Test Report: LOP-600-24

600W 5"×3" Low Profile Open Frame Power Supply

■ DESIGN VERIFY TEST

Output Function Test
Input Function Test
Protection Function Test
Control Function Test
Component Stress Test

■ SAFETY & E.M.C. TEST

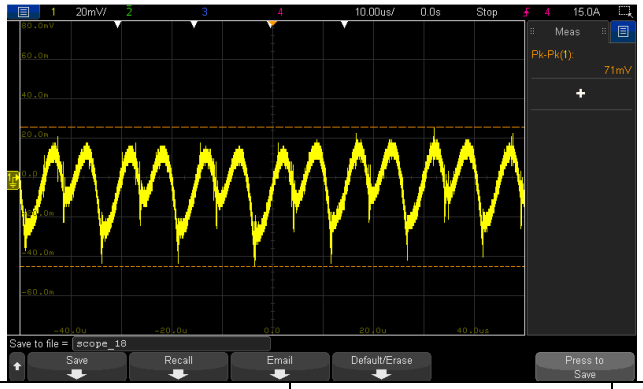
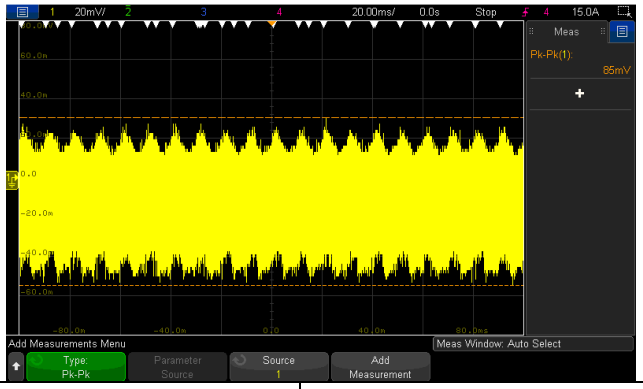
Safety Test
E.M.C. Test

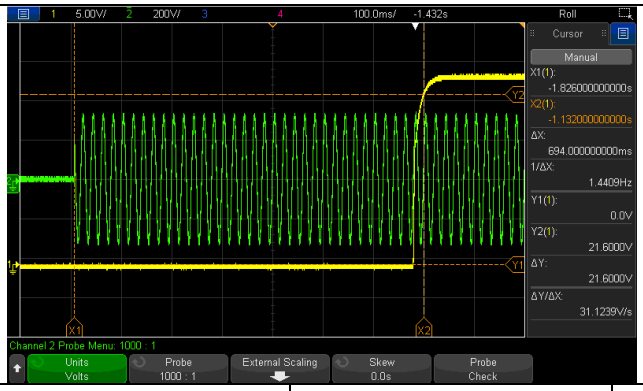
■ RELIABILITY TEST

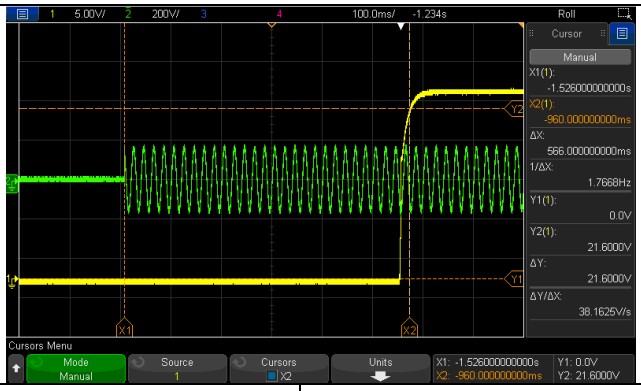
ENVIRONMENT TEST

■ DESIGN VERIFY TEST

OUTPUT FUNCTION TEST

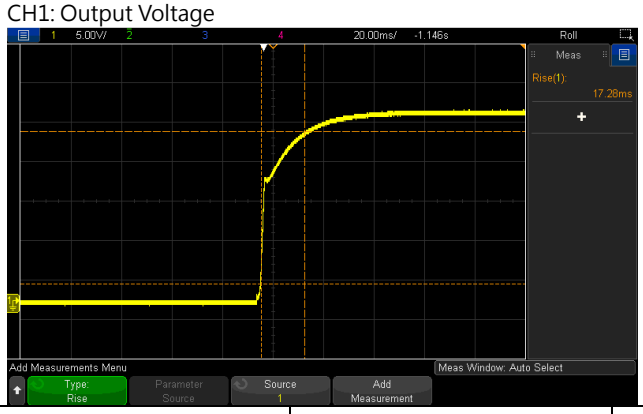
NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	OUTPUT VOLTAGE ADJUST RANGE	CH1: 22.8V~25.2V	I/P : 230 VAC I/P : 115 VAC O/P : MIN LOAD Ta : 25℃	21.94V~25.86V/230VAC 21.94V~25.86/115VAC
2	OUTPUT VOLTAGE TOLERANCE	V1: -2% ~ +2%	I/P: 80VAC~ 264VAC O/P:FULL~ MIN. LOAD Ta:25℃	V1: -0.03% ~0.08%
3	LINE REGULATION	V1: -0.5% ~ +0.5%	I/P: 80VAC~ 264VAC O/P:FULL LOAD Ta:25℃	V1: -0.001% ~0.001%
4	LOAD REGULATION	V1: -1% ~ +1%	I/P: 230VAC O/P:FULL ~MIN LOAD Ta:25℃	V1: -0.03% ~0.08%
5	OVER/UNDERSHOOT TEST	<±5%	I/P: 230VAC O/P:FULL LOAD / NO LOAD Ta:25℃	-1.69%
6	RIPPLE & NOISE (Max)	V1: 200mVp-p	I/P:230VAC O/P: FULL LOAD Ta:25℃	V1: 71mVp-p / high frequency 85mVp-p / low frequency
	high frequency : 		low frequency : 	
7	SET UP TIME(Max)	230VAC/1000ms 115VAC/1500ms	I/P : 230 VAC I/P : 115 VAC O/P : FULL LOAD Ta : 25℃	230VAC/ 694ms 115VAC/566ms
	INPUT=230VAC/50HZ @ FULL LOAD CH1: Output Voltage CH2: AC Input Voltage		INPUT=115VAC/60HZ @ FULL LOAD CH1: Output Voltage CH2: AC Input Voltage	



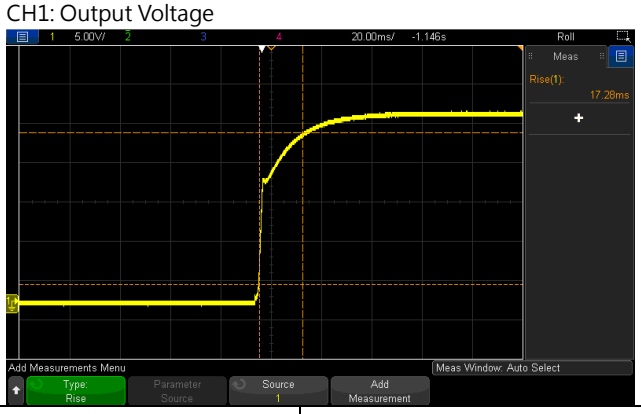


8	RISE TIME (Max)	230VAC/30ms 115VAC/30ms	I/P： 230 VAC I/P： 115 VAC O/P：FULL LOAD Ta：25℃	230VAC/ 17.28ms 115VAC/ 17.28 ms

INPUT=230VAC/50HZ @ FULL LOAD
CH1: Output Voltage

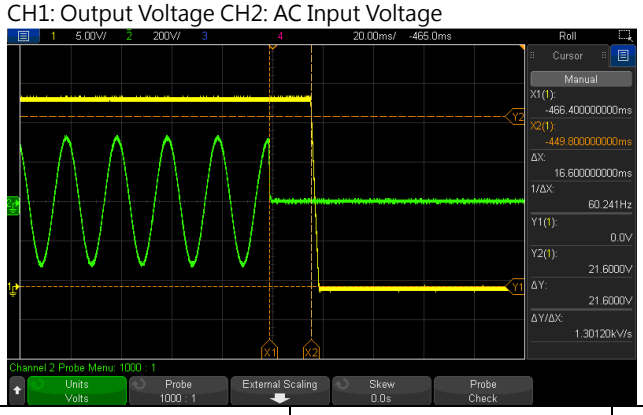


INPUT=115VAC/60HZ @ FULL LOAD
CH1: Output Voltage

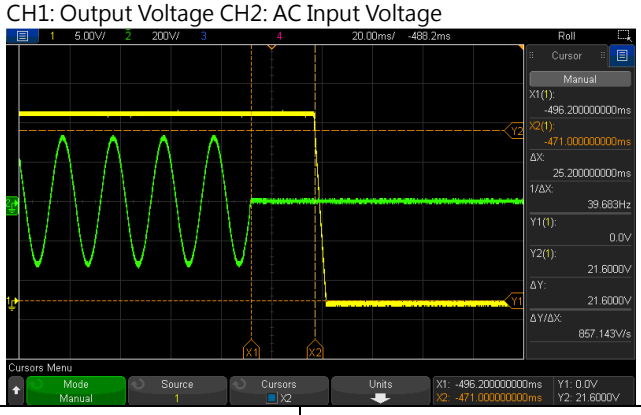


9	HOLD UP TIME (Typ.)	8ms /600W load 12ms /400W load	I/P： 230 VAC O/P：TESTING Ta：25℃	16.6ms /600W load 25.2ms /400W load

INPUT=230VAC/50HZ @ 600W load
CH1: Output Voltage CH2: AC Input Voltage



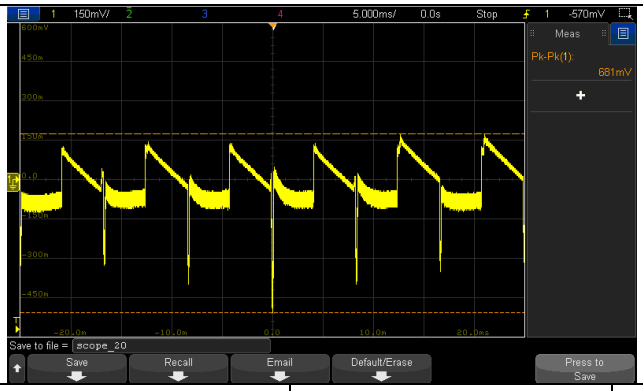
INPUT=230VAC/50HZ @ 400W load
CH1: Output Voltage CH2: AC Input Voltage



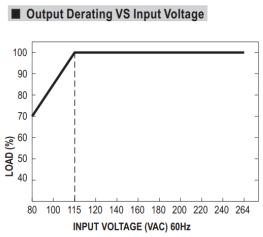
10	DYNAMIC LOAD	V1: 2400mVp-p	I/P: 230VAC O/P: (1) FULL/0% LOAD 50%DUTY / 120HZ (2) FULL/0% LOAD 50%DUTY / 1KHZ Ta:25℃	681mVp-p 627mVp-p

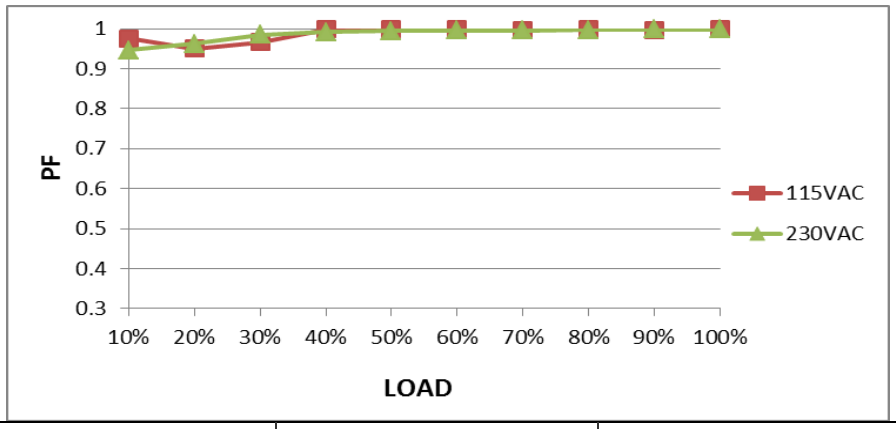
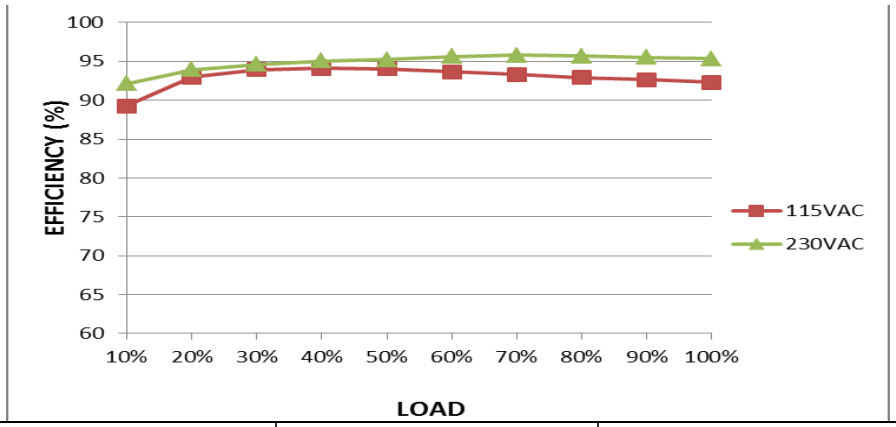
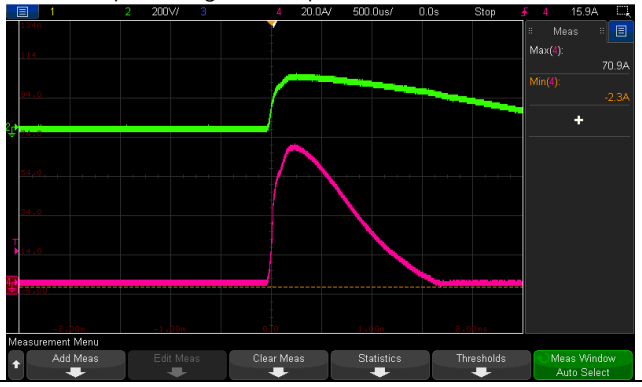
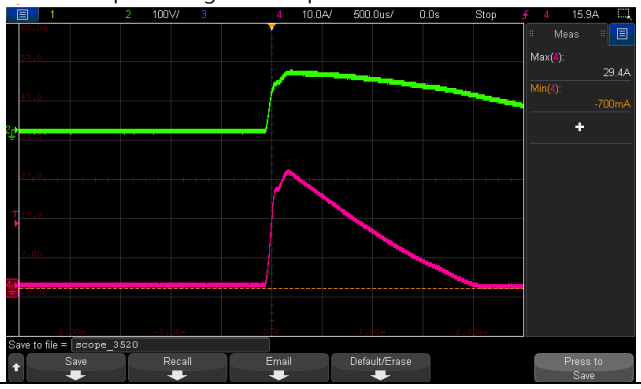
FULL /0% LOAD 50%DUTY / 120HZ

FULL /0% LOAD 50%DUTY / 1KHZ

				
11	TRANSIENT RECOVERY TIME	V1: 2400mVp-p < 500us	I/P: 230VAC O/P:40% LOAD CHANGE 50%DUTY/120HZ 1.25A/us	302mVp-p 0us
12	PEAK LOAD	150% PEAK LOAD@3S	I/P: 264VAC I/P: 115VAC O/P: PEAK LOAD	TEST： OK

INPUT FUNCTION TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	INPUT VOLTAGE RANGE	80VAC~264VAC 113VDC~ 370VDC 	(1) I/P: TESTING O/P: FULL / 70% LOAD (2) I/P: DC TESTING (L: + N: -) O/P: FULL / 70% LOAD (3) I/P: DC TESTING (L: - N: +) O/P: FULL / 70% LOAD Ta:25℃	(1) 70V~264V/ FULL LOAD 70V~264V/ 70% LOAD (2) 96.79Vdc~370Vdc/FULL LOAD 91.42Vdc~370Vdc/70% LOAD (3) 96.79Vdc~370Vdc/FULL LOAD 91.42Vdc~370Vdc/70% LOAD
			I/P: HIGH-LINE+15%=300V O/P:FULL/MIN LOAD (PLEASE CHECK DERATING CURVE) ON: 30 Sec OFF: 30 Sec 10MIN (POWER ON/OFF NO DAMAGE)	TEST：OK
2	INPUT FREQUENCY RANGE	47HZ ~63 HZ NO DAMAGE	I/P:80 VAC ~264 VAC O/P:FULL~MIN LOAD Ta:25℃	TEST：OK
3	INPUT CURRENT (Typ.)	230V/ 3.2A 115V/ 6.4A	I/P： 230 VAC I/P： 115 VAC O/P：FULL LOAD Ta：25℃	I =2.76A/ 230VAC I =5.75A/ 115VAC
4	LEAKAGE CURRENT	Earth leakage current <500uA(rms) @ 264VAC touch current <70uA(rms) @ 264VAC	I/P： 264 VAC/60HZ O/P：Min LOAD Ta：25℃	294.3 uA / 264 VAC@ For Earth 36.5uA / 264 VAC@For Touch
5	NO LOAD CONSUMPTION	<0.5W	I/P：240VAC O/P：NO LOAD Ta：25℃	0.3984W

6	POWER FACTOR (Typ.)	0.94/ 230VAC 0.98/115VAC	I/P： 230 VAC I/P： 115 VAC O/P：FULL LOAD Ta：25℃	PF=0.9973/230VAC PF=0.9985/115VAC
	P.F vs LOAD 			
7	EFFICIENCY(Typ.)	93%	I/P:230 VAC O/P:FULL LOAD Ta:25℃	94.93%
	EFFICIENCY vs LOAD 			
8	INRUSH CURRENT(Typ.)	230V/80A 115V/40A COLD START	I/P： 230 VAC I/P： 115 VAC O/P：FULL LOAD Ta：25℃	I =70.9A/ 230VAC I =29.4A/ 115VAC T50=818 us/230V
	INPUT=230VAC/50HZ @ FULL LOAD CH2: AC Input Voltage CH4: Input current 		INPUT=115VAC/ 60HZ @ FULL LOAD CH2: AC Input Voltage CH4: Input current 	

PROTECTION FUNCTION TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	OVER LOAD PROTECTION	105%~ 150% PROTECTION TYPE : Hiccup after 3 sec, recovers automatically after fault condition is removed	I/P: 264VAC I/P: 230VAC I/P: 115VAC O/P:TESTING Ta:25℃	142.4%/ 264VAC 142.8%/ 230VAC 142.4%/ 115VAC PROTECTION TYPE : Hiccup after 3 sec, recovers automatically after fault condition is removed
2	OVER VOLTAGE PROTECTION	26.4V~31.2V Protection type: Shut down o/p voltage, re-power on to recover	I/P: 264VAC I/P: 80VAC O/P:MIN LOAD Ta:25℃	28.1V/ 264VAC 28.2V/ 80VAC Protection type: Shut down o/p voltage, re-power on to recover
3	OVER TEMPERATURE PROTECTION	Protection type: Shut down o/p voltage, recovers automatically after temperature goes down（Vin=115Vac）; Shut down o/p voltage, re-power on to recover （ Vin=230Vac or FAN LOCK）	I/P: 264VAC I/P: 80VAC O/P:FULL LOAD	O.T.P. Active OK Protection type : Shut down o/p voltage, recovers automatically after temperature goes down（Vin=115Vac）; Shut down o/p voltage, re-power on to recover（Vin=230Vac or FAN LOCK）
4	SHORT PROTECTION	SHORT EVERY OUTPUT 1 HOUR NO DAMAGE Protection type: Hiccup mode, recovers automatically after fault condition is removed	I/P: 264VAC I/P: 80VAC O/P: FULL LOAD Ta:25℃	NO DAMAGEO OK PROTECTION TYPE : Hiccup mode, recovers automatically after fault condition is removed

CONTROL FUNCTION TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	EXTERNAL FAN SUPPLY	12V@0.5A for driving a fan ; tolerance -15% ~ +15% at main output 20% rated current (23CFM)	I/P: 230 VAC O/P: TESTING Ta:25℃	TEST : -0.15 % ~ 0.17 %
2	REMOTE SENSE	S+ / S- The remote sensing compensates voltage drop on the load wiring up to 0.5V	I/P: 230 VAC O/P:FULL LOAD Ta:25℃	TEST : OK

COMPONENT STRESS TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT	
1	PWM Transistor (D to S) or (C to E) Peak Voltage	Q2/ Q3 Rated: 26A/ 600V	AC ON/OFF I/P: High-Line +3V =267V VDS: O/P: (1)Full Load (2)Output Short (3) Dynamic Load Full Load/ Min. Load 90%Duty/1KHz (4) Dynamic Load Full Load/	Q2: VDS: (1) 429V (2) 437V (3) 429V (4) 429V (5) 445V (6) 449V	Q3: VDS: (1) 413V (2) 425V (3) 421V (4) 417V (5) 413V (6) 409V

			Min. Load 90%Duty/3KHz (5) Dynamic Load Full Load/ Min. Load 90%Duty/5KHz (6) Dynamic Load 100% Load/ Min. Load 50%Duty/120Hz (7)0%→400% Load (8) Peak Load Ta:25℃	(7) 441V (8) 433V	(7) 433V (8) 417V
2	P.F.C Transistor (D to S) or (C to E) Peak Voltage	Q1 Rated: 52A/600V	AC ON/OFF I/P: High-Line +3V =267V VDS: O/P: (1)Full Load (2)Output Short (3) Dynamic Load Full Load/ Min. Load 90%Duty/1KHz (4) Dynamic Load Full Load/ Min. Load 90%Duty/3KHz (5) Dynamic Load Full Load/ Min. Load 90%Duty/5KHz (6) Dynamic Load 100% Load/ Min. Load 50%Duty/120Hz (7)0%→400% Load (8) Peak Load Ta:25℃	VDS: (1) 433V (2) 429V (3) 445V (4) 438V (5) 438V (6) 457V (7) 453V (8) 453V	
3	P.F.C DIODE	D2 Rated: 6A/ 650V	I/P: High-Line +3V =267 V AC ON/OFF O/P: (1)Full Load (2)Output Short (3) Dynamic Load Full Load/ Min. Load 90%Duty/5KHz (4) Dynamic Load 100% Load/ Min. Load 50%Duty/120Hz (5) Peak Load Ta:25℃	(1) 407V (2) 391V (3) 411V (4) 415V (5) 419V	
4	Diode Peak Voltage	Q101/Q103 Rated: 120A/ 80V	AC ON/OFF I/P: High-Line +3V =267 V Vo=Vmax O/P: (1)Full Load (2)Output Short (3) Dynamic Load Full Load/ Min. Load 90%Duty/1KHz (4) Dynamic Load Full Load/ Min. Load 90%Duty/3KHz (5) Dynamic Load Full Load/ Min. Load 90%Duty/5KHz (6) Dynamic Load 100% Load/ Min. Load 50%Duty/120Hz (7)0%→400% Load. (8).NO LOAD	Q101: Vo=Vmax VDS: (1) 63.5V (2) 63.0V (3) 68.2V (4) 63.5V (5) 63.5V (6) 65.0V (7) 67.0V (8) 59.3V (9) 58.8V (10) 66.1V Vo=Vnormal (1) 61.7V	Q103 Vo=Vmax VDS: (1) 66.1V (2) 68.2V (3) 67.1V (4) 66.1V (5) 66.1V (6) 67.7V (7) 69.2V (8) 58.0V (9) 61.4V (10) 68.2V Vo=Vnormal (1) 63.5V

			(9) burst Mode (10) Peak Load Vo=Vnormal O/P: (1) Full Load Ta:25℃	
5	Input Capacitor Voltage	C5 Rated: 330μ / 400V	I/P: High-Line +3V =267V O/P: (1)Full Load input on/off (2) Min load input on /Off (3) Full Load /Min load Change (4) Full load continue Ta:25℃	(1) 393V (2) 385V (3) 393V (4) 393V
6	Control IC Voltage Test	PFC /PWM IC U1: Rated：10.4V~28.7 V	AC ON/OFF I/P: High-Line +3V =267 V O/P: (1) FULL LOAD (2) Output Short (3) O.L.P (4) O.V.P. (5) NO LOAD VRmin (LOW LINE) Ta:25℃	U1 U101 (1) 18.8V (1) 10.97V (2) 18.8V (2) 10.65V (3) 18.8V (3) 10.97V (4) 18.8V (4) 11.62V (5) 11.4V (5) 8.96V

■ SAFETY& E.M.C. TEST

SAFETY TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	WITHSTAND VOLTAGE	I/P-O/P: 4KVAC/min I/P-FG :2KVAC/min O/P-FG:1.5KVAC/min	I/P-O/P: 4.4 KVAC/min I/P-FG: 2.4 KVAC/min O/P-FG:1.8 KVAC/min Ta:25℃	I/P-O/P: 1.833mA I/P-FG: 2.36mA O/P-FG:0.846mA NO DAMAGE
2	ISOLATION RESISTANCE	I/P-O/P:500VDC>100MΩ I/P-FG: 500VDC>100MΩ O/P-FG:500VDC>100MΩ	I/P-O/P: 600 VDC I/P-FG: 600 VDC O/P-FG: 600 VDC Ta:25℃	I/P-O/P:50GΩ I/P-FG:50GΩ O/P-FG:50GΩ NO DAMAGE

E.M.C TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	HARMONIC	BS EN/EN61000-3-2 CLASS A	I/P:230VAC/50HZ O/P:FULL LOAD Ta:25℃	PASS
2	CONDUCTION	BS EN/EN55032(CISPR32) Class I : Class B , Class II: Class A BS EN/EN55014(CISPR32) Class I : Class B	I/P： 230 VAC (50HZ) O/P：FULL/50% LOAD Ta：25℃	PASS Test by certified Lab

3	RADIATION	BS EN/EN55032(CISPR32) Class I : Class B , Class II: Class A BS EN/EN55014(CISPR32) Class I : Class B	I/P : 230 VAC (50HZ) O/P : FULL LOAD Ta : 25℃	PASS Test by certified Lab
4	E.S.D	BS EN/EN61000-4-2 ■ MEDICAL AIR : 15KV / Contact : 8KV	I/P : 230 VAC/50HZ O/P : FULL LOAD Ta : 25℃	■ CRITERIA A
5	E.F.T	BS EN/EN61000-4-4 ■ INDUSTRY INPUT : 2KV	I/P : 230 VAC/50HZ O/P : FULL LOAD Ta : 25℃	■ CRITERIA A
6	SURGE	IEC61000-4-5 ■ INDUSTRY L-N : 2KV L,N-PE : 4KV	I/P : 230 VAC/50HZ O/P : FULL LOAD Ta : 25℃	■ CRITERIA A
7	Test by certified Lab & Test Report Prepare Any contradictions of the test results, please refer to the latest EMC test report			

■ RELIABILITY TEST

ENVIRONMENT TEST

NO	TEST ITEM	SPECIFICATION	TEST CONDITION	RESULT
1	TEMPERATURE RISE TEST	MODEL : LOP-600-24 1. ROOM AMBIENT BURN-IN : 2 HRS I/P : 230VAC O/P : FULL LOAD 2. HIGH AMBIENT BURN-IN : 2 HRS I/P : 230VAC O/P : FULL LOAD		

NO	Position	ROOM AMBIENT Ta= 25 ℃ NO FAN	HIGH AMBIENT Ta= 40 ℃ NO FAN	ROOM AMBIENT Ta= 25 ℃ WITH FAN	HIGH AMBIENT Ta= 50 ℃ WITH FAN
1	ZNR1	52.8℃	67.8℃	29.4℃	53.4℃
2	C2	56.9℃	71.8℃	29.8℃	53.7℃
3	LF1	58.8℃	73.7℃	31.1℃	55.6℃
4	LF2	70.4℃	85.1℃	38.6℃	63.2℃
5	BD1	75.9℃	91℃	49.5℃	74.7℃
6	RTH1	70.5℃	84.9℃	31.5℃	55.9℃
7	RY1	76℃	89.9℃	35.7℃	60.5℃
8	C8	57.7℃	72.4℃	37.3℃	61.5℃
9	L1	72.7℃	87.5℃	51.4℃	76.2℃
10	Q1	74.3℃	89.8℃	46.9℃	73.6℃
11	D2	73.5℃	89.3℃	51.7℃	77.7℃
12	RTH3	71.9℃	87.5℃	47.2℃	73.1℃

		NO	Position	ROOM AMBIENT Ta= 25 ℃ NO FAN	HIGH AMBIENT Ta= 40 ℃ NO FAN	ROOM AMBIENT Ta= 25 ℃ WITH FAN	HIGH AMBIENT Ta= 50 ℃ WITH FAN
		13	U1	61.1℃	78.1℃	41.5℃	66.4℃
		14	Q3	72.7℃	88.5℃	48.7℃	74.9℃
		15	Q2	73.5℃	89.4℃	49.5℃	75.9℃
		16	C60	62.4℃	76.7℃	27.7℃	51.4℃
		17	C40	77.4℃	92.4℃	42℃	67.1℃
		18	T1 Coil	98℃	112.4℃	74.7℃	100.4℃
		19	T1 Core	85.2℃	100.5℃	53.9℃	78.2℃
		20	D103	67℃	83.1℃	40.5℃	65.4℃
		21	C125	55.7℃	72.6℃	39.1℃	62.4℃
		22	C120	66℃	81.9℃	42.4℃	67.6℃
		23	TSW1	71.7℃	87.4℃	43℃	68.1℃
		24	Q101	83.6℃	98.9℃	53.4℃	79.6℃
		25	Q103	85.2℃	100.2℃	51.5℃	77.7℃
		26	C103	71.5℃	86.5℃	41.3℃	66.4℃
		27	C102	66℃	81.5℃	42.5℃	67.4℃
		28	L100	59.9℃	75.5℃	44.1℃	69.6℃
		29	D1	62.4℃	76.7℃	34.6℃	59℃
		30	R3	69.5℃	84.4℃	41.8℃	66.5℃
		31	Q7	71.2℃	84.5℃	29.9℃	52.9℃
		32	U101	89℃	103.1℃	35.1℃	63.3℃
		33	R100	88.2℃	102.3℃	42.7℃	67.6℃
		34	Q108	72.1℃	87.1℃	36.4℃	60.8℃
		35	RG100	52.4℃	68.4℃	42.9℃	67.2℃
		36	R122	56.2℃	72.3℃	39.5℃	64.2℃
		37	D105	56.5℃	72.6℃	38.3℃	62.7℃
		38	U4	50.4℃	67.4℃	33.8℃	58.4℃
		39	R106	76.2℃	93.8℃	35.4℃	67.5℃
		40	C5	61.9℃	77.9℃	44.3℃	68.3℃
2	OVER LOAD BURN-IN TEST	NO DAMAGE 1 HOUR (MIN)		I/P： 230 VAC O/P：123%LOAD Ta：25℃		TEST：OK	
3	LOW TEMPERATURE TURN ON TEST	TURN ON AFTER 2 HOUR		I/P： 264VAC/115VAC O/P： 100%LOAD Ta= -45℃		TEST：OK	
4	HIGH HUMIDITY HIGH TEMPERATURE HIGH VOLTAGE TURN ON TEST	AFTER 12 HOURS IN CHAMBER ON CONTROL 50 ℃/95 %R.H NO DAMAGE		I/P： 272 VAC O/P：FULL LOAD Ta= 50 ℃ HUMIDITY= 95 %R.H		TEST：OK	
5	TEMPERATURE COEFFICIENT	± 0.03%/℃(0~50℃)		I/P： 230 VAC O/P：FULL LOAD		±0.008%/℃(0~50℃)	

6	STORAGE TEMPERATURE TEST	-40~85℃	1. Thermal shock Temperature： -45℃~ +90℃ 2. Temperature change rate ：25℃ / MIN 3. Dwell time low and high temperature ： 30 MIN/EACH 4. Total test cycle：10 CYCLE 5. Input/output condition： STATIC
7	THERMAL SHOCK TEST	-40~50℃	1. Thermal shock Temperature： -45℃~ +55℃ 2. Temperature change rate ：25℃ / MIN 3. Dwell time low and high temperature ： 30 MIN/EACH 4. Total test cycle：16 CYCLE 5. Input/output condition： 15cycle:230V/ FULL LOAD AC ON 3sec/AC OFF 1sec TEST 1cycle:230V/ FULL LOAD Burn In Test
8	VIBRATION TEST	10 ~ 500Hz, 2G 10min./1cycle, 60min. each along X, Y, Z axes	1 Carton & 1 Set (1) Waveform： Sine Wave (2) Frequency：10~500Hz (3) Sweep Time：12min/sweep cycle (4) Acceleration：3G (5) Test Time：180min in each axis (X.Y.Z) (6) Ta：25℃
9	CAPACITOR LIFE CYCLE	SUPPOSE C102 IS THE MOST CRITICAL COMPONENT (1) I/P： 230VAC O/P：FULL LOAD Ta= 25 ℃ LIFE TIME (2) I/P： 230VAC O/P：FULL LOAD Ta= 40 ℃ LIFE TIME (3) I/P： 230VAC O/P：75% LOAD Ta= 40 ℃ LIFE TIME (4) I/P： 230VAC O/P：50% LOAD Ta= 40 ℃ LIFE TIME	(1) 123392.5HRS (NO FAN) (2) 43625.8HRS (NO FAN) (3) 57749.9HRS (NO FAN) (4) 189080.9HRS (NO FAN)
		SUPPOSE C102 IS THE MOST CRITICAL COMPONENT (1) I/P： 230VAC O/P：FULL LOAD Ta= 25 ℃ LIFE TIME (2) I/P： 230VAC O/P：FULL LOAD Ta= 50 ℃ LIFE TIME (3) I/P： 230VAC O/P：75% LOAD Ta= 50 ℃ LIFE TIME (4) I/P： 230VAC O/P：50% LOAD Ta= 50 ℃ LIFE TIME	(5) 681703.7 HRS (WITH FAN) (6) 121347.5 HRS (WITH FAN) (7) 240968.3 HRS (WITH FAN) (8) 365167.5 HRS (WITH FAN)
10	MTBF	Conducted by Parts Stress Analysis Prediction 1963.2K hrs min. Telcordia SR-332 (Bellcore) ;310.9K hrs min. MIL-HDBK-217F (25℃)	
11	Ongoing Reliability Test	I/P：230VAC O/P：FULL LOAD TA=50℃ Demonstration Mean Time Between Failure : 30,000 hours	

TEST RESULT	TESTER	REVIEW	APPROVAL
PASS	Yuwei	Liutt	Wangdz

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