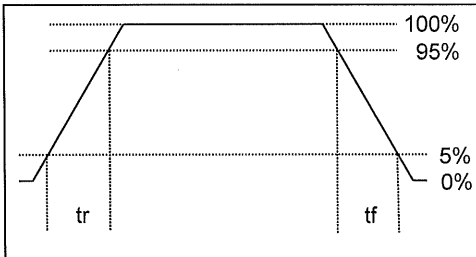
Output current waveform
Iout 50% <---> 100%
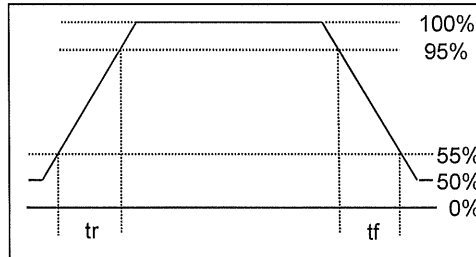
1.1 Circuit used for determination

(9) Response to brown-out characteristics
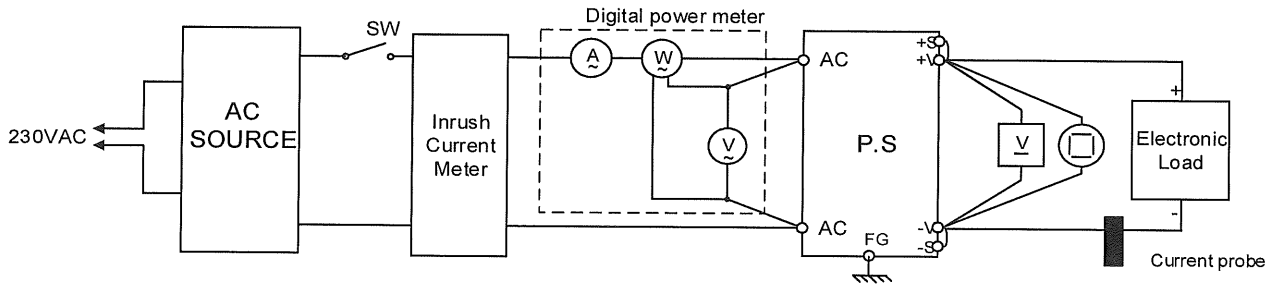
(10) Inrush current characteristics same as Response to brown-out

(11) Leakage current characteristics
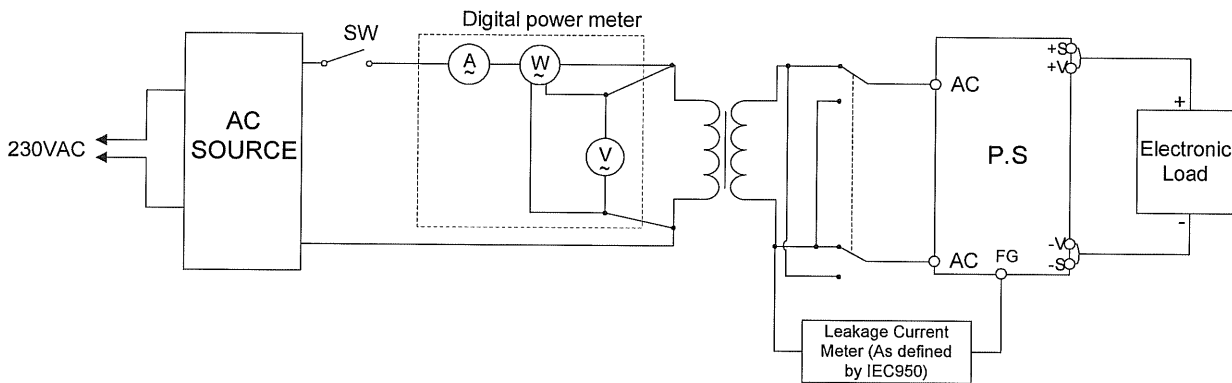
(12) Output Voltage ripple & noise waveform 160V up to 650V models

(a) Normal mode (JEITA Standard RC-9131A)
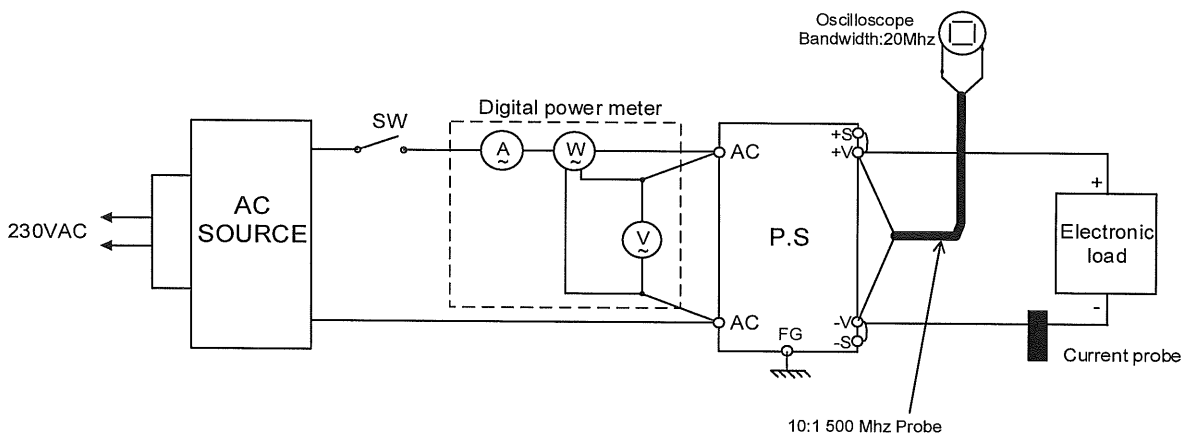
1.1 Circuit used for determination

(12) Output Voltage ripple & noise waveform 160V up to 650V models

(b) Normal + Common mode

Oscilloscope
Bandwidth:20Mhz

10:1 500Mhz Probe

SW

Digital power meter

230VAC

AC
SOURCE

A~   W

V

AC

P.S

AC

FG

+S
+V

L=150mm

C1

L=150mm

C1-Film Cap.
0.1uF

-V
-S

L=150mm

Electronic
load

+

−

Current probe
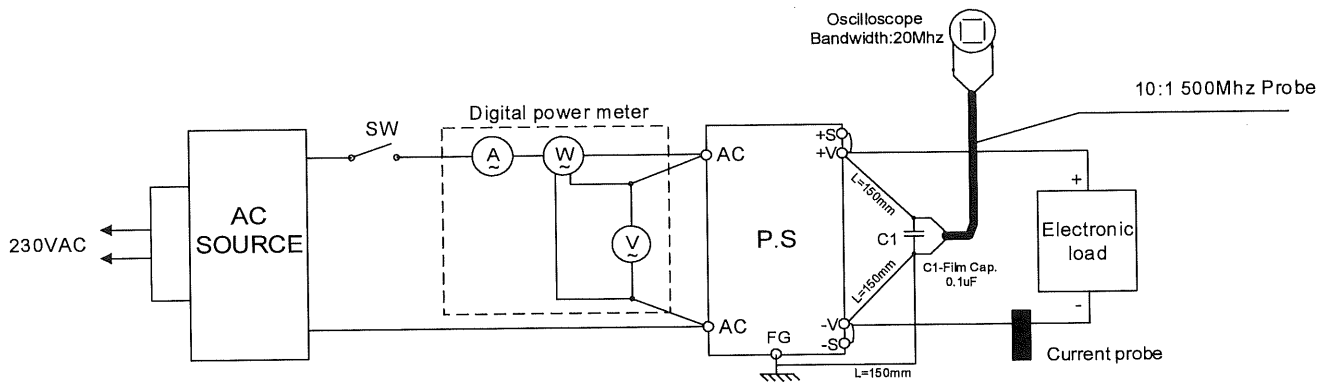
(13) Output Current rms ripple 160V to 650V models

Oscilloscope
Bandwidth:20Mhz

50Ω

4700pF

10:1 500Mhz Probe

SW

Digital power meter

230VAC

AC
SOURCE

A~   W

V

AC

P.S

AC

FG

+S
+V

-V
-S

Load

Current probe
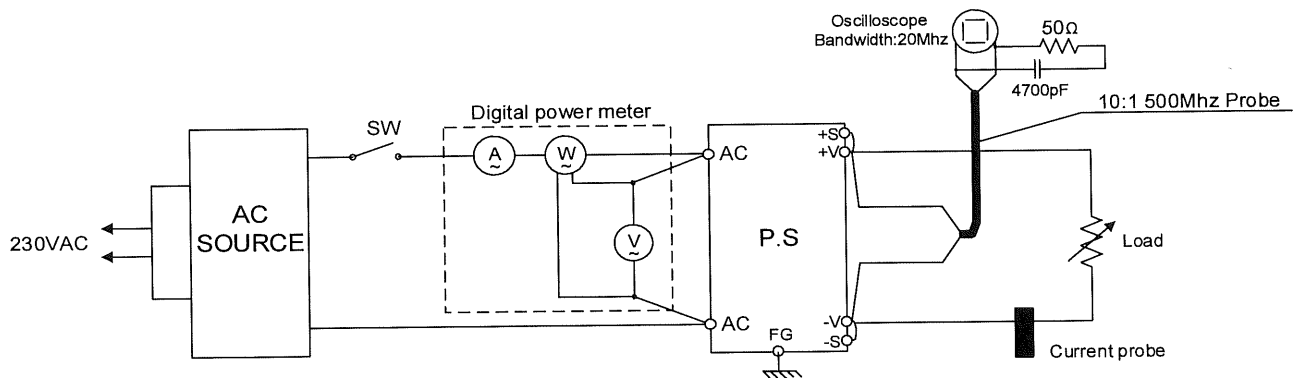
Notes:
(*) Ouput Current rms ripple = Output Voltage rms ripple divided by the Load resistance.

1.2 List of equipment used

	EQUIPMENT USED	MANUFACTURER	MODEL No.
1	Digital oscilloscope	YOKOGAWA	DL1740 E/EL
2	Digital multimeter	AGILENT	34401A
3	Digital power meter	YOKOGAWA	WT230 / WT110
4	AC source	CHROMA	6590/6463/6520/6530
5	Electronic load	H&H	ZS1880/ZS7060/ZS4260
6	Electronic load	CHROMA	63202 / 63204
7	Leakage current tester	KIKUSUI	TOS3200
8	Voltage probe	YOKOGAWA	701939/701944
9	Current probe	YOKOGAWA	701933
10	Inrush Current Meter	TAKAMISAWA	PSA-210
11	Data acquisition / switch unit	AGILENT	34970A
12	Controlled temp. chamber	THERMOTRON	SM-16-3800
13	Controlled temp. chamber	THERMOTRON	SM-16-8200
14	Controlled temp. chamber	THERMOTRON	SE-600-5-5
15	Controlled temp. chamber	THERMOTRON	SE-600-6-6

2. CHARACTERISTIC

2.1 Steady state data

(1) Regulation - Line & Load, Temperature drift

Z160-5

Conditions: Ta = 25°C

1. Regulation - Line & Load, C.V mode (Readings in [V])

Io	Vin (AC)				Line Regulation	
	85	100	200	265		
0%	159.9867	159.9864	159.9866	159.9866	0.3	0.000
25%	159.9863	159.9866	159.9861	159.9865	0.5	0.000
50%	159.9858	159.9859	159.9862	159.9862	0.4	0.000
75%	159.9861	159.9862	159.9861	159.9861	0.1	0.000
100%	159.9860	159.9861	159.9853	159.9858	0.8	0.001
Load Regulation	0.9	0.7	1.3	0.8	ΔV(mV)	(%)
	0.001	0.000	0.001	0.001	(%)	

2. Temperature drift, C.V mode

Conditions: Vin:100Vac
Iout:100%

Ta	0°C	25°C	50°C	Temp. Coefficient (0°C~50°C)	
Vout	159.989	159.973	159.978	16 mV	1.4 ppm/°C

2.1 Steady state data

(1) Regulation - Line & Load, Temperature drift

| Z650-1.25 |

Conditions: Ta = 25°C

1. Regulation - Line & Load, C.V mode (Readings in [V])

Io	Vin (AC)				Line Regulation	
	85	100	200	265		
0%	649.9532	649.9539	649.9550	649.9565	3.3	0.001
25%	649.9846	649.9853	649.9851	649.9850	0.7	0.000
50%	649.9867	649.9869	649.9867	649.9871	0.4	0.000
75%	649.9859	649.9862	649.9870	649.9870	1.1	0.000
100%	649.9829	649.9831	649.9832	649.9835	0.6	0.000
Load Regulation	33.5	33.0	32.0	30.6	ΔV(mV)	(%)
	0.005	0.005	0.005	0.005	(%)	

2. Temperature drift, C.V mode

Conditions: Vin:100Vac
Iout:100%

Ta	0°C	25°C	50°C	Temp. Coefficient (0°C~50°C)	
Vout	650.029	650.022	650.140	118 mV	3.4 ppm/°C

2.1 Steady state data

(1) Regulation - Line & Load, Temperature drift

| Z160-5 |

Conditions: Ta = 25°C

1. Regulation - Line & Load, C.C mode (*) (Readings in [A])

Vo	Vin (AC)				Line Regulation	
	85	100	200	265		
0%	5.0019	5.0019	5.0018	5.0018	0.1	0.002
25%	4.9999	4.9999	4.9999	4.9999	0.0	0.000
50%	4.9997	4.9997	4.9996	4.9997	0.1	0.002
75%	4.9995	4.9995	4.9994	4.9995	0.1	0.002
100%	4.9993	4.9993	4.9991	4.9992	0.2	0.004
Load Regulation	2.6	2.6	2.7	2.6	ΔI(mA)	(%)
	0.052	0.052	0.054	0.052	(%)	

Notes:
(*) Not including load regulation thermal drift effect.

2. Temperature drift, C.C mode

Conditions: Vin:100Vac
Iout:100%

Ta	0°C	25°C	50°C	Temp. Coefficient (0°C~50°C)	
Iout	4.9992	4.9995	5.0033	4.1 mA	16 ppm/°C

2.1 Steady state data

(1) Regulation - Line & Load, Temperature drift

Z650-1.25

Conditions: Ta = 25°C

1. Regulation - Line & Load, C.C mode (*) (Readings in [A])

Vo	Vin (AC)				Line Regulation	
	85	100	200	265		
0%	1.2497	1.2497	1.2497	1.2497	0.0	0.000
25%	1.2499	1.2499	1.2499	1.2499	0.0	0.000
50%	1.2500	1.2500	1.2500	1.2500	0.0	0.000
75%	1.2501	1.2501	1.2501	1.2501	0.0	0.000
100%	1.2501	1.2501	1.2501	1.2501	0.0	0.000
Load Regulation	0.4	0.4	0.4	0.4	ΔI(mA)	(%)
	0.032	0.032	0.032	0.032	(%)	

Notes:
(*) Not including load regulation thermal drift effect.

2. Temperature drift, C.C mode

Conditions: Vin:100Vac
Iout:100%

Ta	0°C	25°C	50°C	Temp. Coefficient (0°C~50°C)	
Iout	1.24772	1.24770	1.24832	0.6 mA	10 ppm/°C

2.1 Steady state data

(2) Output voltage and ripple voltage v.s input voltage

C.V mode
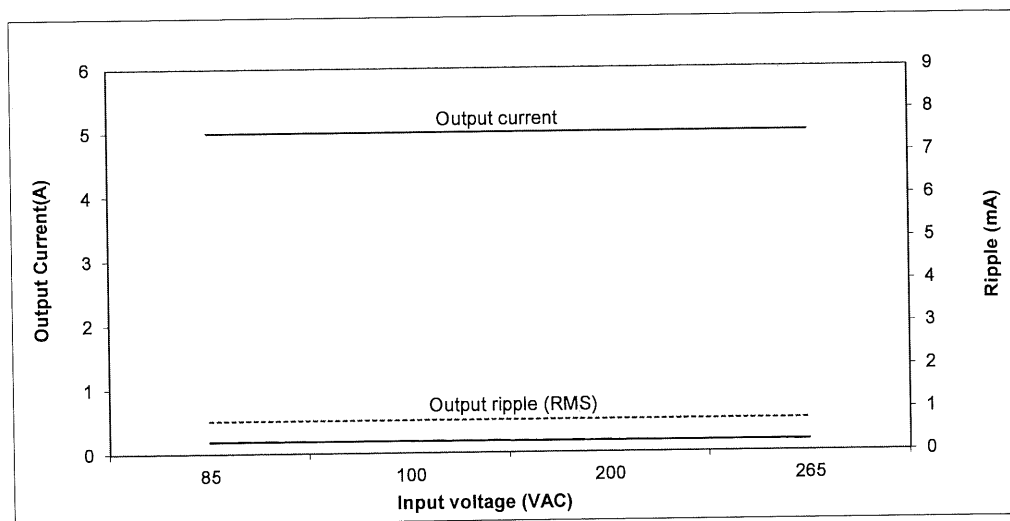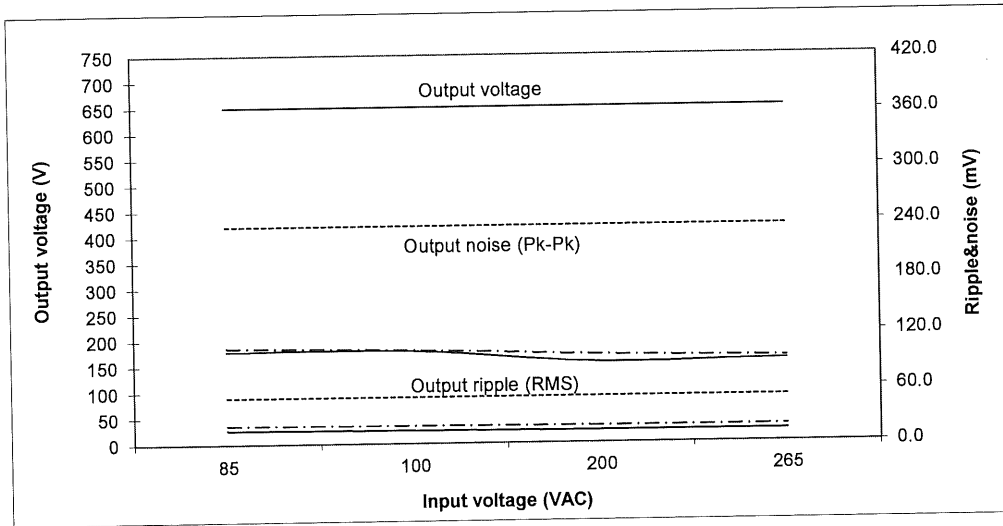
Conditions: Iout:100%

| Z160-5 |

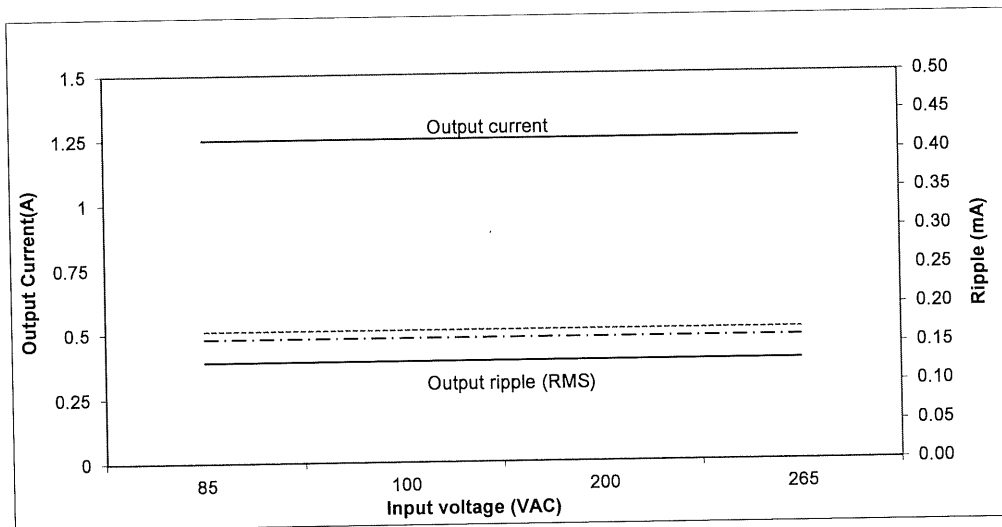Ta: 0°C -------------
     25°C ------------
     50°C _____
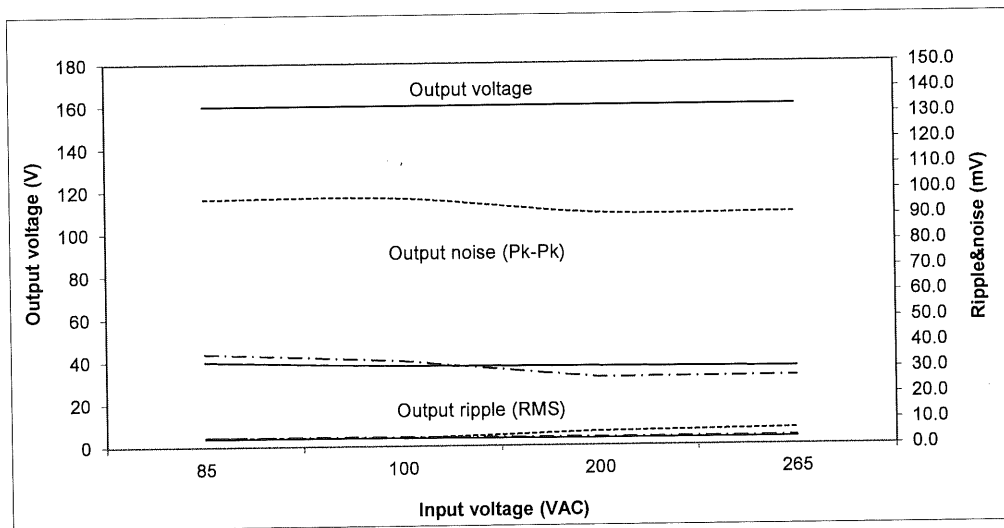
(3) Output current and ripple current v.s input voltage

C.C mode

Conditions: Vout:100%
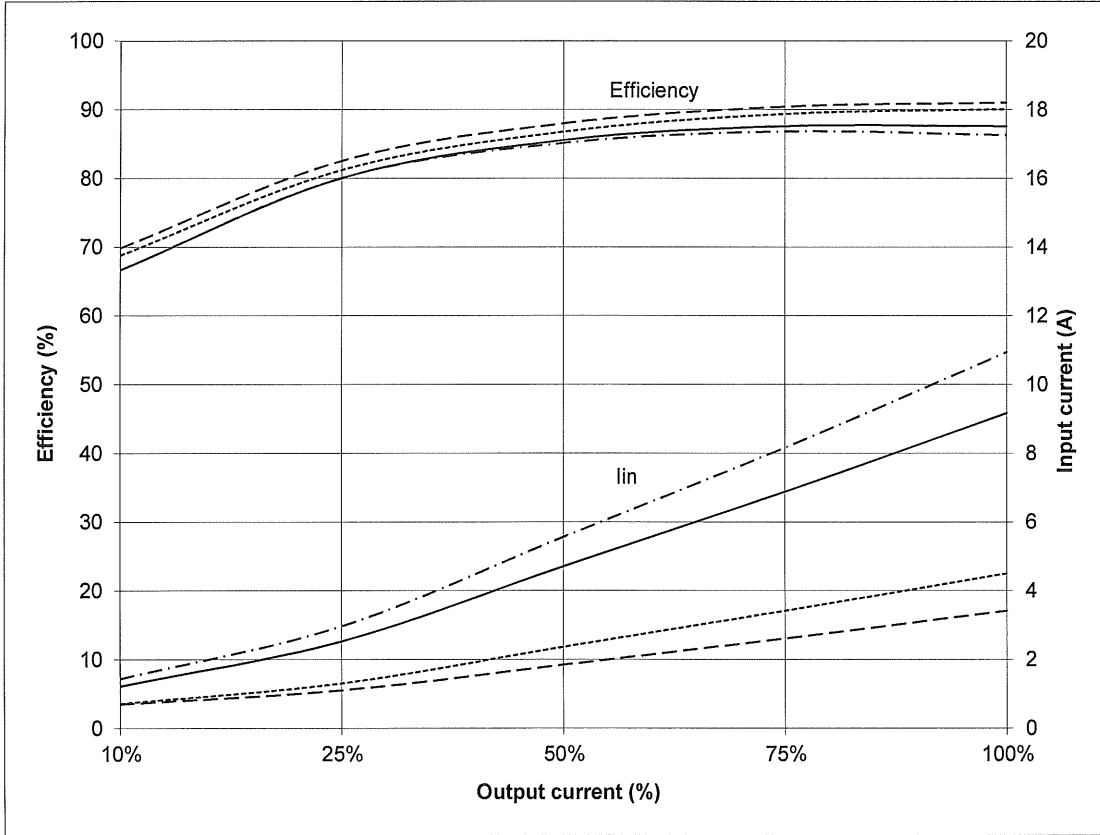
| Z160-5 |

Ta: 0°C -------------
     25°C ------------
     50°C _____

TDK-Lambda

2.1 Steady state data

(2) Output voltage and ripple voltage v.s input voltage

C.V mode

Conditions: Iout:100%

| Z650-1.25 |

Ta: 0°C   ------------
      25°C —·—·—·—·—·
      50°C —————————

(3) Output current and ripple current v.s input voltage

C.C mode

Conditions: Vout:100%

| Z650-1.25 |

Ta: 0°C   ------------
      25°C —·—·—·—·—·
      50°C —————————

TDK-Lambda

2.1 Steady state data

(4) Efficiency and Input current vs. Output current

Conditions:
Vin: 85 VAC   —·—·—·—·—
      100VAC   ————
      200 VAC   - - - - - - -
      265 VAC   — — — —
Vout:100%
Ta: 25°C

Z160-5

TDK-Lambda   T-12

2.1 Steady state data

(4) Efficiency and Input current vs. Output current

Conditions:
Vin: 85 VAC   ─·─··─··─··─
     100VAC   ─────────
     200 VAC   ─────────
     265 VAC   ── ── ── ──
Vout:100%
Ta: 25°C
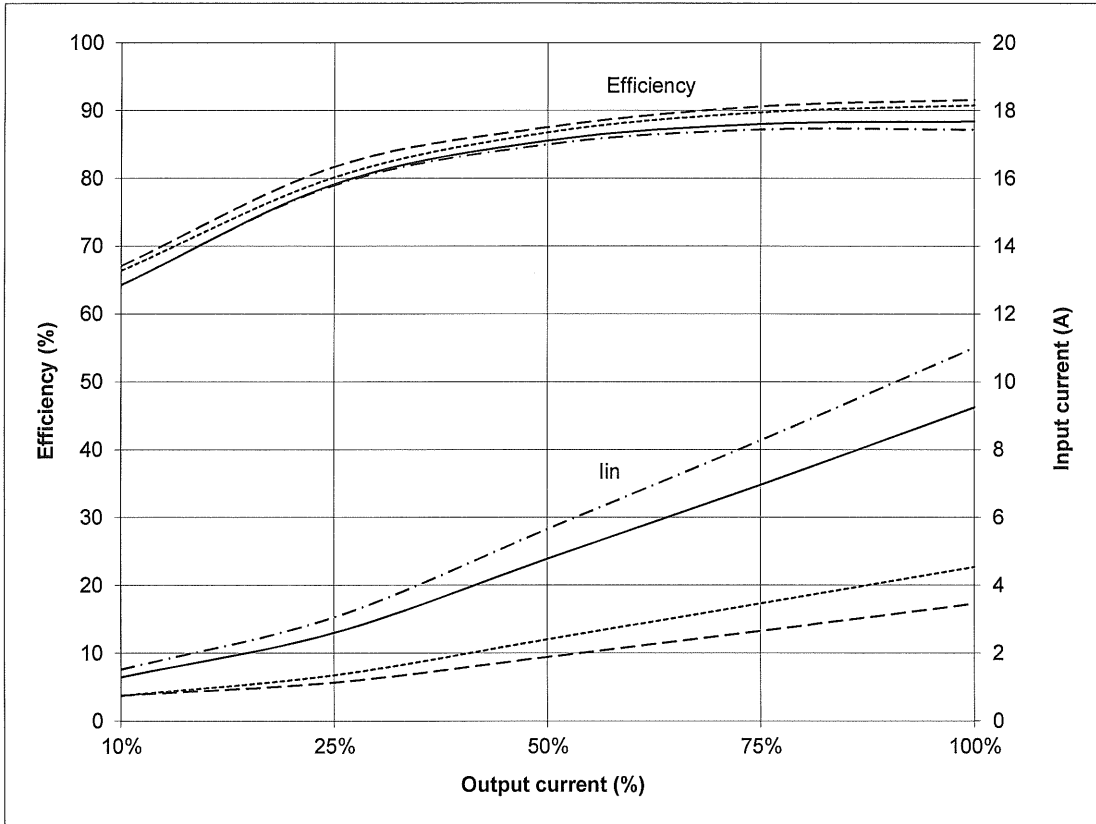
Z650-1.25

2.2 Warm up drift & stability
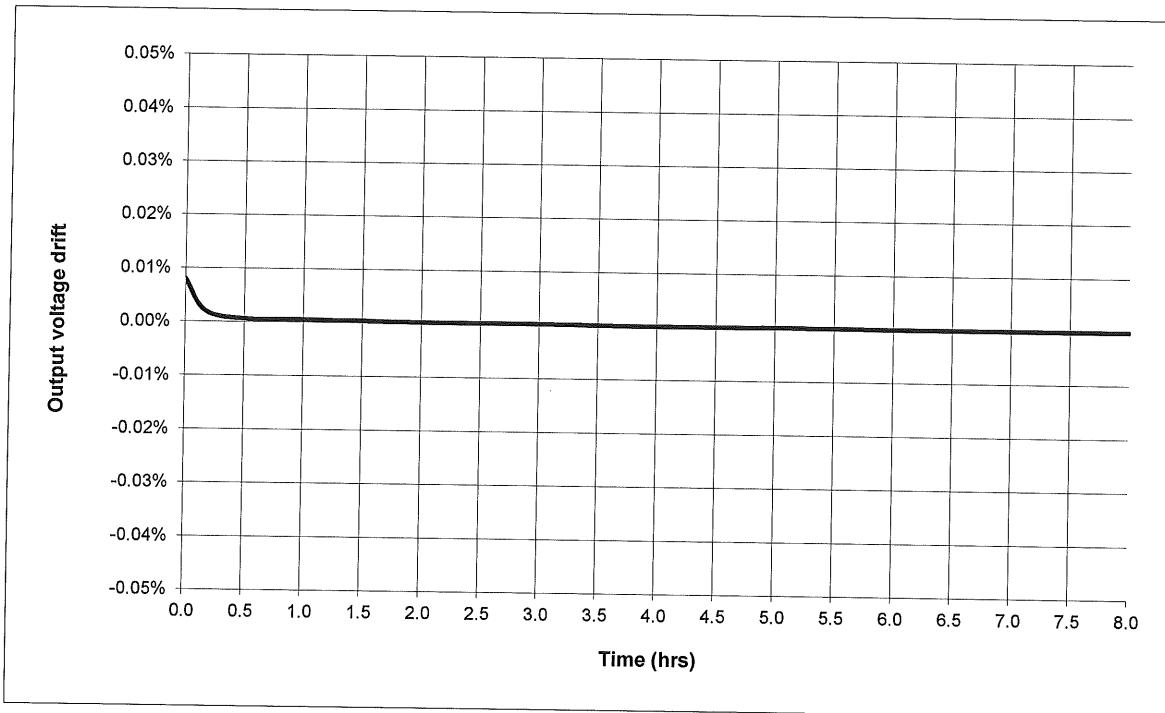
C.V mode

Z160-5

C.C mode

Z160-5
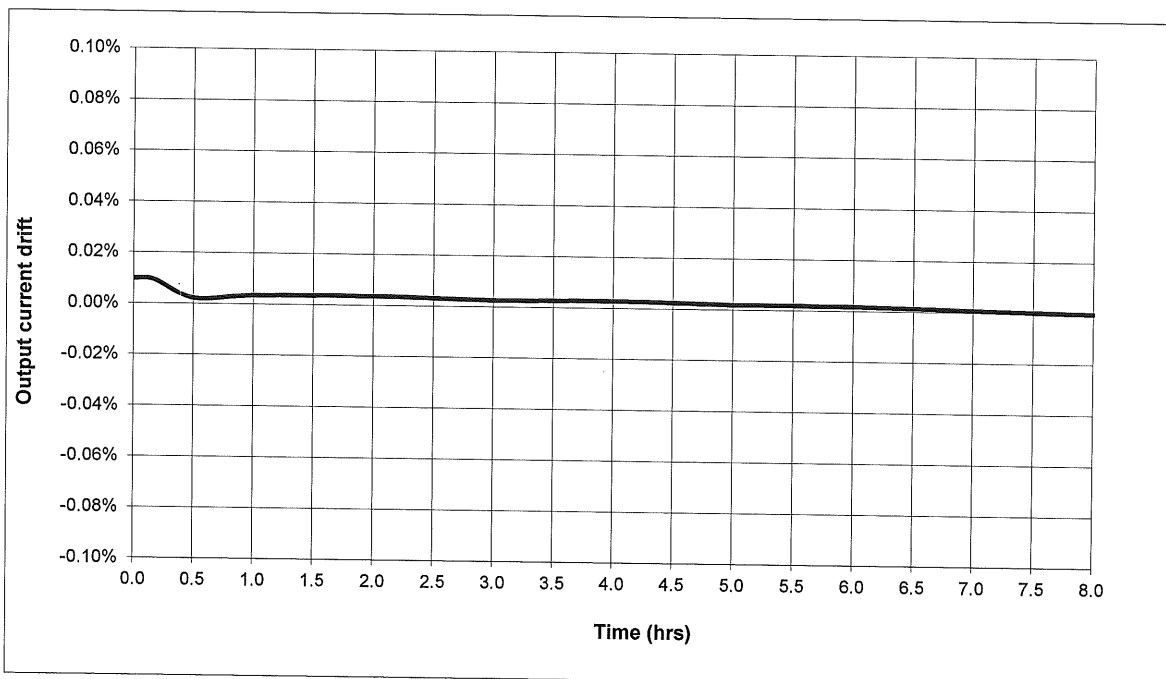
2.2 Warm up drift & stability

C.V mode

Z650-1.25

C.C mode

Z650-1.25

TDK-Lambda
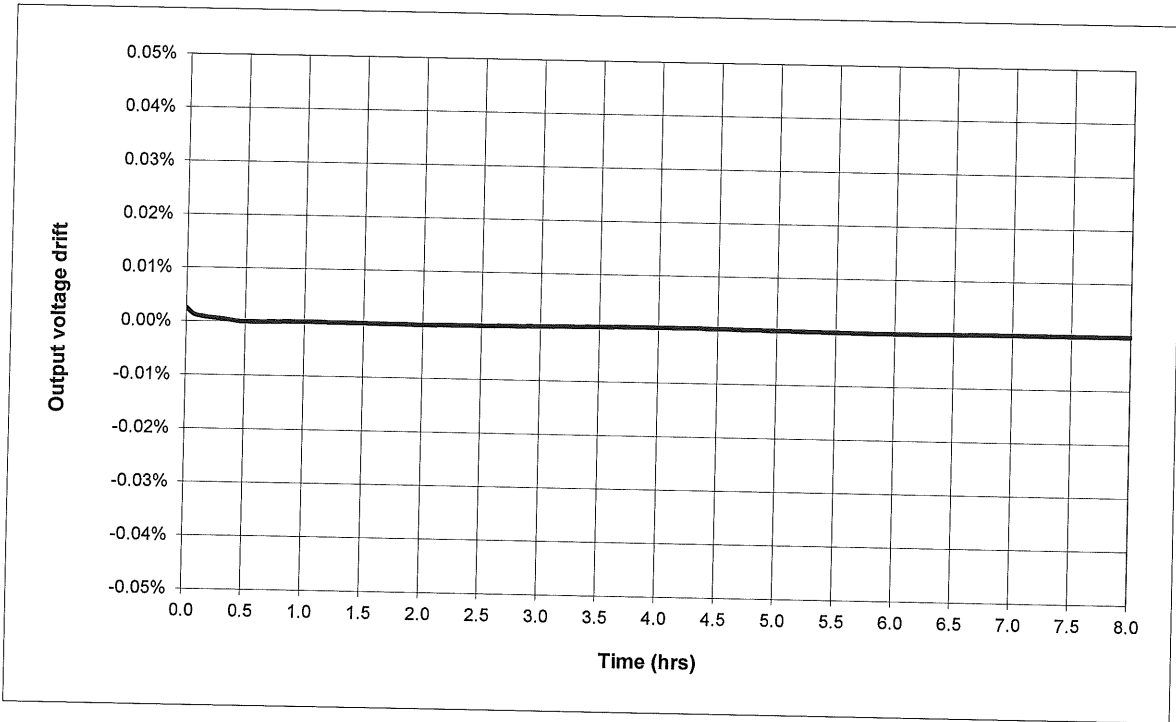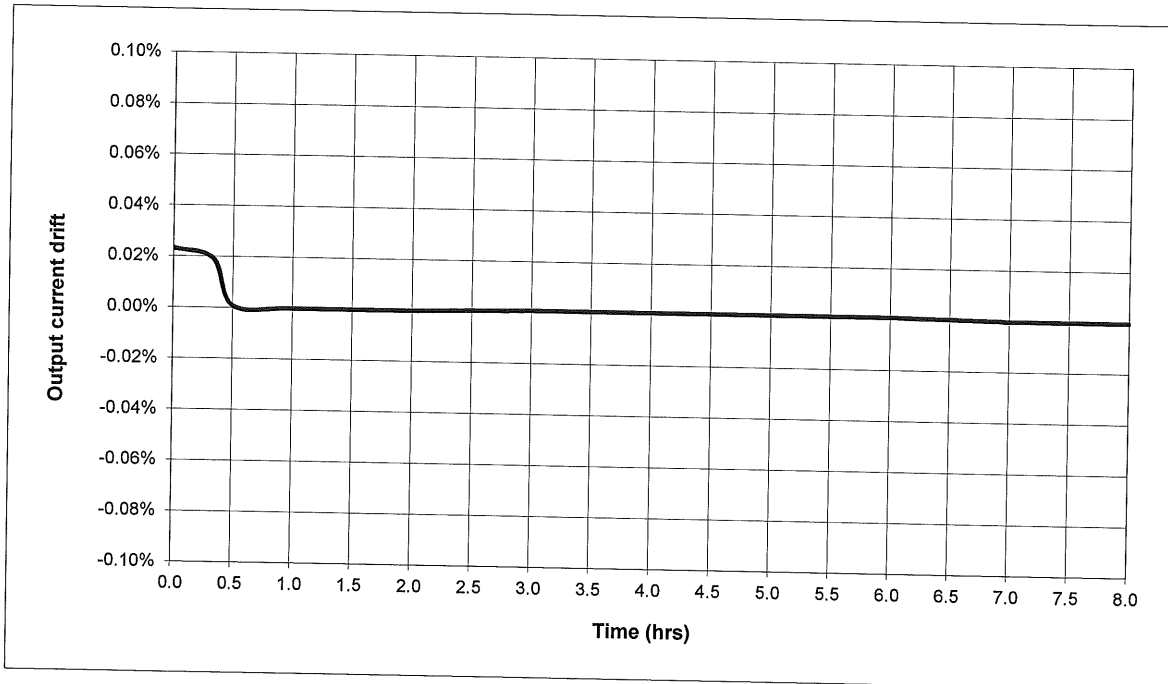
2.3 Over voltage protection characteristics

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

Z160-5

| 50^V/DIV | 500^{ms}/DIV |
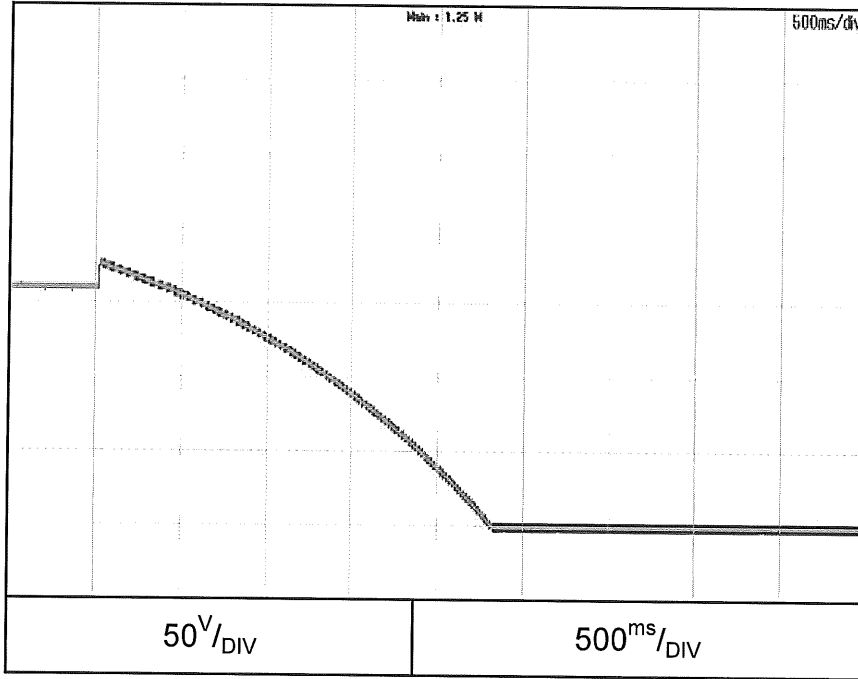
OVP setting: 176V

Z650-1.25

| 200^V/DIV | 500^{ms}/DIV |
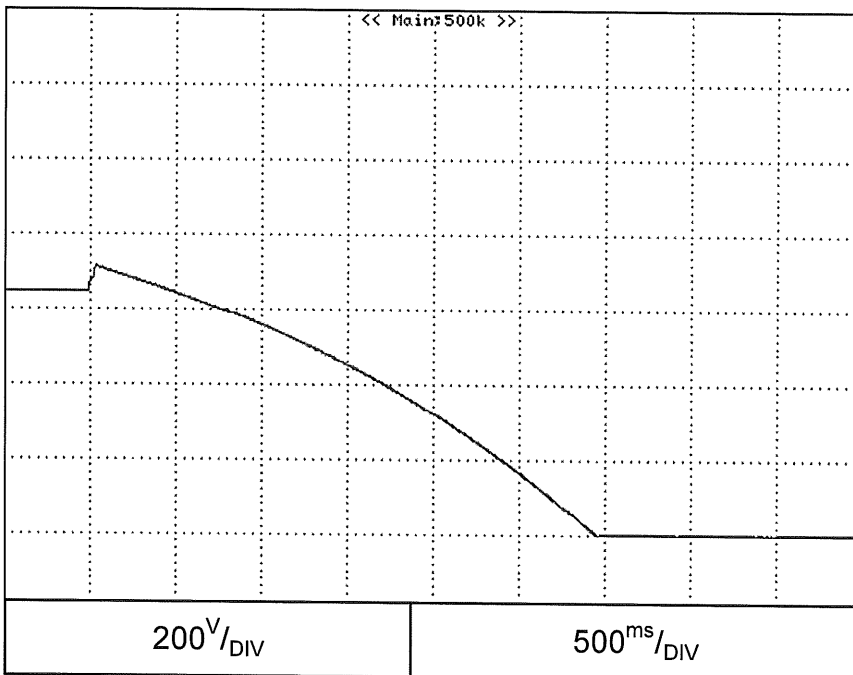
OVP setting: 717V

2.4 ON/OFF Output rise characteristics

C.V mode

Conditions: Vin:100Vac
Vout: 100%
Iout: 0%
Iset=105%
Ta = 25°C

Z160-5

50^V/$_{DIV}$	20^{ms}/$_{DIV}$

Z650-1.25

200^V/$_{DIV}$	20^{ms}/$_{DIV}$

TDK-Lambda

2.4 ON/OFF Output rise characteristics

C.V mode

Conditions:

Vin:100Vac
Vout: 100%
Iout: 100%
Iset=105%
Load: CR
Ta = 25°C

Z160-5

| 50^V/DIV | 20^{ms}/DIV |

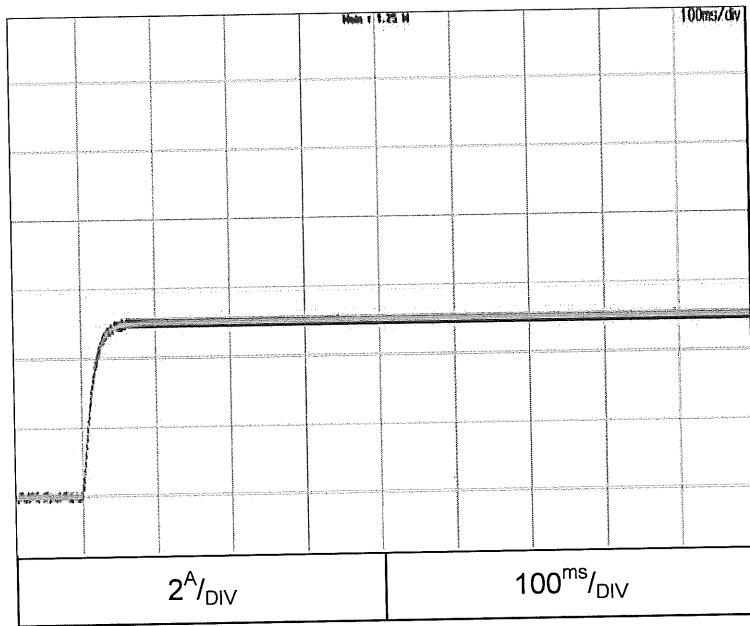### Z650-1.25

| 200^V/DIV | 50^{ms}/DIV |

2.4 ON/OFF Output rise characteristics

Conditions:

Vin:100Vac
Vout: 100%
Iout: 100%
Vset=105%
Load: CR
Ta = 25°C

C.C mode

Z160-5

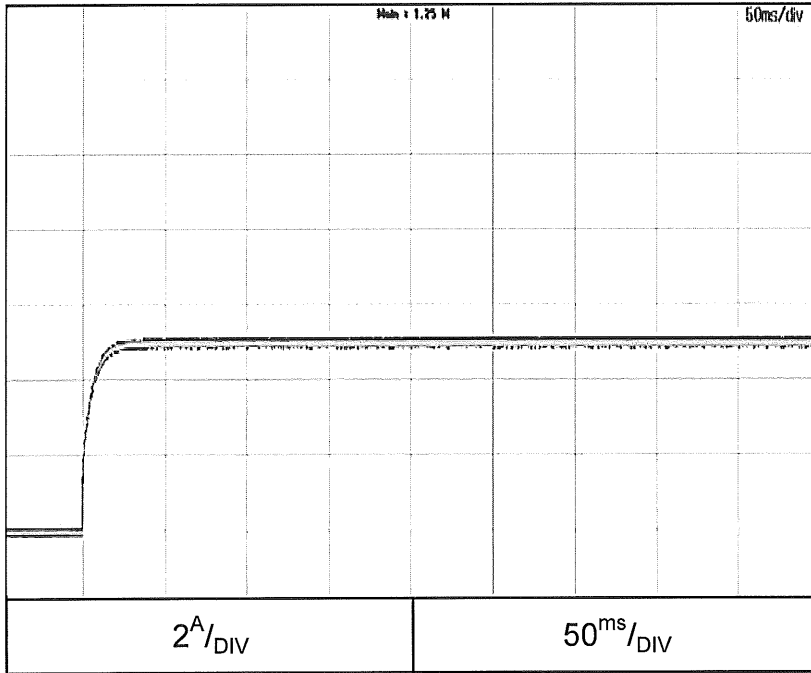
$2^A/_{DIV}$	$100^{ms}/_{DIV}$

Z650-1.25

$0.5^A/_{DIV}$	$50^{ms}/_{DIV}$

TDK-Lambda

2.4 ON/OFF Output rise characteristics

Conditions: Vin:100Vac
Iout: 100%
Vset=105%
shorted output
Ta = 25°C

C.C mode

Z160-5

Main : 1.25 N	50ms/div

2^A/$_{DIV}$	50^{ms}/$_{DIV}$

Z650-1.25

<< Main:400k >>

0.5^A/$_{DIV}$	20^{ms}/$_{DIV}$

2.5 ON/OFF Output fall characteristics

C.V mode

Conditions: Vin:100Vac
Vout: 100%
Iout: 0%
Iset=105%
Ta = 25°C

Z160-5

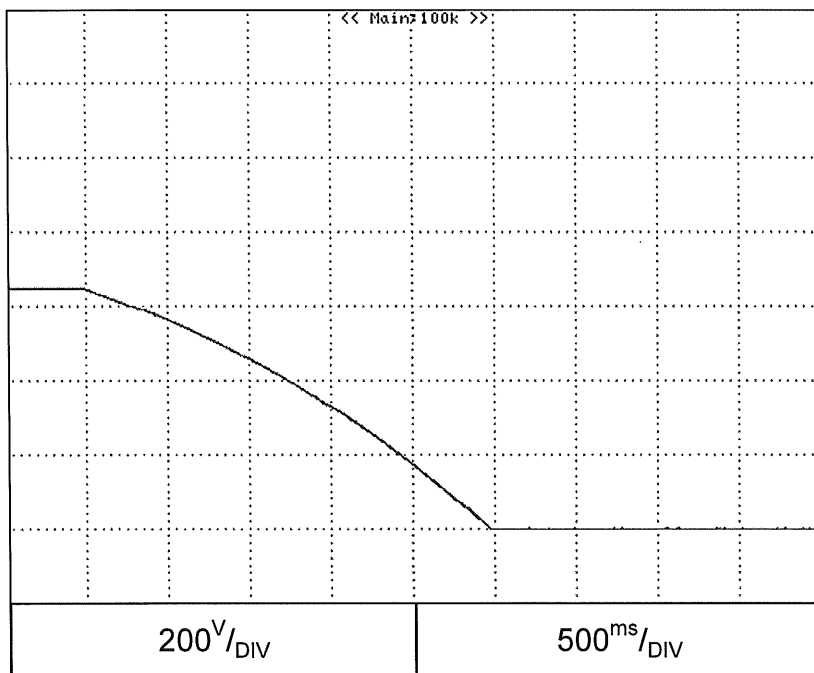| 50^V/$_{DIV}$	500^{ms}/$_{DIV}$

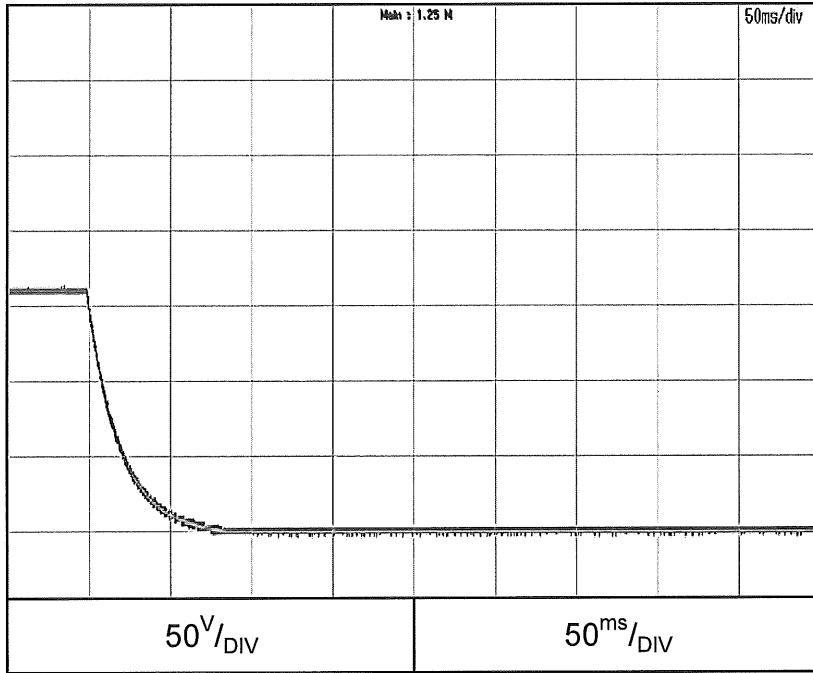| Z650-1.25 |
|---|

200^V/$_{DIV}$	500^{ms}/$_{DIV}$

2.5 ON/OFF Output fall characteristics

Conditions: Vin:100Vac
Vout: 100%
Iout: 100%
Iset=105%
Load: CR
Ta = 25°C

C.V mode

| Z160-5 |

| 50^V/$_{DIV}$ | 50^{ms}/$_{DIV}$ |

| Z650-1.25 |

| 200^V/$_{DIV}$ | 50^{ms}/$_{DIV}$ |
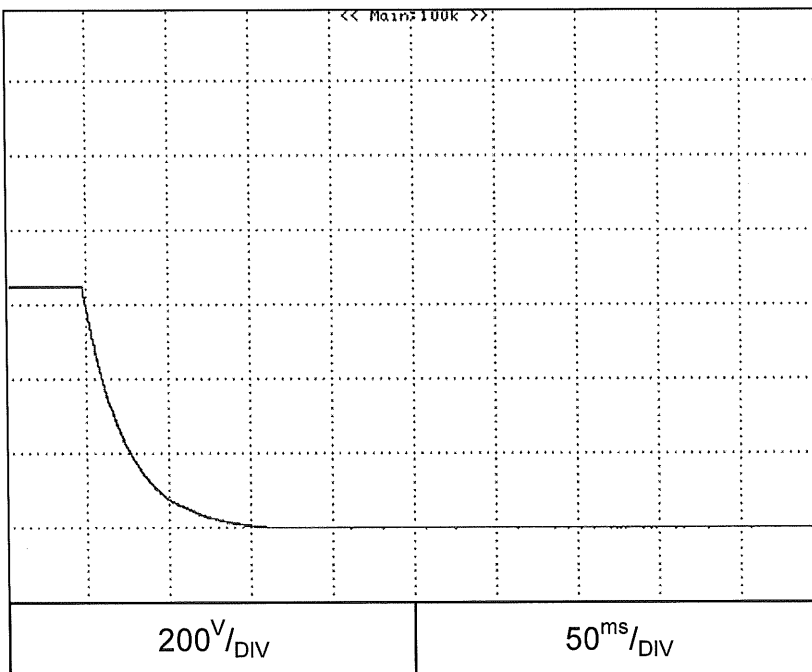
TDK-Lambda

2.5 ON/OFF Output fall characteristics

Conditions: Vin:100Vac
Vout: 100%
Iout: 100%
Vset=105%
Load: CR
Ta = 25°C

C.C mode

Z160-5

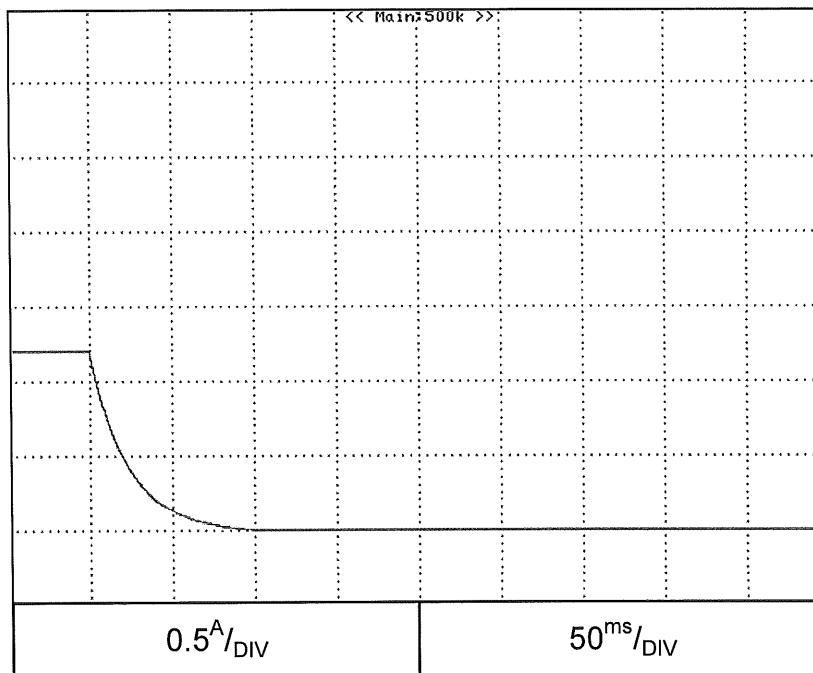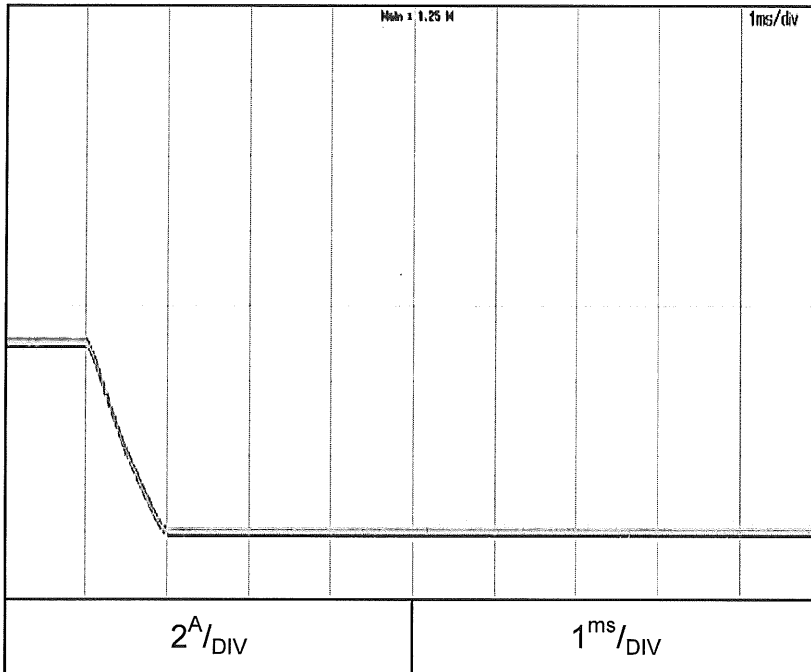| $2^A/_{DIV}$	$100^{ms}/_{DIV}$

Z650-1.25

$0.5^A/_{DIV}$	$50^{ms}/_{DIV}$

2.5 ON/OFF Output fall characteristics

Conditions: Vin:100Vac
Iout: 100%
Vset=105%
shorted output
Ta = 25°C
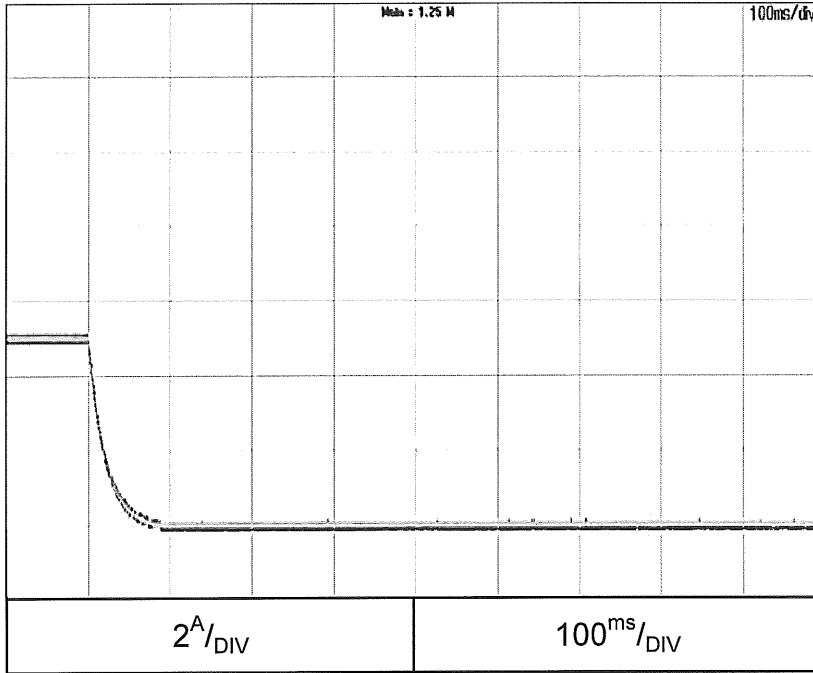
C.C mode

| Z160-5 |

| $2^A/_{DIV}$ | $1^{ms}/_{DIV}$ |

| Z650-1.25 |

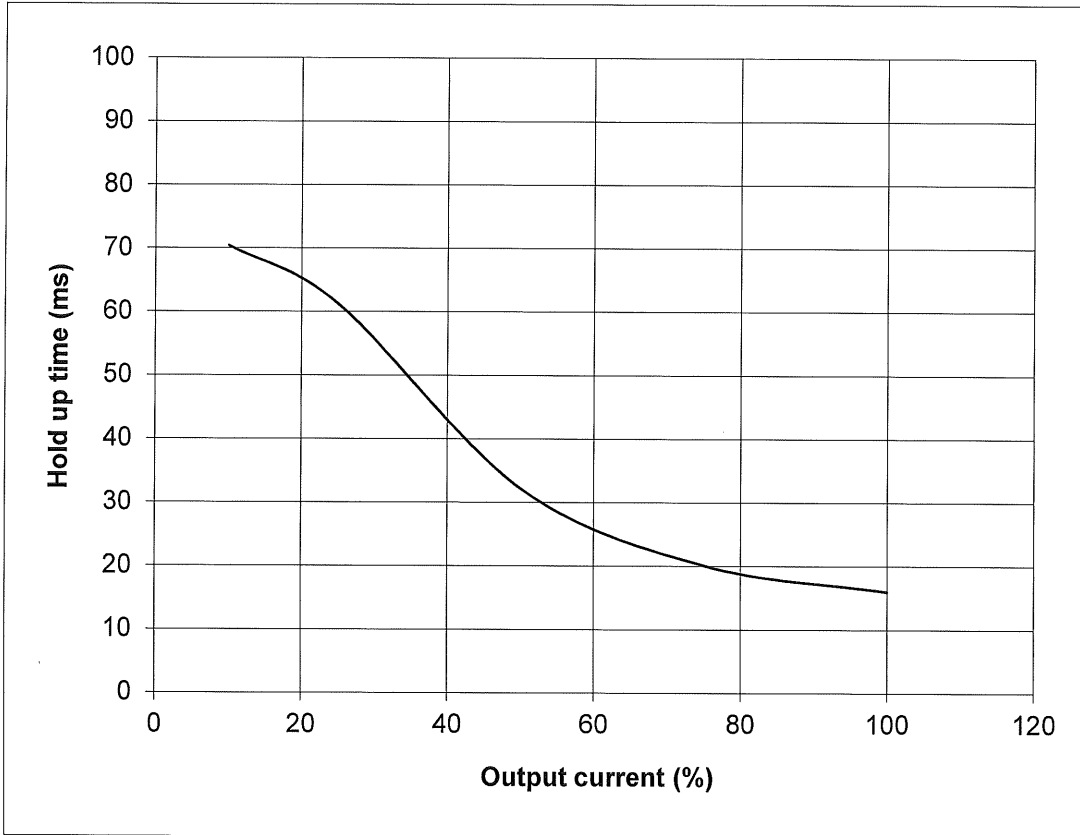| $0.5^A/_{DIV}$ | $2^{ms}/_{DIV}$ |
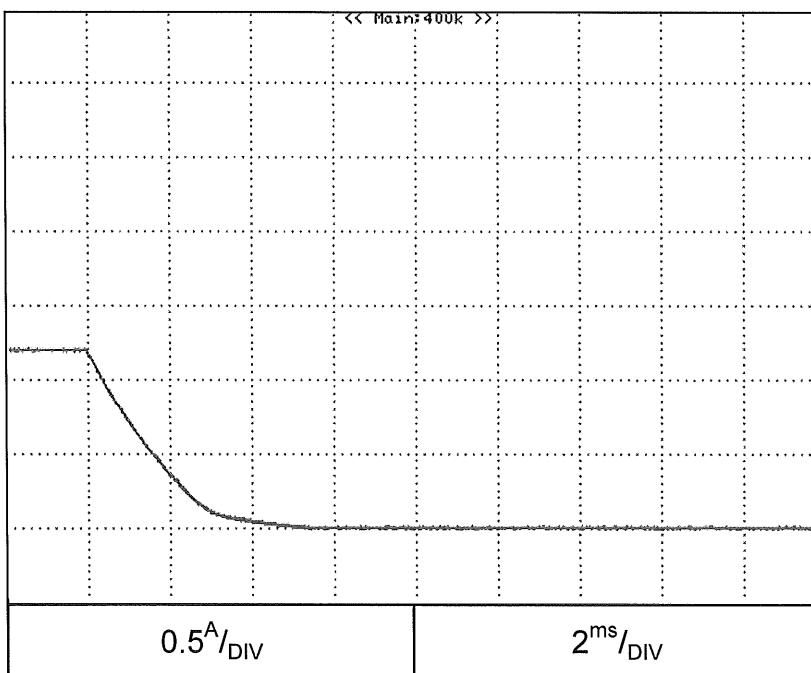
2.6 Hold up time characteristics

Conditions: Vin:100Vac
Vout: 100%
Ta = 25°C

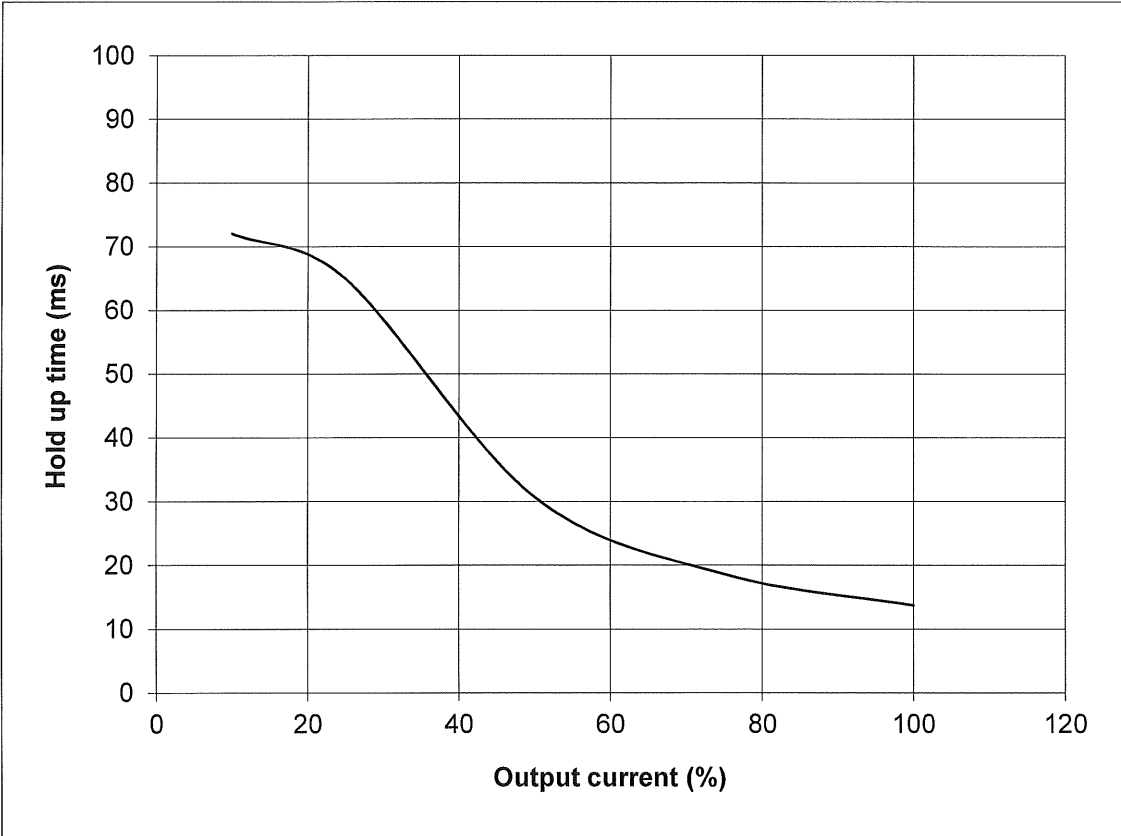Z160-5
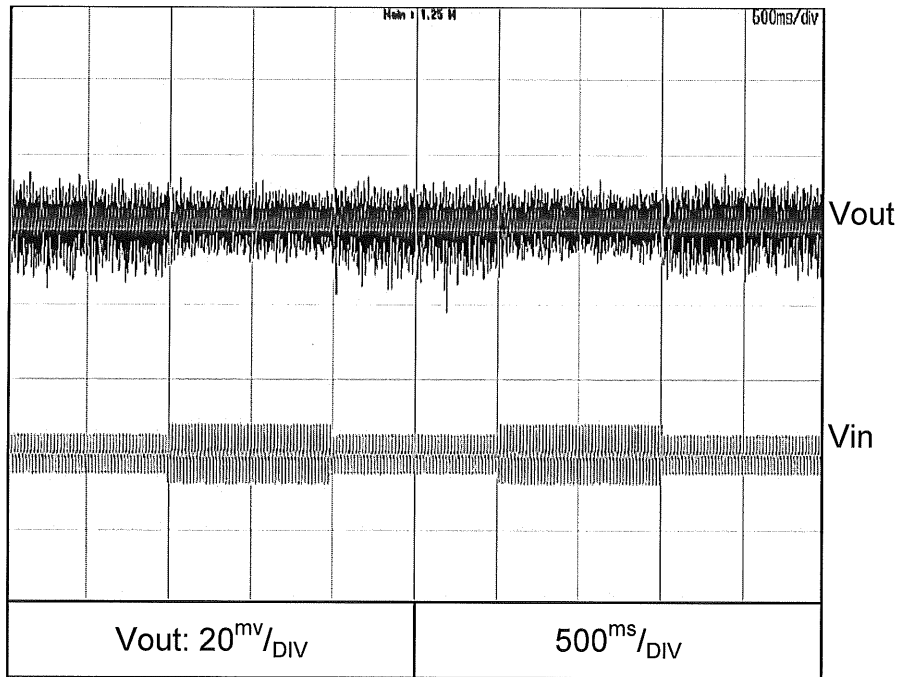
2.6 Hold up time characteristics

Conditions: Vin:100Vac
                                Vout: 100%
                                Ta = 25°C

Z650-1.25

TDK-Lambda

2.7 Dynamic line response characteristics

C.V mode

Conditions: Vin:85↔132V
Vout: 100%
Iout: 100%
Ta = 25°C

Z160-5

Vout: 20^{mv}/$_{DIV}$	500^{ms}/$_{DIV}$

Conditions: Vin:170↔265V
Vout: 100%
Iout: 100%
Ta = 25°C

Vout: 20^{mv}/$_{DIV}$	500^{ms}/$_{DIV}$

2.7 Dynamic line response characteristics

Conditions: Vin:85↔132V
Vout: 100%
Iout: 100%
Ta = 25°C

C.V mode

Z650-1.25
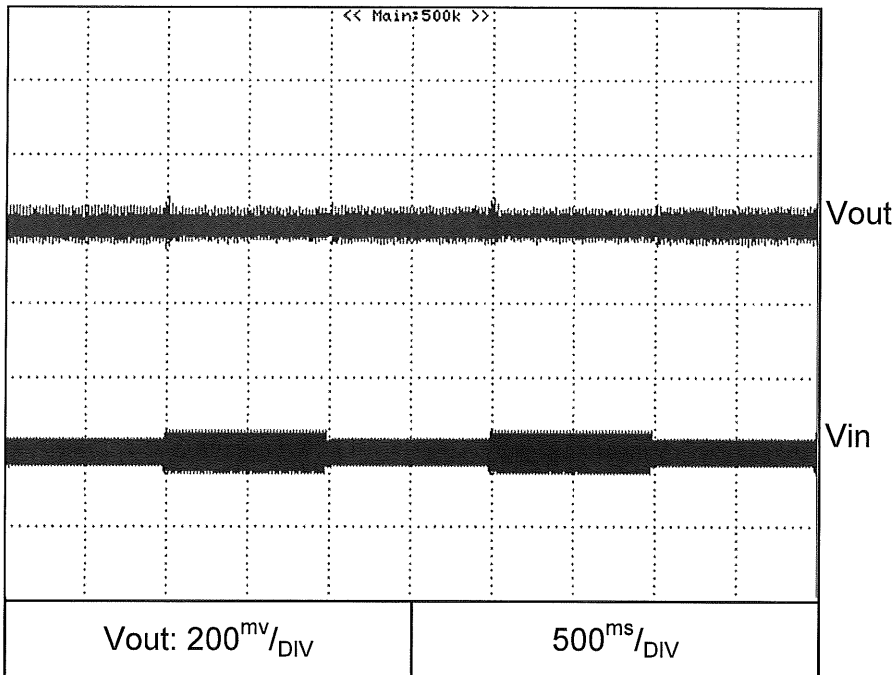
<< Main:500k >>

Vout

Vin

Vout: 200ᵐᵛ/DIV	500ᵐˢ/DIV

Conditions: Vin:170↔265V
Vout: 100%
Iout: 100%
Ta = 25°C

<< Main:500k >>

Vout

Vin

Vout:200ᵐᵛ/DIV	500ᵐˢ/DIV

TDK-Lambda
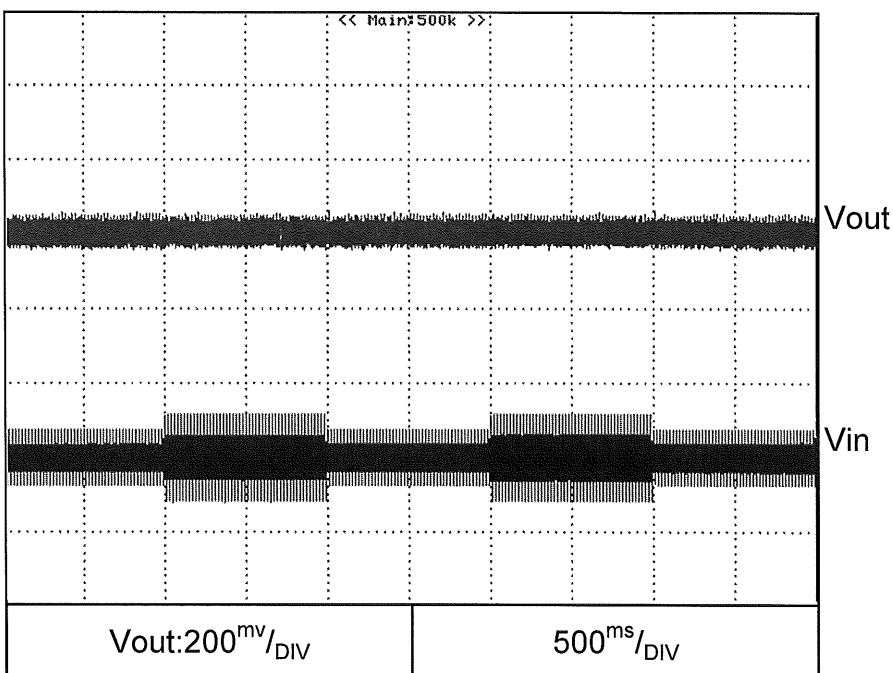
2.7 Dynamic line response characteristics

Conditions:
Vin:85↔132V
Vout: 100%
Iout: 100%
Ta = 25°C

C.C mode

Z160-5
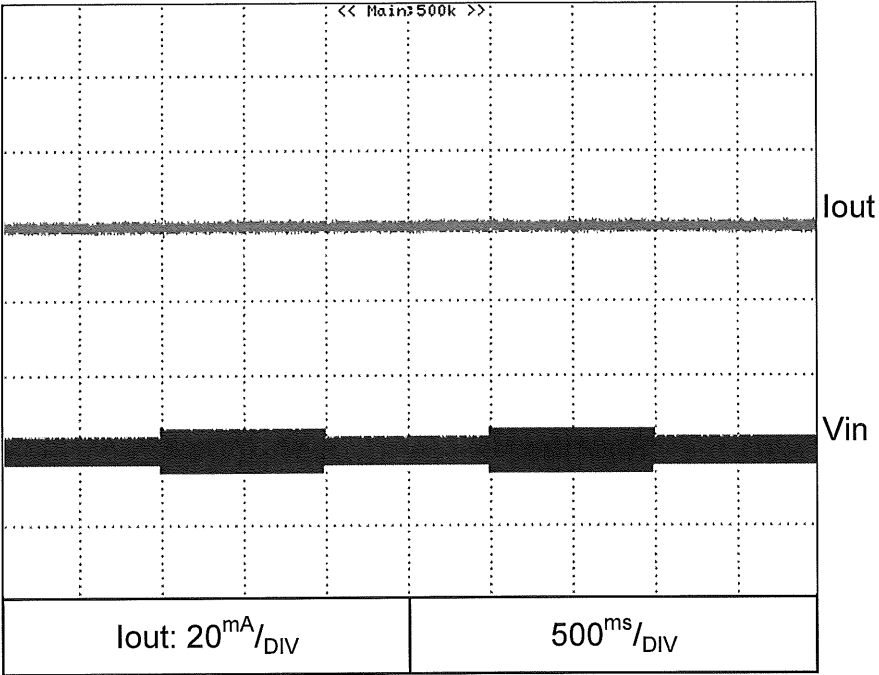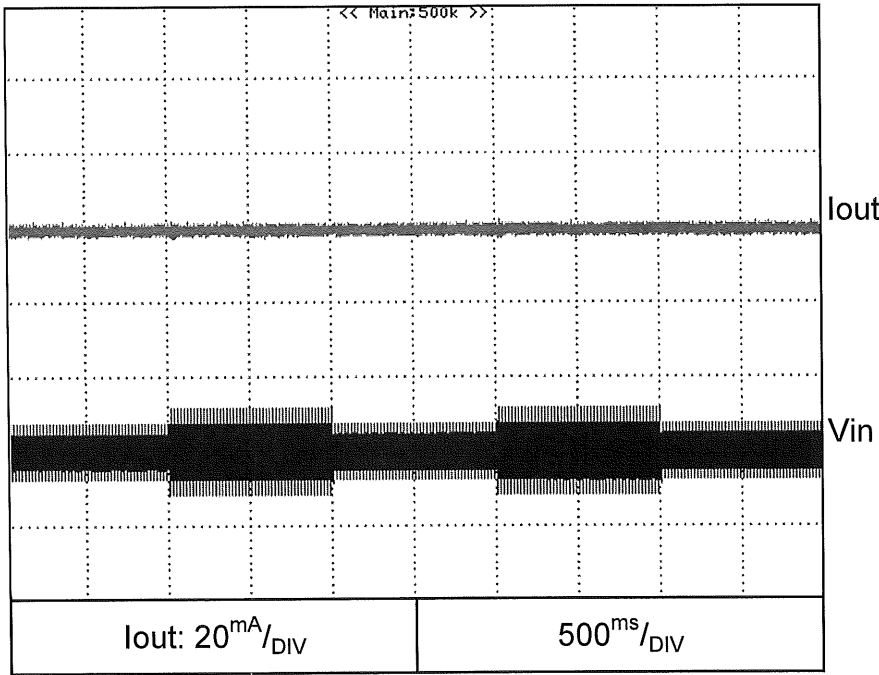
Iout: 20^{mA}/$_{DIV}$	500^{ms}/$_{DIV}$

Conditions:
Vin:170↔265V
Vout: 100%
Iout: 100%
Ta = 25°C

Iout: 20^{mA}/$_{DIV}$	500^{ms}/$_{DIV}$

2.7 Dynamic line response characteristics

C.C mode

Conditions: Vin:85↔132V
Vout: 100%
Iout: 100%
Ta = 25°C

Z650-1.25

<< Main:500k >>

Iout

Vin

Iout: 20^{mA}/$_{DIV}$ 500^{ms}/$_{DIV}$

Conditions: Vin:170↔265V
Vout: 100%
Iout: 100%
Ta = 25°C

<< Main:500k >>

Iout

Vin

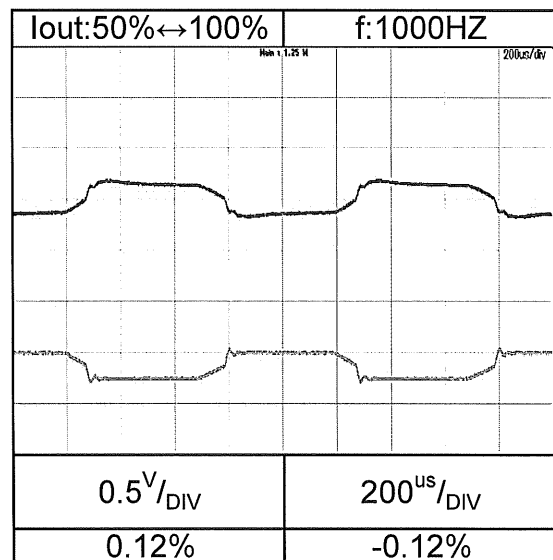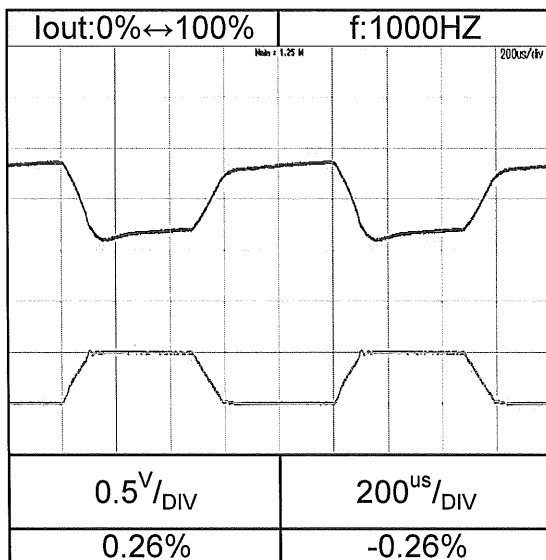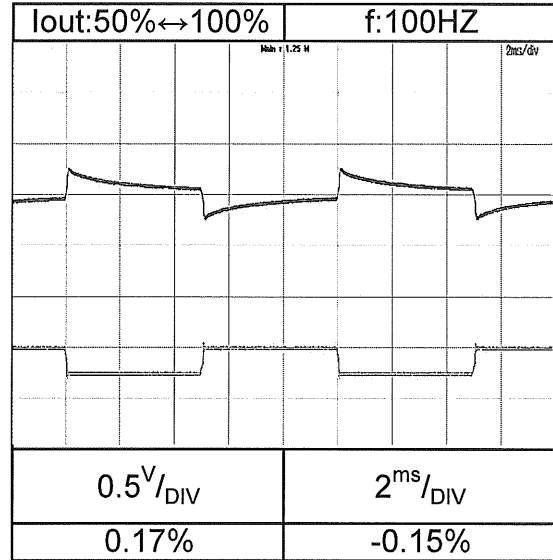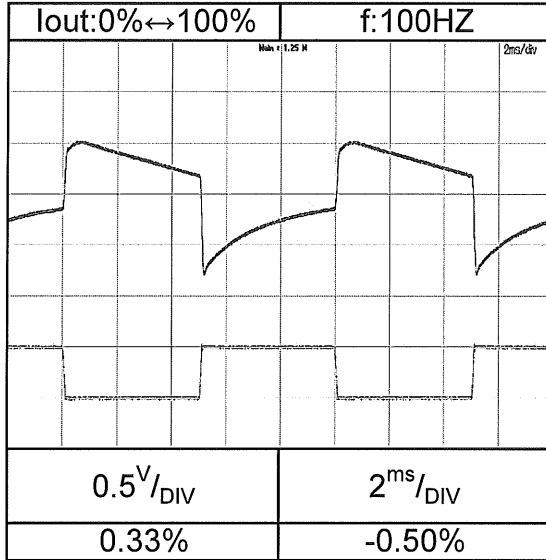Iout: 20^{mA}/$_{DIV}$ 500^{ms}/$_{DIV}$

2.8 Dynamic load response characteristics

C.V mode

Conditions: Vin:100Vac
Vout: 100%
Ta = 25°C

Load current: tr=tf=100us

Z160-5

Iout:0%↔100%	f:100HZ
	Main : 1.25 H	2ms/div
0.5 V/DIV	2 ms/DIV
0.33%	-0.50%

Iout:50%↔100%	f:100HZ
	Main : 1.25 H	2ms/div
0.5 V/DIV	2 ms/DIV
0.17%	-0.15%

Iout:0%↔100%	f:1000HZ
	Main : 1.25 H	200us/div
0.5 V/DIV	200 us/DIV
0.26%	-0.26%

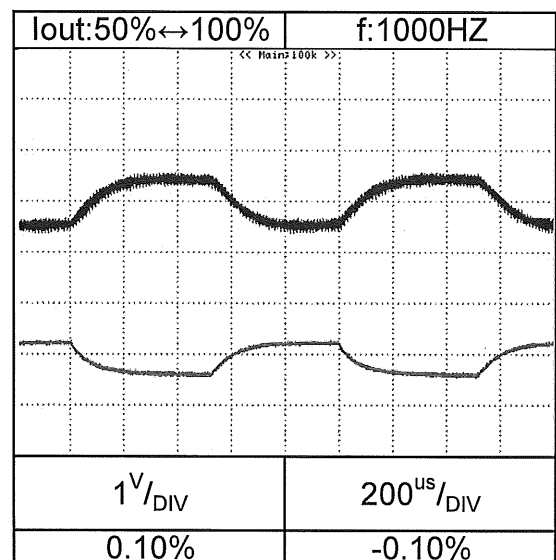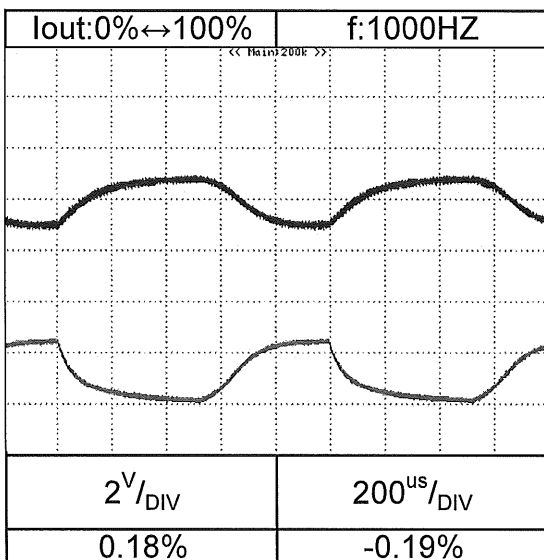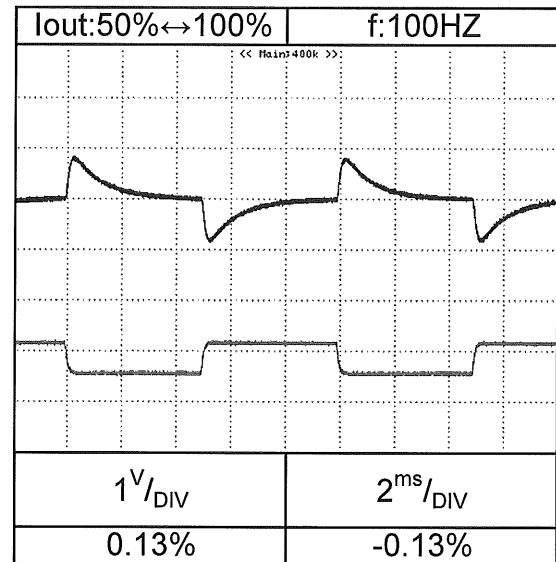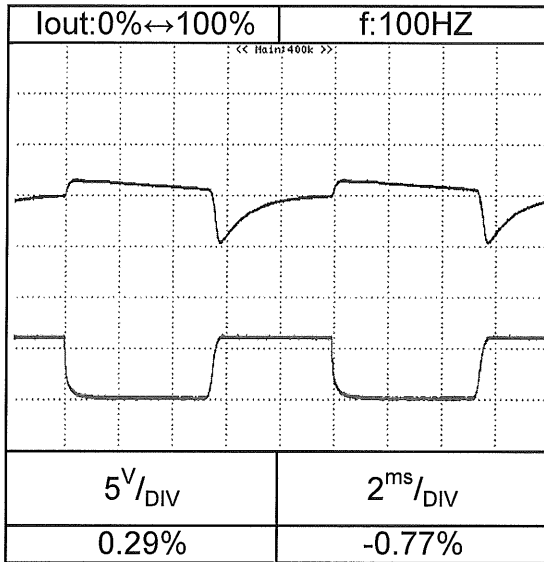| Iout:50%↔100%	f:1000HZ
	Main : 1.25 H	200us/div
0.5 V/DIV	200 us/DIV
0.12%	-0.12%

2.8 Dynamic load response characteristics

C.V mode

Conditions: Vin:100Vac
Vout: 100%
Ta = 25°C

Load current: tr=tf=100us

Z650-1.25

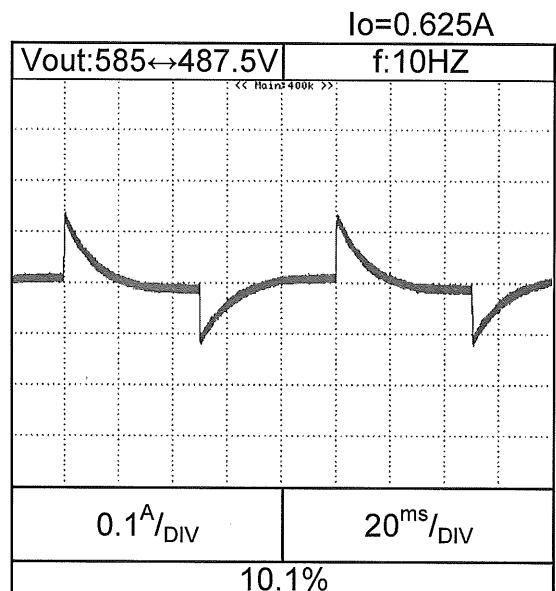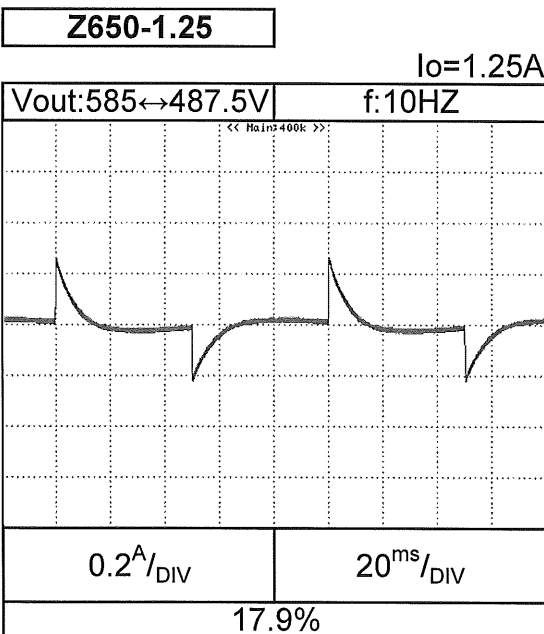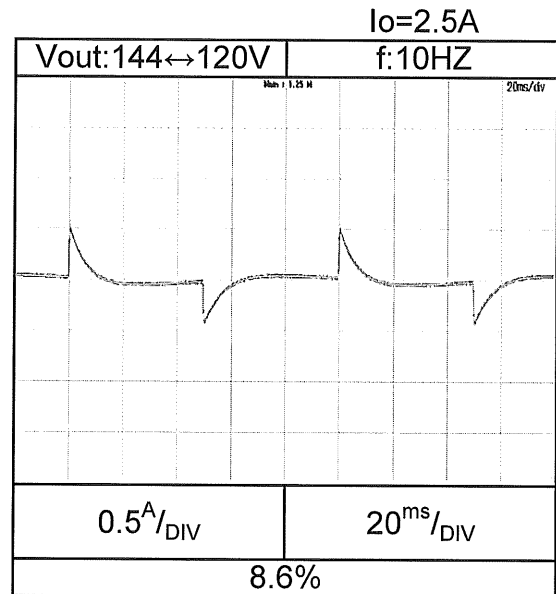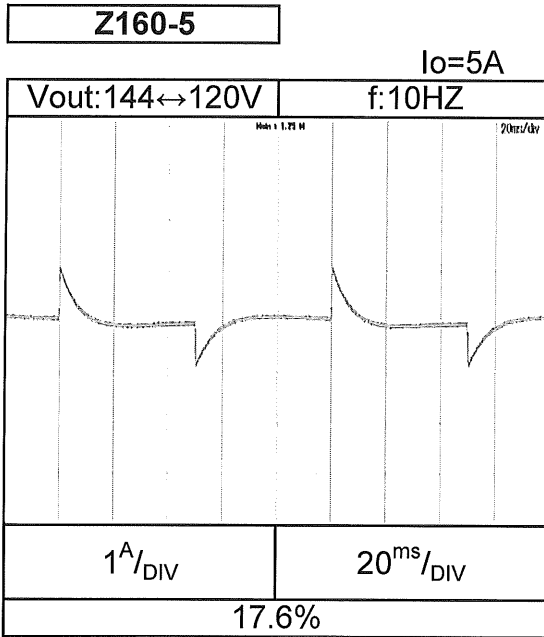| Iout:0%↔100%	f:100HZ
<< Main 400k >>	

$5^V/_{DIV}$	$2^{ms}/_{DIV}$
0.29%	-0.77%

Iout:50%↔100%	f:100HZ
<< Main 400k >>	

$1^V/_{DIV}$	$2^{ms}/_{DIV}$
0.13%	-0.13%

Iout:0%↔100%	f:1000HZ
<< Main 200k >>	

$2^V/_{DIV}$	$200^{us}/_{DIV}$
0.18%	-0.19%

Iout:50%↔100%	f:1000HZ
<< Main 100k >>	

$1^V/_{DIV}$	$200^{us}/_{DIV}$
0.10%	-0.10%

2.8 Dynamic load response characteristics

Conditions: Vin:100Vac
Ta = 25°C

C.C mode

Z160-5

Io=5A

Vout:144↔120V	f:10HZ

1^A/DIV	20^ms/DIV
17.6%	

Io=2.5A

Vout:144↔120V	f:10HZ

0.5^A/DIV	20^ms/DIV
8.6%	

Z650-1.25

Io=1.25A

Vout:585↔487.5V	f:10HZ

0.2^A/DIV	20^ms/DIV
17.9%	

Io=0.625A

Vout:585↔487.5V	f:10HZ

0.1^A/DIV	20^ms/DIV
10.1%	

TDK-Lambda

2.9 Response to brown-out characteristics

C.V mode

Conditions: Vin:100VAC
Vout: 100%
Iout: 100%
Ta = 25°C

Z160-5

Brown-out time
A - 16mS

C - 48mS

Vout: 50ᵛ/DIV   100ᵐˢ/DIV

2.9 Response to brown-out characteristics

Conditions: Vin:100VAC
Vout: 100%

C.V mode
          Iout: 100%
Ta = 25°C

Z650-1.25

Vout: 200^V/$_{DIV}$	100^{ms}/$_{DIV}$

Brown-out time
A - 15ms
C - 18ms

2.9 Response to brown-out characteristics

C.C mode

Conditions: Vin:100VAC
Vout: 100%
Iout: 100%
Ta = 25°C

Z160-5
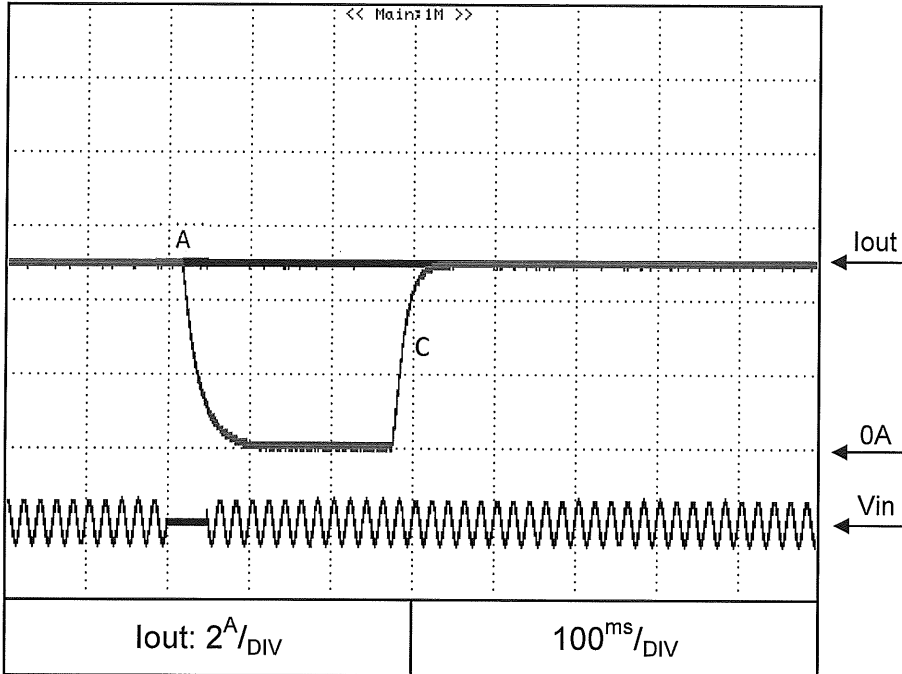
Brown-out time
A - 17mS

C - 48mS

Iout: 2^A/DIV	100^{ms}/DIV

TDK-Lambda

2.9 Response to brown-out characteristics

C.C mode

Conditions: Vin:100VAC
Vout: 100%
Iout: 100%
Ta = 25°C

```
┌──────────────┐
│  Z650-1.25   │
└──────────────┘
```

<< Main:500k >>

Iout ←

A

C
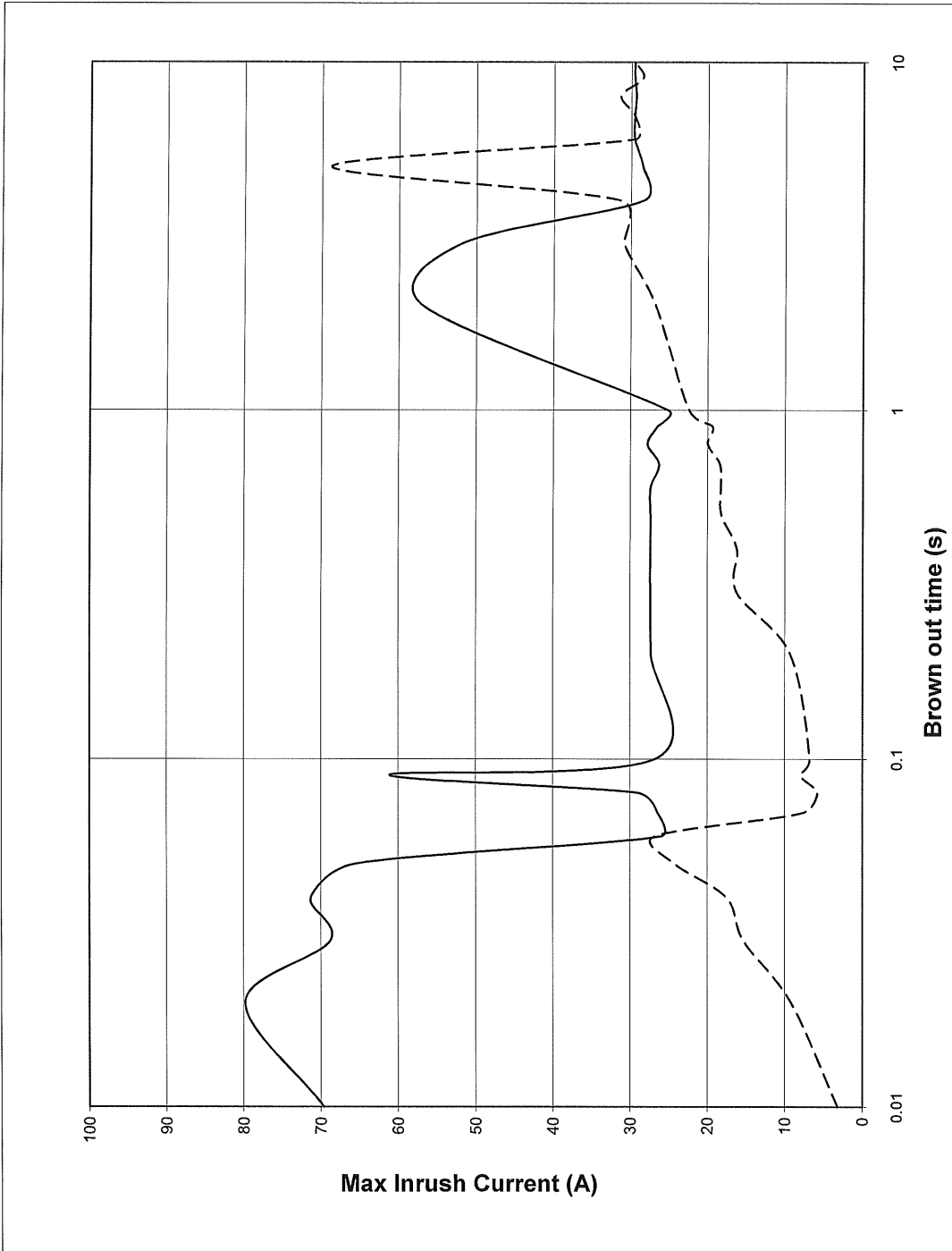
0A ←

Vin ←

Iout: 0.5ᴬ/DIV   100ᵐˢ/DIV
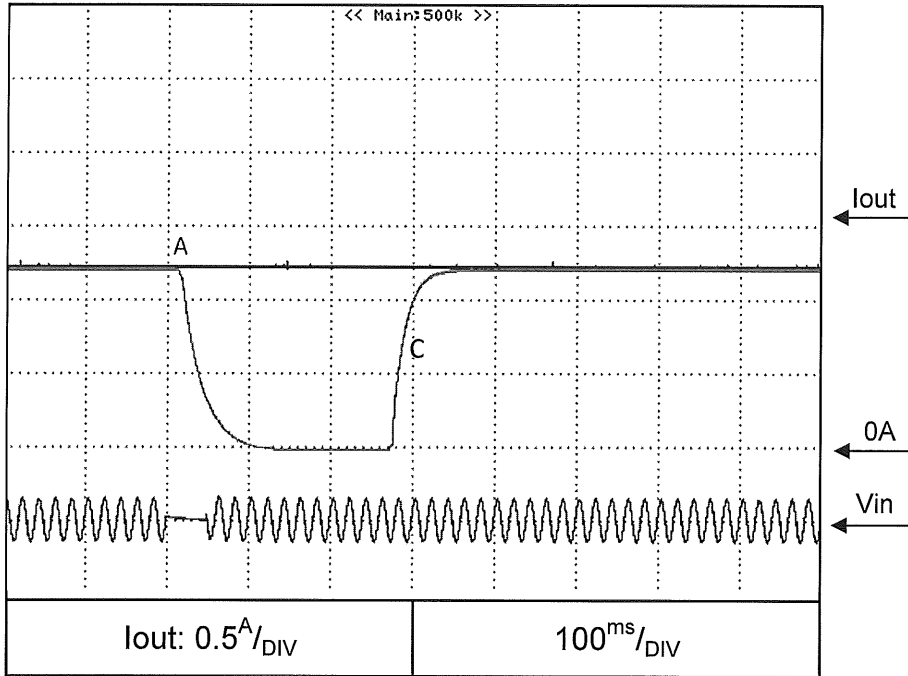
Brown-out time
A - 15mS

C - 49mS

**2.10 Inrush Current Characteristics
during line brown outs**
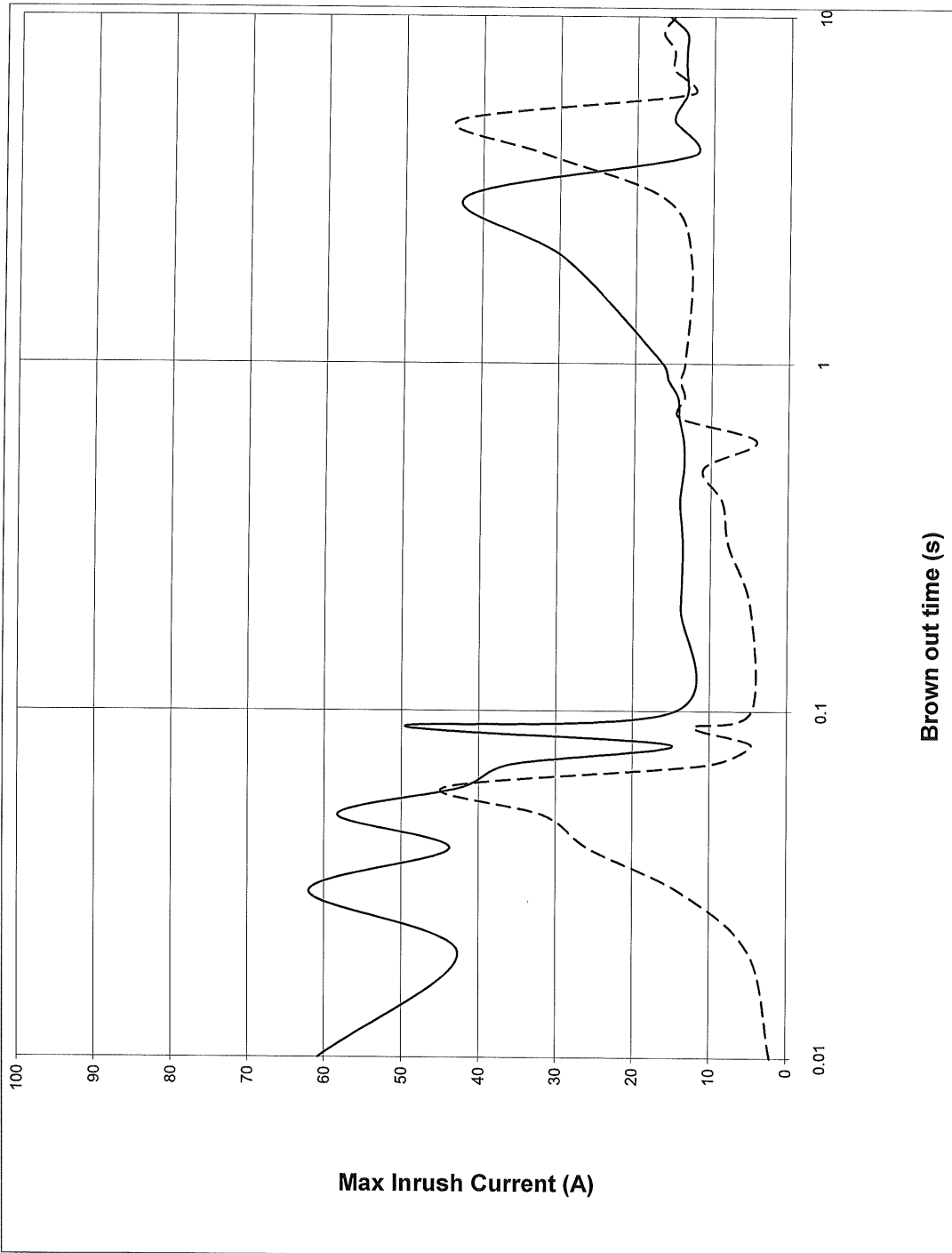
Conditions: Vin: 100VAC
Vout: 100%
Iout: 0% - - - - - - - - - -
Iout: 100% ——————
Ta = 25°C

Z160-5

Max Inrush Current (A)

Brown out time (s)

2.10 Inrush Current Characteristics during line brown outs

Conditions: Vin: 200VAC
Vout: 100%
Iout: 0%   - - - - - - - - -
Iout: 100%   ————
Ta = 25°C

Z160-5

Brown out time (s)

Max Inrush Current (A)

2.11 Inrush current waveform

Z160-5

Switch on phase angle
of input AC voltage

Φ=0°

| 20^A/$_{DIV}$ | 100^{ms}/$_{DIV}$ |

Switch on phase angle
of input AC voltage

Φ=90°

| 20^A/$_{DIV}$ | 100^{ms}/$_{DIV}$ |

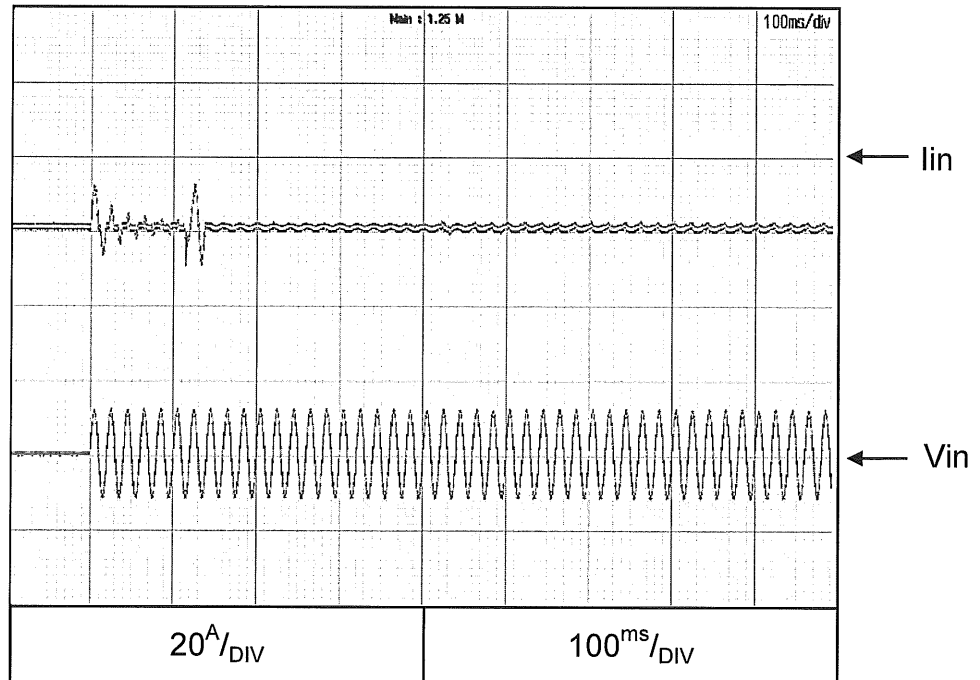## 2.11 Inrush current waveform

Conditions: Vin: 200V
Vout: 100%
Iout: 100%
Ta = 25°C

Z160-5

Switch on phase angle
of input AC voltage

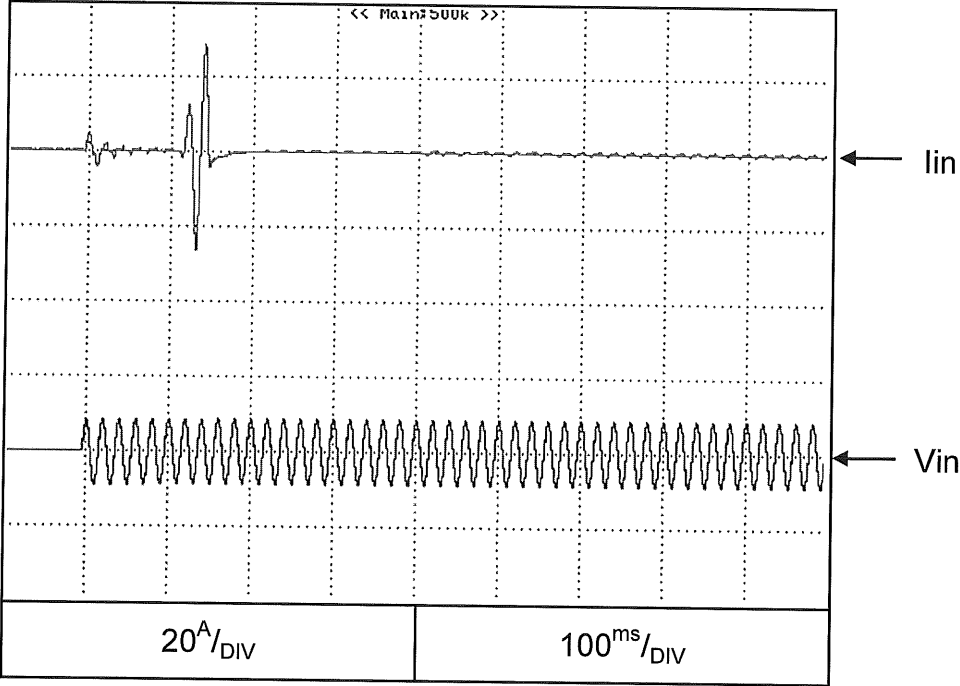Φ=0°

$$20^A/_{DIV} \qquad 100^{ms}/_{DIV}$$

← Iin

← Vin

Switch on phase angle
of input AC voltage

Φ=90°

← Iin

← Vin

← Iin

← Vin

$$20^A/_{DIV} \qquad 50^{us}/_{DIV}$$
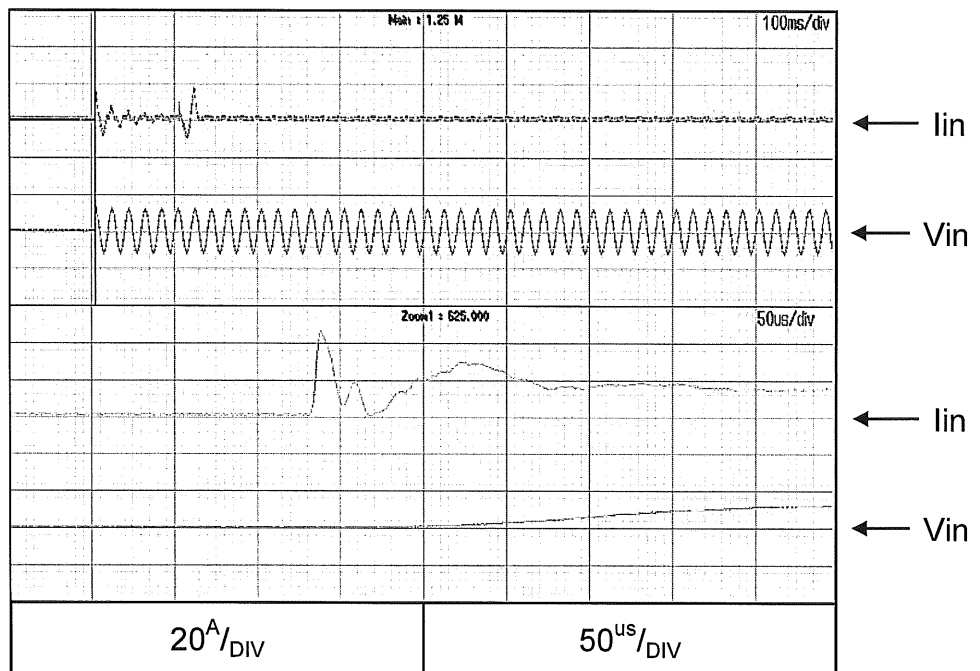
2.11 Inrush current waveform

Conditions: Vin: 100V
Vout: 100%
Iout: 100%
Ta = 25°C

Z650-1.25

Switch on phase angle
of input AC voltage
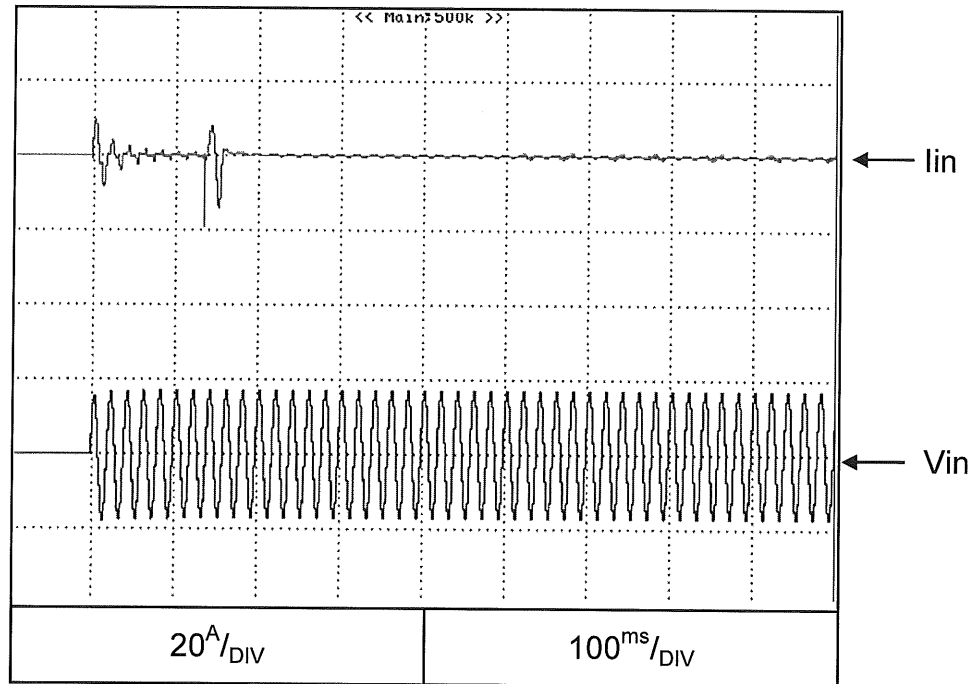
Φ=0°

Iin

Vin

$20^A/_{DIV}$ $100^{ms}/_{DIV}$

Switch on phase angle
of input AC voltage

Φ=90°

Iin

Vin

$20^A/_{DIV}$ $100^{ms}/_{DIV}$

2.11 Inrush current waveform

Conditions: Vin: 200V
Vout: 100%
Iout: 100%
Ta = 25°C

Z650-1.25

Switch on phase angle
of input AC voltage

Φ=0°

| 20ᴬ/DIV | 100ᵐˢ/DIV |

Switch on phase angle
of input AC voltage

Φ=90°

| 50ᴬ/DIV | 200ᵘˢ/DIV |

2.12 Input current waveform

Conditions: Vin: 100VAC
Vout: 100%
Iout: 100%
Ta = 25°C

Z160-5

| 20^A/_DIV | 5^ms/_DIV |

Conditions: Vin: 200VAC
Vout: 100%
Iout: 100%
Ta = 25°C

| 10^A/_DIV | 5^ms/_DIV |

2.12 Input current waveform

Conditions: Vin: 100VAC
Vout: 100%
Iout: 100%
Ta = 25°C

Z650-1.25

<< Main:500k >>

← Iin

← Vin

| 20ᴬ/DIV | 5ᵐˢ/DIV |

Conditions: Vin: 200VAC
Vout: 100%
Iout: 100%
Ta = 25°C

<< Main:500k >>

← Iin

← Vin

| 10ᴬ/DIV | 5ᵐˢ/DIV |

TDK-Lambda

T-45
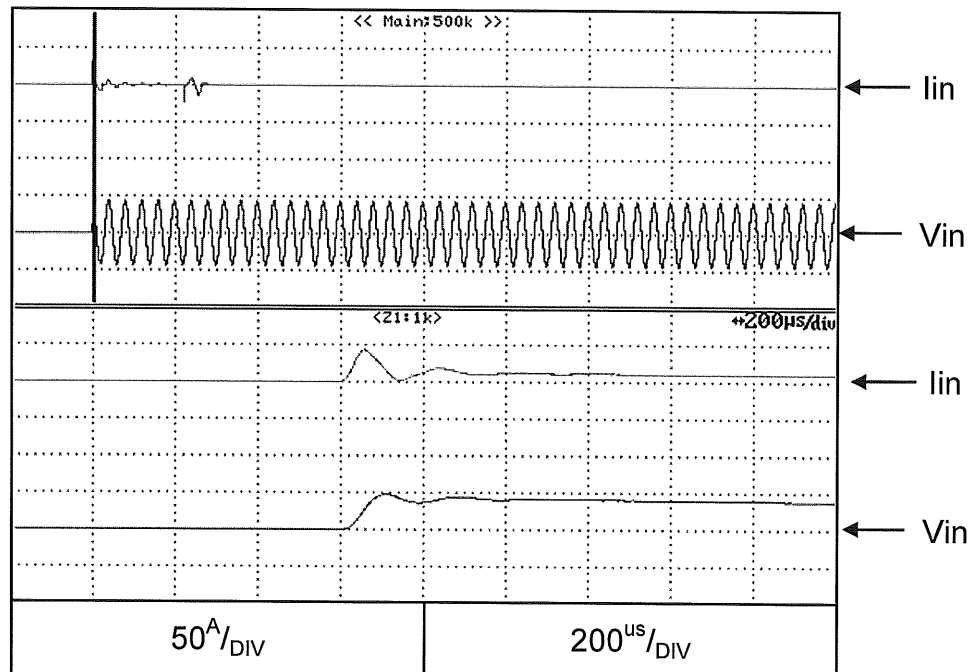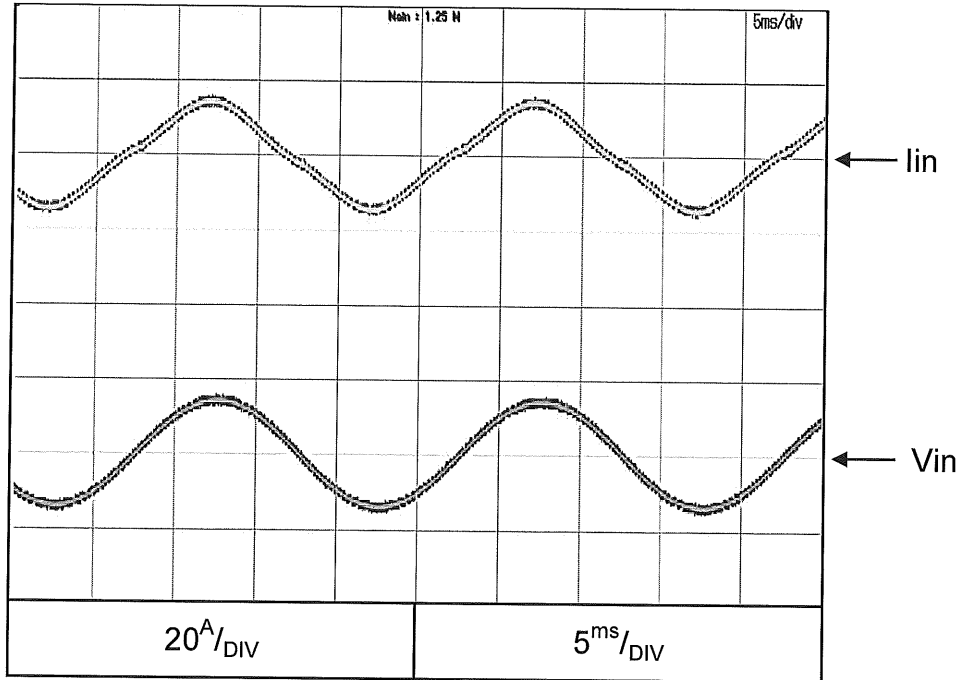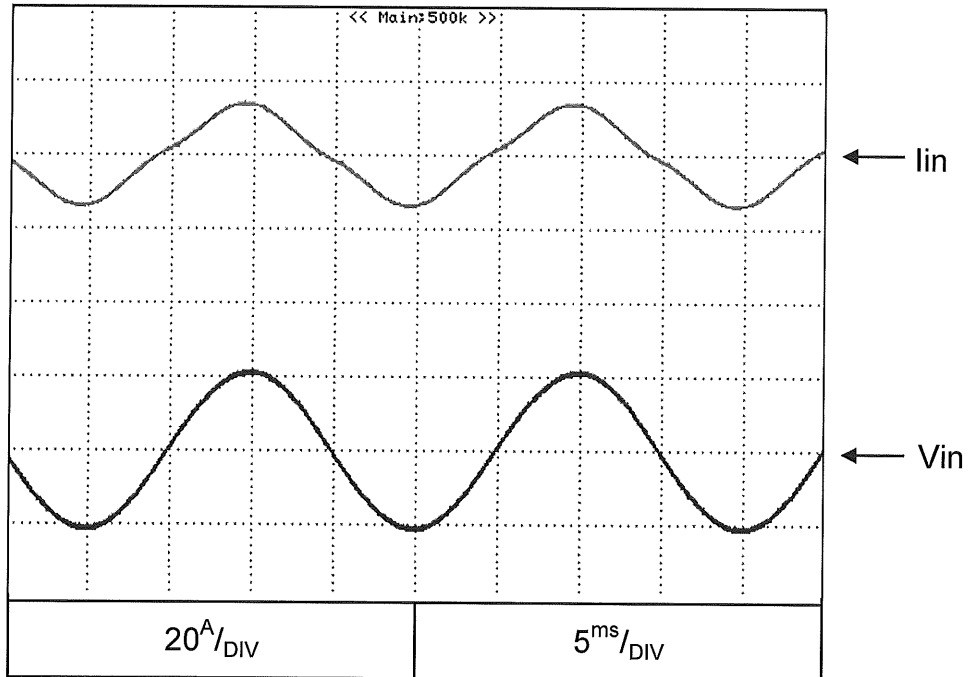
2.13 Leakage current characteristics

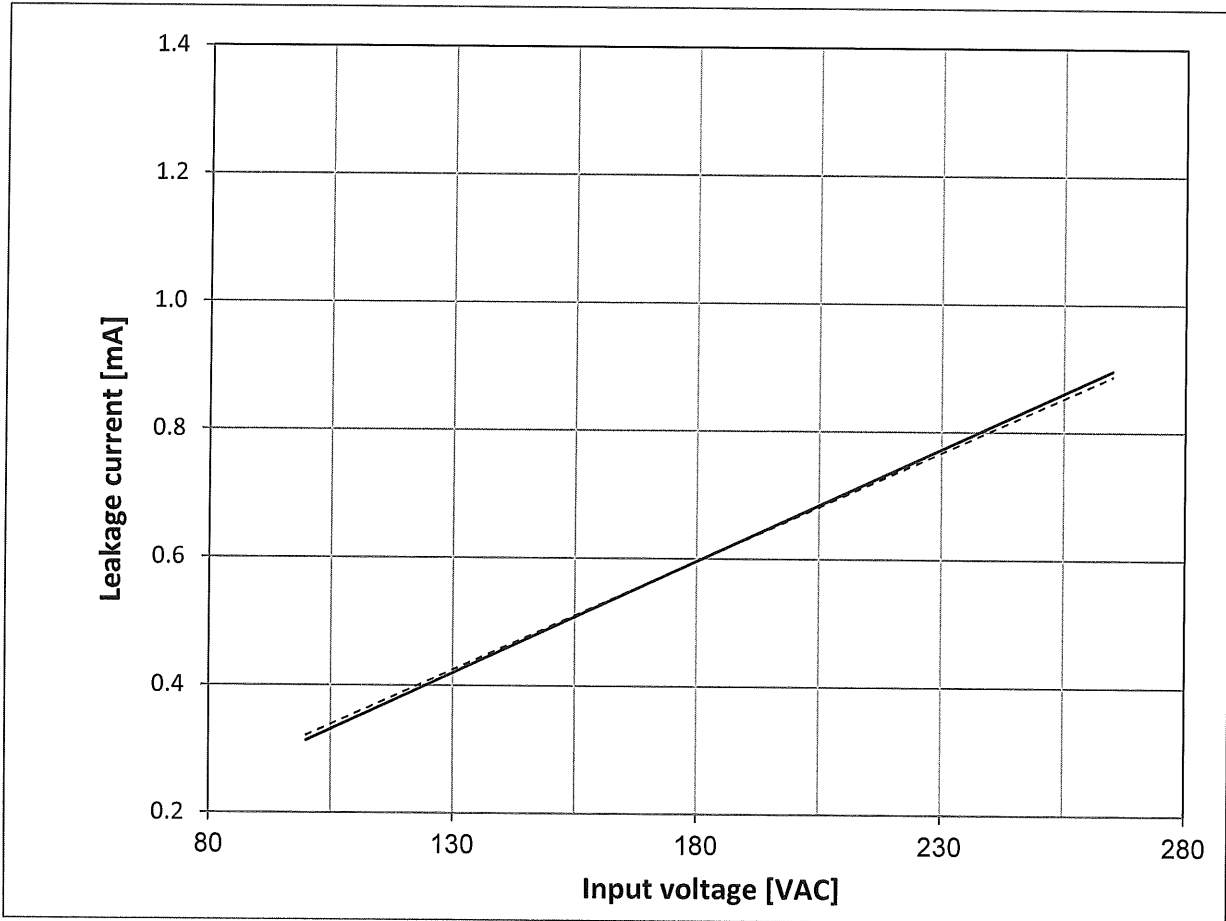Conditions: Vin: 100~265Vac
Iout: 0%   ━ ━ ━ ━ ━
Iout:100%   ━━━━━
Ta = 25°C
f=50HZ

Z650-1.25

2.14 Output voltage ripple & noise waveform

C.V mode

Conditions: Vin: 100VAC
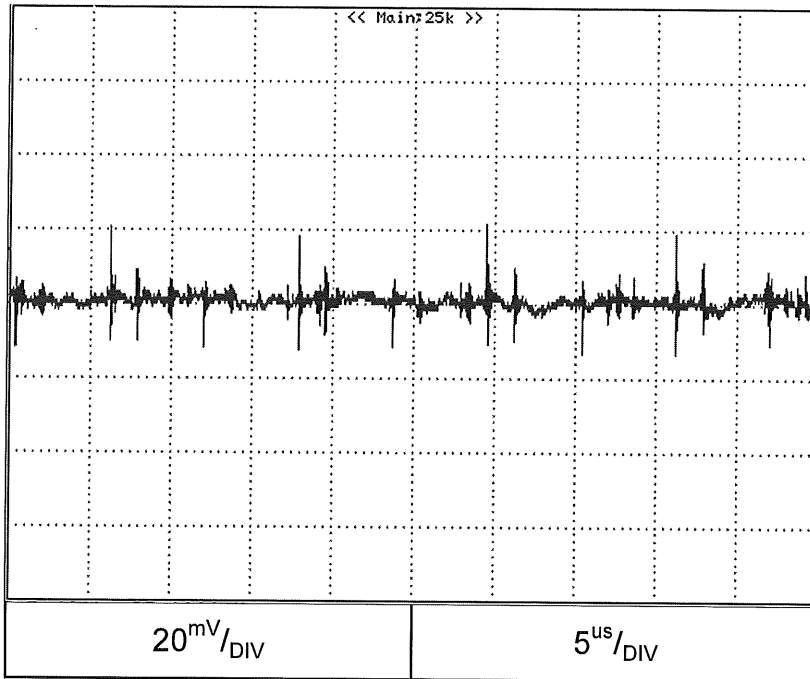Vout: 100%
Iout: 100%
Ta = 25°C

<u>Normal Mode</u>

Z160-5

| 20$^{mV}/_{DIV}$ | 5$^{us}/_{DIV}$ |

Z650-1.25

| 50$^{mV}/_{DIV}$ | 5$^{us}/_{DIV}$ |