

REFERENCE LIST

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APPENDICES

Appendix A – Design simulations with ToroidEZE programme for designs with steel area ratio Uncut : Cut – 1.0 : 0.7

TI-173622 (1000VA) – Uncut centre core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY .</u>		
Design No	: TI-173622 (1000VA) - Uncut core	Printed : 2017-10-31
Customer	:	Designer : Sameera
Customer P/N	:	Noratel SL
Notes:		
Design File : 173622- un-cut core.tfx		
Core : 133 x 90 x 90 mm CK-37	Iron Loss : 9.2 W	Finished Dim's : 153 x 57 x 116 mm
Fe Weight : 5.1 kg	Coil Weight : 5.66 kg	Tot. Weight : 10.827 kg
Induction : 1.311 T	Load Loss : 34.69 W	Tot. Power : 999 VA
Frequency : 50 Hz	Sec Loss : 18.45 W	Temp. Rise : 42/50 deg.C
Excitation: 110.9 mA	Fri Loss : 16.24 W	Optimized : 1:0.36 Wdg+
Core/Coil : 0.9:1 kg	Window Fill : 83.6 %	Wire Fill : 38.3 %
Windings.	Primary	Sec 1
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	4.54A	4.5A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	999
Conductor.	Cu	Cu
Turns.	430ts	430ts
Wire Gauge.	1.900mm	1.900mm
Filars.	-	-
	-	-
Ohms @ 20°C.	0.641	0.74
	-	-
Copper grams.	2629	3035
	-	-
Full-Load Volts.	-	222.9v
No-Load Volts.	-	230v
Regulation %.	1.5%	3.1%
	-	-
Watts Loss Hot.	16.24	18.45
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm ² .	1.6	1.59
Copper Fill %.	19.16%	19.16%
ToroidEZE-AL v.2.6.1		
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TI-173622 (1000VA) – Composite core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>		
Design No	: TI-173622 (1000VA) - Composite core	Printed : 2017-10-31
Customer	:	Designer : Sameera
Customer P/N	:	Noratel SL
<u>Notes:</u>		
Design File : 173622.tfx		
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Core : 165 x 90 x 90 mm 27-M0H	Iron Loss : 2.13 W	Finished Dim's : 182 x 57 x 114 mm
Fe Weight : 10.17 kg	Coil Weight : 6.27 kg	Tot. Weight : 16.521 kg
Induction : 0.751 T	Load Loss : 37.25 W	Tot. Power : 999 VA
Frequency : 50 Hz	Sec Loss : 19.64 W	Temp. Rise : 34/41 deg.C
Excitation: 13.7 mA	Pri Loss : 17.61 W	Optimized : 1:0.65 Wdg+
Core/Coil : 1.6:1 kg	Window Fill : 83.6 %	Wire Fill : 38.3 %
<hr/>		
Windings.	Primary	Sec 1
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	4.51A	4.5A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	999
Conductor.	Cu	Cu
Turns.	430ts	430ts
Wire Gauge.	1.900mm	1.900mm
Filars.	-	-
	-	-
Ohms @ 20°C.	0.72	0.808
	-	-
Copper grams.	2954	3315
	-	-
Full-Load Volts.	-	222.3v
No-Load Volts.	-	230v
Regulation %.	1.6%	3.3%
	-	-
Watts Loss Hot.	17.61	19.64
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm ² .	1.59	1.59
Copper Fill %.	19.16%	19.16%
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ToroidEZE-AL v.2.6.1		Page 1 of 1.

TI-173618C (2000VA) – Uncut centre core

TOROIDAL TRANSFORMER DESIGN SUMMARY.		
Design No : TI-173618C (2000VA) - Uncut core	Printed : 2017-10-31	
Customer :	Designer : Sameera	
Customer P/N :	Noratel SL	
Notes:		
Design File : 173618C- un-cut core.tfx		
Core : 180 x 90 x 60 mm CK-37	Iron Loss : 15.21 W	Finished Dim's : 195 x 61 x 81 mm
Fe Weight : 8.61 kg	Coil Weight : 4.43 kg	Tot. Weight : 13.11 kg
Induction : 1.299 T	Load Loss : 101.4 W	Tot. Power : 2000 VA
Frequency : 50 Hz	Sec Loss : 35.01 W	Temp. Rise : 97/116 deg.C
Excitation: 178.1 mA	Pri Loss : 66.41 W	Optimized : 1:0.78 Wdg+
Core/Coil : 1.9:1 kg	Window Fill : 75.2 %	Wire Fill : 33.1 %
Windings.	Primary	Sec 1
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	9.2A	9.01A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	2000
Conductor.	Cu	Cu
Turns.	311ts	314ts
Wire Gauge.	1.180mm	1.700mm
Filars.	(x2)	(x2)
	-	-
Ohms @ 20°C.	0.537	0.295
	-	-
Copper grams.	1315	3113
	-	-
Full-Load Volts.	-	222v
No-Load Volts.	-	232.2v
Regulation %.	3%	4.4%
	-	-
Watts Loss Hot.	66.41	35.01
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm ² .	4.21	1.98
Copper Fill %.	10.69%	22.41%
ToroidEZE-AL v.2.6.1 Page 1 of 1.		

TI-173618C (2000VA) – Composite core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY</u>			
Design No	: TI-173618C (2000VA) - Composite core	Printed	: 2017-10-31
Customer	:	Designer	: Sameera
Customer P/N	:	Noratel SL	
<u>Notes:</u>			
Design File : ED-173618C total core.tfx			
Core	: 247 x 90 x 60 mm 27-MOH	Iron Loss	: 3.87 W
Fe Weight	: 18.75 kg	Coil Weight	: 5.66 kg
Induction	: 0.745 T	Load Loss	: 127.2 W
Frequency	: 50 Hz	Sec Loss	: 42.67 W
Excitation	: 25 mA	Pri Loss	: 84.57 W
Core/Coil	: 3.3:1 kg	Window Fill	: 75.2 %
Finished Dim's	: 259 x 61 x 80 mm	Tot. Weight	: 24.524 kg
Tot. Power	: 2000 VA	Temp. Rise	: 84/100 deg.C
Optimized	: 1:1.32 Fe+	Wire Fill	: 33.1 %
Windings.	Primary	Sec 1	
	0	0	
Rated Volts rms.	230v	222v	
Rated Amps rms.	9.27A	9.01A	
Duty Cycle %.	-	100%	
VA rms.	-	2000	
Conductor.	Cu	Cu	
Turns.	311ts	314ts	
Wire Gauge.	1.180mm	1.700mm	
Filars.	(x2)	(x2)	
Ohms @ 20°C.	0.701	0.374	
Copper grams.	1716	3941	
Full-Load Volts.	-	219.4v	
No-Load Volts.	-	232.2v	
Regulation %.	3.7%	5.5%	
Watts Loss Hot.	84.57	42.67	
Insulation Tape.	-	-	
Width. mm.	-	13	
Thickness. mm.	-	0.05	
Layers.	-	3	
Screening Tape.	-	-	
Width. mm.	-	-	
Thickness. mm.	-	-	
Layers.	-	-	
A/mm^2.	4.24	1.98	
Copper Fill %.	10.69%	22.41%	
ToroidEZE-AL v.2.6.1			Page 1 of 1.

TI-173618D (3000VA) – Uncut centre core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>			
Design No	: TI-173618D (3000VA) - Uncut core	Printed	: 2017-10-31
Customer	:	Designer	: Sameera
Customer P/N	:	Noratel SL	
<u>Notes:</u>			
Design File : 173618D- un-cut core.tfx			
Core	: 180 x 90 x 80 mm CK-37	Iron Loss	: 20.75 W
Fe Weight	: 11.48 kg	Coil Weight	: 6.57 kg
Induction	: 1.311 T	Load Loss	: 201.6 W
Frequency	: 50 Hz	Sec Loss	: 36.33 W
Excitation	: 250.3 mA	Pri Loss	: 165.2 W
Core/Coil	: 1.7:1 kg	Window Fill	: 86.1 %
Finished Dim's	: 197 x 56 x 105 mm	Tot. Weight	: 18.139 kg
		Tot. Power	: 2999 VA
		Temp. Rise	: 140/168 deg.C
		Optimized	: 1:0.7 Wdg+
		Wire Fill	: 41.5 %
Windings.	Primary	Sec 1	
	0	0	
Rated Volts rms.	230v	222v	
Rated Amps rms.	14.01A	13.51A	
Duty Cycle %.	-	100%	
	-	-	
VA rms.	-	2999	
Conductor.	Cu	Cu	
Turns.	231ts	231ts	
Wire Gauge.	1.600mm	2.000mm	
Filars.	-	(x3)	
	-	-	
Ohms @ 20°C.	0.513	0.121	
	-	-	
Copper grams.	1060	5511	
	-	-	
Full-Load Volts.	-	216.7v	
No-Load Volts.	-	230v	
Regulation %.	4.8%	5.8%	
	-	-	
Watts Loss Hot.	165.2	36.33	
	-	-	
Insulation Tape.	-	-	
Width. mm.	-	13	
Thickness. mm.	-	0.05	
Layers.	-	3	
	-	-	
Screening Tape.	-	-	
Width. mm.	-	-	
Thickness. mm.	-	-	
Layers.	-	-	
	-	-	
A/mm ² .	6.97	1.43	
Copper Fill %.	7.3%	34.22%	
ToroidEZE-AL v.2.6.1			Page 1 of 1.

TI-173618D (3000VA) – Composite core

TOROIDAL TRANSFORMER DESIGN SUMMARY.					
Design No	: TI-173618D (3000VA) - Composite core		Printed	: 2017-10-31	
Customer	:		Designer	: Sameera	
Customer P/N	:		Noratel SL		
<u>Notes:</u>					
Design File : ED-173618D - total core.tfx					
Core	: 247 x 90 x 80 mm 27-M0H	Iron Loss	: 5.25 W	Finished Dim's	: 261 x 56 x 103 mm
Fe Weight	: 25.01 kg	Coil Weight	: 8.07 kg	Tot. Weight	: 33.219 kg
Induction	: 0.752 T	Load Loss	: 245.5 W	Tot. Power	: 2999 VA
Frequency	: 50 Hz	Sec Loss	: 42.6 W	Temp. Rise	: 124/149 deg.C
Excitation	: 33.8 mA	Pri Loss	: 202.9 W	Optimized	: 1:1.24 Fe+
Core/Coil	: 3.1:1 kg	Window Fill	: 86.1 %	Wire Fill	: 41.5 %
Windings.	Primary	Sec 1			
	0	0			
Rated Volts rms.	230v	222v			
Rated Amps rms.	14.13A	13.51A			
Duty Cycle %.	-	100%			
	-	-			
VA rms.	-	2999			
Conductor.	Cu	Cu			
Turns.	231ts	231ts			
Wire Gauge.	1.600mm	2.000mm			
Filars.	-	(x3)			
	-	-			
Ohms @ 20°C.	0.645	0.148			
	-	-			
Copper grams.	1334	6738			
	-	-			
Full-Load Volts.	-	213.9v			
No-Load Volts.	-	230v			
Regulation %.	5.9%	7%			
	-	-			
Watts Loss Hot.	202.9	42.6			
	-	-			
Insulation Tape.	-	-			
Width. mm.	-	13			
Thickness. mm.	-	0.05			
Layers.	-	3			
	-	-			
Screening Tape.	-	-			
Width. mm.	-	-			
Thickness. mm.	-	-			
Layers.	-	-			
	-	-			
A/mm ² .	7.03	1.43			
Copper Fill %.	7.3%	34.22%			
ToroidEZE-AL v.2.6.1				Page 1 of 1.	

TI-173618E (4500VA) – Uncut centre core

TOROIDAL TRANSFORMER DESIGN SUMMARY.			
Design No	: TI-173618E (4500VA) - Uncut core	Printed	: 2017-10-31
Customer	:	Designer	: Sameera
Customer P/N	:	Noratel SL	
Notes:			
Design File : 173618E- un-cut core.tfx			
Core	: 180 x 90 x 100 mm CK-37	Iron Loss	: 25.54 W
Fe Weight	: 14.36 kg	Coil Weight	: 7.88 kg
Induction	: 1.303 T	Load Loss	: 509.3 W
Frequency	: 50 Hz	Sec Loss	: 74.02 W
Excitation	: 302.1 mA	Pri Loss	: 435.3 W
Core/Coil	: 1.8:1 kg	Window Fill	: 87.6 %
Finished Dim's	: 198 x 55 x 126 mm	Tot. Weight	: 22.338 kg
		Tot. Power	: 4500 VA
		Temp. Rise	: 163/185 deg.C
		Optimized	: 1:0.73 Wdg+
		Wire Fill	: 42.8 %
Windings.	Primary	Sec 1	
	0	0	
Rated Volts rms.	230v	222v	
Rated Amps rms.	21.89A	20.27A	
Duty Cycle %.	-	100%	
VA rms.	-	4500	
Conductor.	Cu	Cu	
Turns.	186ts	183ts	
Wire Gauge.	1.700mm	2.000mm	
Filars.	-	(x4)	
Ohms @ 20°C.	0.422	0.084	
Copper grams.	1112	6767	
Full-Load Volts.	-	204.7v	
No-Load Volts.	-	226.3v	
Regulation %.	8.2%	9.5%	
Watts Loss Hot.	435.3	74.02	
Insulation Tape.	-	-	
Width. mm.	-	13	
Thickness. mm.	-	0.05	
Layers.	-	3	
Screening Tape.	-	-	
Width. mm.	-	-	
Thickness. mm.	-	-	
Layers.	-	-	
A/mm ² .	9.64	1.61	
Copper Fill %.	6.64%	36.15%	
ToroidEZE-AL v.2.6.1			Page 1 of 1.

TI-173618E (4500VA) – Composite core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>					
Design No	: TI-173618E (4500VA) - Composite core		Printed	: 2017-10-31	
Customer	:		Designer	: Sameera	
Customer P/N	:		Noratel SL		
Notes:					
Special!!!- cut core					
Design File : ED-173618E - total core.tfx					
<hr/>					
Core	: 247 x 90 x 100 mm 27-MOH	Iron Loss	: 6.48 W	Finished Dim's	: 261 x 55 x 124 mm
Fe Weight	: 31.26 kg	Coil Weight	: 9.39 kg	Tot. Weight	: 40.8 kg
Induction	: 0.747 T	Load Loss	: 605.1 W	Tot. Power	: 4500 VA
Frequency	: 50 Hz	Sec Loss	: 83.49 W	Temp. Rise	: 137/185 deg.C
Excitation	: 41.8 mA	Pri Loss	: 521.6 W	Optimized	: 1:1.33 Fe+
Core/Coil	: 3.3:1 kg	Window Fill	: 87.6 %	Wire Fill	: 42.8 %
<hr/>					
Windings.	Primary	Sec 1			
	0	0			
Rated Volts rms.	230v	222v			
Rated Amps rms.	22.22A	20.27A			
Duty Cycle %.	-	100%			
	-	-			
VA rms.	-	4500			
Conductor.	Cu	Cu			
Turns.	186ts	183ts			
Wire Gauge.	1.700mm	2.000mm			
Filars.	-	(x4)			
	-	-			
Ohms @ 20°C.	0.716	0.099			
	-	-			
Copper grams.	1360	8029			
	-	-			
Full-Load Volts.	-	201v			
No-Load Volts.	-	226.3v			
Regulation %.	9.6%	11.2%			
	-	-			
Watts Loss Hot.	521.6	83.49			
	-	-			
Insulation Tape.	-	-			
Width. mm.	-	13			
Thickness. mm.	-	0.05			
Layers.	-	3			
	-	-			
Screening Tape.	-	-			
Width. mm.	-	-			
Thickness. mm.	-	-			
Layers.	-	-			
	-	-			
A/mm ² .	9.79	1.61			
Copper Fill %.	6.64%	36.15%			
<hr/>					
ToroidEEE-AL v.2.6.1				Page 1 of 1.	

Appendix B – Design simulations with ToroidEZE programme for designs with different steel area ratios

TI-173628 (1000VA with Cut:Uncut ratio = 0.6:1.0) – Uncut centre core

TOROIDAL TRANSFORMER DESIGN SUMMARY.		
Design No	: TI-173628 (1000VA) - Uncut core	
Customer	:	
Customer P/N	:	
		Printed : 2017-11-03
		Designer : Sameera
		Noratel SL
<u>Notes:</u>		
Design File : 173628- un-cut core.tfx		
Core	: 133 x 90 x 90 mm CK-37	Iron Loss : 9.2 W
Fe Weight	: 5.1 kg	Coil Weight : 5.66 kg
Induction	: 1.311 T	Load Loss : 34.7 W
Frequency	: 50 Hz	Sec Loss : 18.45 W
Excitation	: 110.9 mA	Pri Loss : 16.24 W
Core/Coil	: 0.9:1 kg	Window Fill : 83.6 %
		Finished Dim's : 153 x 57 x 116 mm
		Tot. Weight : 10.827 kg
		Tot. Power : 999 VA
		Temp. Rise : 42/50 deg.C
		Optimized : 1:0.36 Wdg+
		Wire Fill : 38.3 %
Windings.	Primary	Sec 1
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	4.54A	4.5A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	999
Conductor.	Cu	Cu
Turns.	430ts	430ts
Wire Gauge.	1.900mm	1.900mm
Filars.	-	-
	-	-
Ohms @ 20°C.	0.641	0.74
	-	-
Copper grams.	2629	3035
	-	-
Full-Load Volts.	-	222.9v
No-Load Volts.	-	230v
Regulation %.	1.5%	3.1%
	-	-
Watts Loss Hot.	16.24	18.45
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm ² .	1.6	1.59
Copper Fill %.	19.16%	19.16%
ToroidEZE-AL v.2.6.1		
Page 1 of 1.		

TI-173628 (1000VA with Cut:Uncut ratio = 0.6:1.0) – Composite core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>			
Design No	: TI-173628 (1000VA) - Composite core	Printed	: 2017-11-03
Customer	:	Designer	: Sameera
Customer P/N	:	Noratel SL	
Notes:			
Special!!			
Design File : ED-173628.tfx			
<hr/>			
Core	: 161 x 90 x 90 mm 27-M0H	Iron Loss	: 2.18 W
Fe Weight	: 9.48 kg	Coil Weight	: 6.18 kg
Induction	: 0.794 T	Load Loss	: 36.75 W
Frequency	: 50 Hz	Sec Loss	: 19.39 W
Excitation	: 14.1 mA	Pri Loss	: 17.35 W
Core/Coil	: 1.5:1 kg	Window Fill	: 83.6 %
Finished Dim's	: 179 x 57 x 115 mm	Tot. Weight	: 15.743 kg
		Tot. Power	: 999 VA
		Temp. Rise	: 34/41 deg.C
		Optimized	: 1:0.61 Wdg+
		Wire Fill	: 38.3 %
<hr/>			
Windings.	Primary	Sec 1	
	0	0	
Rated Volts rms.	230v	222v	
Rated Amps rms.	4.51A	4.5A	
Duty Cycle %.	-	100%	
	-	-	
VA rms.	-	999	
Conductor.	Cu	Cu	
Turns.	430ts	430ts	
Wire Gauge.	1.900mm	1.900mm	
Filars.	-	-	
	-	-	
Ohms @ 20°C.	0.71	0.798	
	-	-	
Copper grams.	2912	3273	
	-	-	
Full-Load Volts.	-	222.4v	
No-Load Volts.	-	230v	
Regulation %.	1.6%	3.3%	
	-	-	
Watts Loss Hot.	17.35	19.39	
	-	-	
Insulation Tape.	-	-	
Width. mm.	-	13	
Thickness. mm.	-	0.05	
Layers.	-	3	
	-	-	
Screening Tape.	-	-	
Width. mm.	-	-	
Thickness. mm.	-	-	
Layers.	-	-	
	-	-	
A/mm^2.	1.59	1.59	
Copper Fill %.	19.16%	19.16%	
<hr/>			
ToroidEZE-AL v.2.6.1			Page 1 of 1.

TI-173630 (1000VA with Cut:Uncut ratio = 0.8:1.0) – Uncut centre core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>		
Design No : TI-173630 (1000VA) - Uncut core	Printed : 2017-11-03	
Customer :	Designer : Sameera	
Customer P/N :	Noratel SL	
<u>Notes:</u>		
Design File : TI-173630- un-cut core.tfx		
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Core : 133 x 90 x 90 mm CK-37	Iron Loss : 9.2 W	Finished Dim's : 153 x 57 x 116 mm
Fe Weight : 5.1 kg	Coil Weight : 5.66 kg	Tot. Weight : 10.827 kg
Induction : 1.311 T	Load Loss : 34.69 W	Tot. Power : 999 VA
Frequency : 50 Hz	Sec Loss : 18.45 W	Temp. Rise : 42/50 deg.C
Excitation: 110.9 mA	Pri Loss : 16.24 W	Optimized : 1:0.36 Wdg+
Core/Coil : 0.9:1 kg	Window Fill : 83.6 %	Wire Fill : 38.3 %
<hr/>		
Windings.	Primary	Sec 1
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	4.54A	4.5A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	999
Conductor.	Cu	Cu
Turns.	430ts	430ts
Wire Gauge.	1.900mm	1.900mm
Filars.	-	-
	-	-
Ohms @ 20°C.	0.641	0.74
	-	-
Copper grams.	2629	3035
	-	-
Full-Load Volts.	-	222.9v
No-Load Volts.	-	230v
Regulation %.	1.5%	3.1%
	-	-
Watts Loss Hot.	16.24	18.45
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm^2.	1.6	1.59
Copper Fill %.	19.16%	19.16%
<hr/>		
ToroidEZE-AL v.2.6.1	Page 1 of 1.	

TI-173630 (1000VA with Cut:Uncut ratio = 0.80:1.0) – Composite core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>		
Design No : TI-173630 (1000VA) - Composite core		Printed : 2017-11-03
Customer :		Designer : Sameera
Customer P/N :		Noratel SL
Notes:		
<i>Special!!</i>		
Design File : TI-173630 - Composite.tfx		
<hr/>		
Core : 169 x 90 x 90 mm 27-MOH	Iron Loss : 2.08 W	Finished Dim's : 186 x 57 x 114 mm
Fe Weight : 10.88 kg	Coil Weight : 6.34 kg	Tot. Weight : 17.304 kg
Induction : 0.713 T	Load Loss : 37.65 W	Tot. Power : 999 VA
Frequency : 50 Hz	Sec Loss : 19.87 W	Temp. Rise : 34/41 deg.C
Excitation: 13.5 mA	Pri Loss : 17.78 W	Optimized : 1:0.69 Wdg+
Core/Coil : 1.7:1 kg	Window Fill : 83.6 %	Wire Fill : 38.3 %
<hr/>		
Windings.	Primary	Sec 1
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	4.52A	4.5A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	999
Conductor.	Cu	Cu
Turns.	430ts	430ts
Wire Gauge.	1.900mm	1.900mm
Filars.	-	-
	-	-
Ohms @ 20°C.	0.727	0.819
	-	-
Copper grams.	2982	3358
	-	-
Full-Load Volts.	-	222.2v
No-Load Volts.	-	230v
Regulation %.	1.6%	3.4%
	-	-
Watts Loss Hot.	17.78	19.87
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm ² .	1.59	1.59
Copper Fill %.	19.16%	19.16%
<hr/>		
ToroidEZE-AL v.2.6.1		Page 1 of 1.

TI-173618M (2500VA with Cut:Uncut ratio = 0.6:1.0) – Uncut centre core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>			
Design No	: TI-173618M (2500VA) - Uncut core	Printed	: 2017-11-03
Customer	:	Designer	: Sameera
Customer P/N	:	Noratel SL	
Notes:			
Design File : 173618M- uncut core.tfx			
<hr/>			
Core	: 180 x 90 x 80 mm CK-37	Iron Loss	: 20.75 W
Fe Weight	: 11.48 kg	Coil Weight	: 6.42 kg
Induction	: 1.311 T	Load Loss	: 140.8 W
Frequency	: 50 Hz	Sec Loss	: 23.11 W
Excitation	: 250.3 mA	Pri Loss	: 117.7 W
Core/Coil	: 1.8:1 kg	Window Fill	: 84.7 %
Finished Dim's	: 197 x 57 x 105 mm	Tot. Weight	: 17.991 kg
Tot. Power	: 2500 VA	Temp. Rise	: 108/130 deg.C
Optimized	: 1:0.71 Wdg+	Wire Fill	: 40.6 %
<hr/>			
Windings.	Primary	Sec 1	
	0	0	
Rated Volts rms.	230v	222v	
Rated Amps rms.	11.57A	11.26A	
Duty Cycle %.	-	100%	
VA rms.	-	2500	
Conductor.	Cu	Cu	
Turns.	231ts	231ts	
Wire Gauge.	1.500mm	2.000mm	
Filars.	-	(x3)	
Ohms @ 20°C.	0.582	0.121	
Copper grams.	930.2	5494	
Full-Load Volts.	-	218.8v	
No-Load Volts.	-	230v	
Regulation %.	4.2%	4.9%	
Watts Loss Hot.	117.7	23.11	
Insulation Tape.	-	-	
Width. mm.	-	13	
Thickness. mm.	-	0.05	
Layers.	-	3	
Screening Tape.	-	-	
Width. mm.	-	-	
Thickness. mm.	-	-	
Layers.	-	-	
A/mm^2.	6.55	1.19	
Copper Fill %.	6.42%	34.22%	
ToroidEZE-AL v.2.6.1			Page 1 of 1.

TI-173618M (2500VA with Cut:Uncut ratio = 0.6:1.0) – Composite core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>		
Design No : TI-173618M (2500VA) - Composite core	Printed : 2017-11-03	
Customer :	Designer : Sameera	
Customer P/N :	Noratel SL	
Notes:		
Special!!!- cut core		
Design File : ED-173618M - composite core.tfx		
<hr/>		
Core : 238 x 90 x 80 mm 27-M0H	Iron Loss : 5.33 W	Finished Dim's : 252 x 57 x 103 mm
Fe Weight : 22.94 kg	Coil Weight : 7.71 kg	Tot. Weight : 30.776 kg
Induction : 0.797 T	Load Loss : 165.6 W	Tot. Power : 2500 VA
Frequency : 50 Hz	Sec Loss : 26.5 W	Temp. Rise : 93/112 deg.C
Excitation: 34.3 mA	Pri Loss : 139.1 W	Optimized : 1:1.19 Fe+
Core/Coil : 3:1 kg	Window Fill : 84.7 %	Wire Fill : 40.6 %
<hr/>		
Windings.	Primary	Sec 1
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	11.61A	11.26A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	2500
Conductor.	Cu	Cu
Turns.	231ts	231ts
Wire Gauge.	1.500mm	2.000mm
Filars.	-	(x3)
	-	-
Ohms @ 20°C.	0.713	0.144
	-	-
Copper grams.	1139	6569
	-	-
Full-Load Volts.	-	216.9v
No-Load Volts.	-	230v
Regulation %.	4.9%	5.7%
	-	-
Watts Loss Hot.	139.1	26.5
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm^2.	6.57	1.19
Copper Fill %.	6.42%	34.22%
<hr/>		
ToroidEZE-AL v.2.6.1		Page 1 of 1.

TI-173618N (3500VA with Cut:Uncut ratio = 0.8:1.0) – Uncut core

<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>		
Design No : TI-173618N (3500VA) - Uncut core	Printed : 2017-11-03	
Customer :	Designer : Sameera	
Customer P/N :	Noratel SL	
<u>Notes:</u>		
Design File : TI-173618N- uncut core.tfx		
Core : 180 x 90 x 80 mm CK-37	Iron Loss : 20.75 W	Finished Dim's : 197 x 57 x 105 mm
Fe Weight : 11.48 kg	Coil Weight : 6.42 kg	Tot. Weight : 17.991 kg
Induction : 1.311 T	Load Loss : 423.6 W	Tot. Power : 3501 VA
Frequency : 50 Hz	Sec Loss : 63.19 W	Temp. Rise : 151/301 deg.C
Excitation: 250.3 mA	Pri Loss : 360.4 W	Optimized : 1:0.71 Wdg+
Core/Coil : 1.8:1 kg	Window Fill : 84.7 %	Wire Fill : 40.6 %
<u>Windings.</u>	<u>Primary</u>	<u>Sec 1</u>
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	17.15A	15.77A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	3501
Conductor.	Cu	Cu
Turns.	231ts	231ts
Wire Gauge.	1.500mm	2.000mm
Filars.	-	(x3)
	-	-
Ohms @ 20°C.	0.582	0.121
	-	-
Copper grams.	930.2	5494
	-	-
Full-Load Volts.	-	207.1v
No-Load Volts.	-	230v
Regulation %.	8.6%	10%
	-	-
Watts Loss Hot.	360.4	63.19
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm^2.	9.71	1.67
Copper Fill %.	6.42%	34.22%
ToroidEZE-AL v.2.6.1		
Page 1 of 1.		

TI-173618N (3500VA with Cut:Uncut ratio = 0.8:1.0) – Composite core

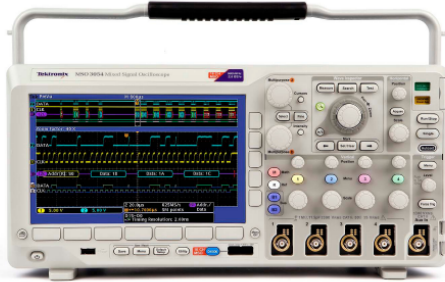
<u>TOROIDAL TRANSFORMER DESIGN SUMMARY.</u>		
Design No : TI-173618N (3500VA) - Composite core	Printed : 2017-11-03	
Customer :	Designer : Sameera	
Customer P/N :	Noratel SL	
<u>Notes:</u>		
Design File : ED-173618N - Composite core.tfx		
Core : 256 x 90 x 80 mm 27-MOH	Iron Loss : 5.16 W	Finished Dim's : 269 x 57 x 103 mm
Fe Weight : 27.14 kg	Coil Weight : 8.09 kg	Tot. Weight : 35.378 kg
Induction : 0.711 T	Load Loss : 560.3 W	Tot. Power : 3501 VA
Frequency : 50 Hz	Sec Loss : 77.3 W	Temp. Rise : 138/286 deg.C
Excitation: 33.6 mA	Pri Loss : 483 W	Optimized : 1:1.34 Fe+
Core/Coil : 3.4:1 kg	Window Fill : 84.7 %	Wire Fill : 40.6 %
Windings.	Primary	Sec 1
	0	0
Rated Volts rms.	230v	222v
Rated Amps rms.	17.68A	15.77A
Duty Cycle %.	-	100%
	-	-
VA rms.	-	3501
Conductor.	Cu	Cu
Turns.	231ts	231ts
Wire Gauge.	1.500mm	2.000mm
Filars.	-	(x3)
	-	-
Ohms @ 20°C.	0.753	0.152
	-	-
Copper grams.	1204	6891
	-	-
Full-Load Volts.	-	200.5v
No-Load Volts.	-	230v
Regulation %.	11.2%	12.8%
	-	-
Watts Loss Hot.	483	77.3
	-	-
Insulation Tape.	-	-
Width. mm.	-	13
Thickness. mm.	-	0.05
Layers.	-	3
	-	-
Screening Tape.	-	-
Width. mm.	-	-
Thickness. mm.	-	-
Layers.	-	-
	-	-
A/mm^2.	10	1.67
Copper Fill %.	6.42%	34.22%
ToroidEZE-AL v.2.6.1		
Page 1 of 1.		

Appendix C – Test equipment details

Mixed Signal Oscilloscope (DPO3000)

Mixed Signal Oscilloscopes

MSO3000 Series, DPO3000 Series Data Sheet



Features & Benefits

Key Performance Specifications

- 500, 300, 100 MHz Bandwidth Models
- 2 and 4 Analog Channel Models
- 16 Digital Channels (MSO Series)
- 2.5 GS/s Sample Rate on All Channels
- 5 Megapoint Record Length on All Channels
- >50,000 wfm/s Maximum Waveform Capture Rate
- Suite of Advanced Triggers

Ease of Use Features

- Wave Inspector® Controls provide Easy Navigation and Automated Search of Waveform Data
- 29 Automated Measurements, and FFT Analysis for Simplified Waveform Analysis
- TekVPI® Probe Interface Supports Active, Differential, and Current Probes for Automatic Scaling and Units
- 9 in. (229 mm) WVGA Widescreen Color Display
- Small Footprint and Lightweight – Only 5.8 in. (147 mm) deep and 9 lb. (4 kg)

Connectivity

- USB 2.0 Host Port on both the Front Panel and Rear Panel for Quick and Easy Data Storage, Printing, and Connecting a USB Keyboard
- USB 2.0 Device Port on Rear Panel for Easy Connection to a PC or Direct Printing to a PictBridge®-compatible Printer
- Integrated 10/100 Ethernet Port for Network Connection and Video Out Port to Export the Oscilloscope Display to a Monitor or Projector

Optional Serial Triggering and Analysis

- Automated Serial Triggering, Decode, and Search Options for I²C, SPI, CAN, LIN, RS-232/422/485/UART, and I²S/LJ/RJ/TDM

Mixed Signal Design and Analysis (MSO Series)

- Automated Triggering, Decode, and Search on Parallel Buses
- Multichannel Setup and Hold Triggering
- MagniVu™ High-speed Acquisition Provides 121.2 ps Fine Timing Resolution on Digital Channels


Optional Application Support

- Power Analysis
- HDTV and Custom Video Analysis

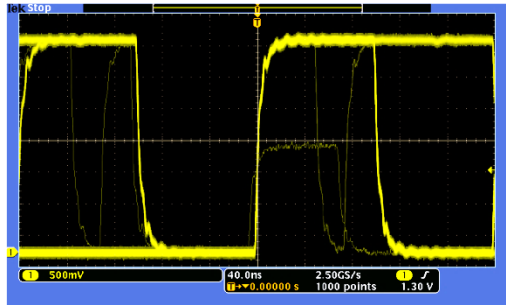
Feature-rich Tools for Debugging Mixed Signal Designs

With the MSO/DPO3000 Mixed Signal Oscilloscope Series, you can analyze up to 20 analog and digital signals with a single instrument to quickly find and diagnose problems in complex designs. Bandwidths up to 500 MHz and a minimum of 5X oversampling on all channels ensure you have the performance you need for many of today's mainstream applications. To capture long windows of signal activity while maintaining fine timing resolution, the MSO/DPO3000 offers a deep record length of 5 Mpoints standard on all channels.

With Wave Inspector® controls for rapid waveform navigation, automated serial and parallel bus analysis, and automated power analysis – the MSO/DPO3000 Oscilloscope Series from Tektronix provides the feature-rich tools you need to simplify and speed debug of your complex design.



Data Sheet



Discover – Fast waveform capture rate - over 50,000 wfms/s - maximizes the probability of capturing elusive glitches and other infrequent events.

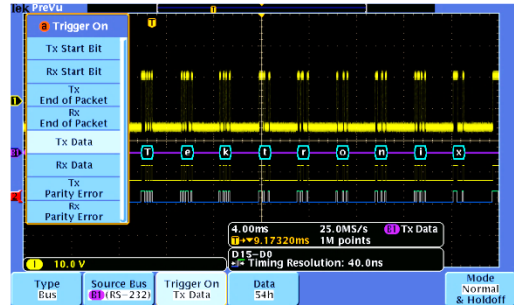
Comprehensive Features Speed Every Stage of Debug

The MSO/DPO3000 Series offers a robust set of features to speed every stage of debugging your design – from quickly discovering an anomaly and capturing it, to searching your waveform record for the event and analyzing its characteristics and your device's behavior.

Discover

To debug a design problem, first you must know it exists. Every design engineer spends time looking for problems in their design, a time-consuming and frustrating task without the right debug tools.

The MSO/DPO3000 Series offers the industry's most complete visualization of signals, providing fast insight into the real operation of your device. A fast waveform capture rate – greater than 50,000 waveforms per second – enables you to see glitches and other infrequent transients within seconds, revealing the true nature of device faults. A digital phosphor display with intensity grading shows the history of a signal's activity by intensifying areas of the signal that occur more frequently, providing a visual display of just how often anomalies occur.



Capture – Triggering on a specific transmit data packet going across an RS-232 bus. A complete set of triggers, including triggers for specific serial packet content, ensures you quickly capture your event of interest.

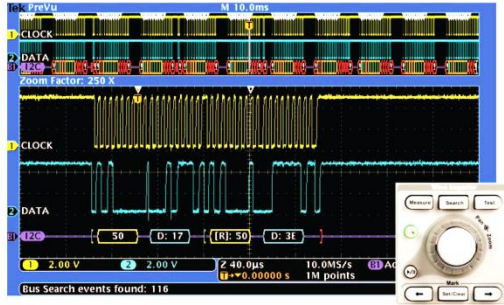
Capture

Discovering a device fault is only the first step. Next, you must capture the event of interest to identify root cause.

The MSO/DPO3000 Series provides a complete set of triggers – including runt, logic, pulse width/glitch, setup/hold violation, serial packet, and parallel data – to help quickly find your event. With up to a 5 Mpoint record length, you can capture many events of interest, even thousands of serial packets, in a single acquisition for further analysis while maintaining high resolution to zoom in on fine signal details.

From triggering on specific packet content to automatic decode in multiple data formats, the MSO/DPO3000 Series provides integrated support for the industry's broadest range of serial buses – I²C, SPI, CAN, LIN, RS-232/422/485/UART, and I²S/LJ/RJ/TDM. The ability to decode up to two serial and/or parallel buses simultaneously means you gain insight into system-level problems quickly.

To further help troubleshoot system-level interactions in complex embedded systems, the MSO3000 Series offers 16 digital channels in addition to its analog channels. Since the digital channels are fully integrated into the oscilloscope, you can trigger across all input channels, automatically time-correlating all analog, digital, and serial signals. The MagniVu™ high-speed acquisition enables you to acquire fine signal detail (up to 121.2 ps resolution) around the trigger point for precision measurements. MagniVu is essential for making accurate timing measurements for setup and hold measurements, clock delay, signal skew, and glitch characterization.

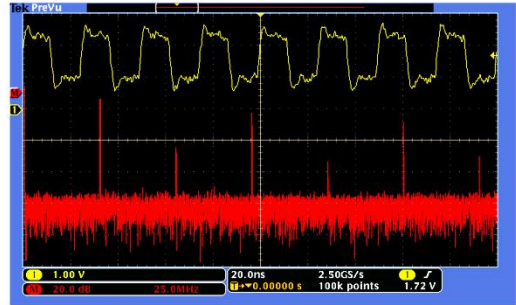


Search – I²C decode showing results from a Wave Inspector search for Address value 50. Wave Inspector controls provide unprecedented efficiency in viewing and navigating waveform data.

Search

Finding your event of interest in a long waveform record can be time consuming without the right search tools. With today's record lengths pushing beyond a million data points, locating your event can mean scrolling through thousands of screens of signal activity.

The MSO/DPO3000 Series offers the industry's most comprehensive search and waveform navigation with its innovative Wave Inspector® controls. These controls speed panning and zooming through your record. With a unique force-feedback system, you can move from one end of your record to the other in just seconds. User marks allow you to mark any location that you may want to reference later for further investigation. Or, automatically search your record for criteria you define. Wave Inspector will instantly search your entire record, including analog, digital, and serial bus data. Along the way it will automatically mark every occurrence of your defined event so you can quickly move between events.



Analyze – FFT analysis of a pulsed signal. A comprehensive set of integrated analysis tools speeds verification of your design's performance.

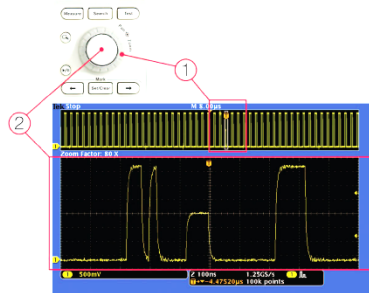
Analyze

Verifying that your prototype's performance matches simulations and meets the project's design goals requires analyzing its behavior. Tasks can range from simple checks of rise times and pulse widths to sophisticated power loss analysis and investigation of noise sources.

The MSO/DPO3000 Series offers a comprehensive set of integrated analysis tools including waveform- and screen-based cursors, 29 automated measurements, advanced waveform math including arbitrary equation editing, FFT analysis, and trend plots for visually determining how a measurement is changing over time. Specialized application support for serial bus analysis, power supply design, and video design and development is also available.

For extended analysis, National Instrument's LabVIEW SignalExpress™ Tektronix Edition provides over 200 built-in functions including time and frequency domain analysis, limit testing, data logging, and customizable reports.

Data Sheet



Wave Inspector controls provide unprecedented efficiency in viewing, navigating, and analyzing waveform data. Zip through your 5 Mpoint record by turning the outer pan control (1). Get from the beginning to end in seconds. See something of interest and want to see more details? Just turn the inner zoom control (2).

Wave Inspector® Navigation and Search

A 5 Mpoint record length represents thousands of screens of information. The MSO/DPO3000 Series enables you to find your event in seconds with Wave Inspector, the industry's best tool for navigation and search.

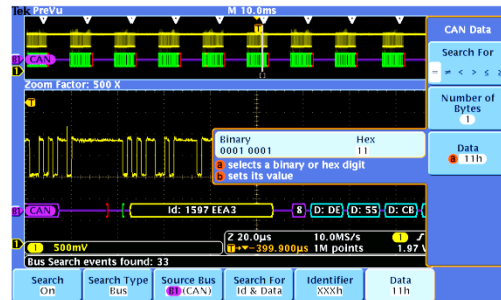
Wave Inspector offers the following innovative controls:

Zoom/Pan

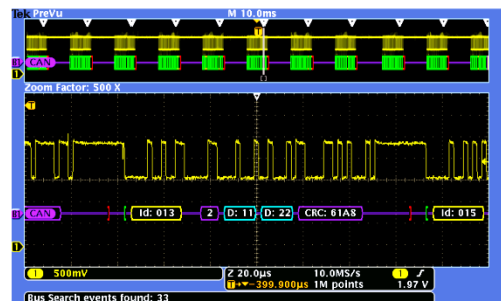
A dedicated, two-tier front-panel control provides intuitive control of both zooming and panning. The inner control adjusts the zoom factor (or zoom scale); turning it clockwise activates zoom and goes to progressively higher zoom factors, while turning it counterclockwise results in lower zoom factors and eventually turning zoom off. No longer do you need to navigate through multiple menus to adjust your zoom view. The outer control pans the zoom box across the waveform to quickly get to the portion of waveform you are interested in. The outer control also utilizes force-feedback to determine how fast to pan on the waveform. The farther you turn the outer control, the faster the zoom box moves. Pan direction is changed by simply turning the control the other way.

Play/Pause

A dedicated **Play/Pause** front-panel button scrolls the waveform across the display automatically while you look for anomalies or an event of interest. Playback speed and direction are controlled using the intuitive pan control. Once again, turning the control further makes the waveform scroll faster and changing direction is as simple as turning the control the other way.



Search step 1: You define what you would like to find.



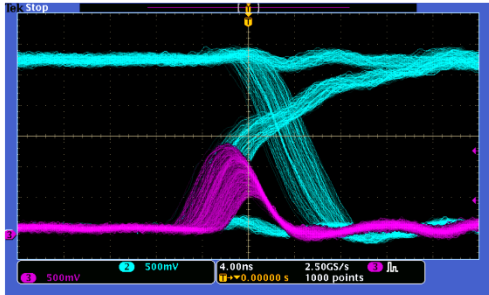
Search step 2: Wave Inspector automatically searches through the record and marks each event with a hollow white triangle. You can then use the **Previous** and **Next** buttons to jump from one event to the next.

User Marks

Press the **Set Mark** front-panel button to place one or more marks on the waveform. Navigating between marks is as simple as pressing the **Previous** (←) and **Next** (→) buttons on the front panel.

Search Marks

The **Search** button allows you to automatically search through your long acquisition looking for user-defined events. All occurrences of the event are highlighted with search marks and are easily navigated to, using the front-panel **Previous** (←) and **Next** (→) buttons. Search types include edge, pulse width/glitch, runt, logic, setup and hold, rise/fall time parallel bus, and I²C, SPI, CAN, LIN, RS-232/422/485/UART, and I²S/LJ/RJ/TDM packet content.



Digital phosphor technology enables greater than 50,000 wfms/s waveform capture rate and real-time intensity grading on the MSO/DPO3000 Series.

Digital Phosphor Technology

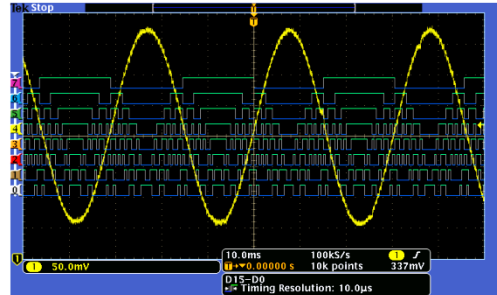
The MSO/DPO3000 Series' digital phosphor technology provides you with fast insight into the real operation of your device. Its fast waveform capture rate – greater than 50,000 wfms/s – gives you a high probability of quickly seeing the infrequent problems common in digital systems: runt pulses, glitches, timing issues, and more.

Waveforms are superimposed with one another and waveform points that occur more frequently are intensified. This quickly highlights the events that over time occur more often or, in the case of infrequent anomalies, occur less often.

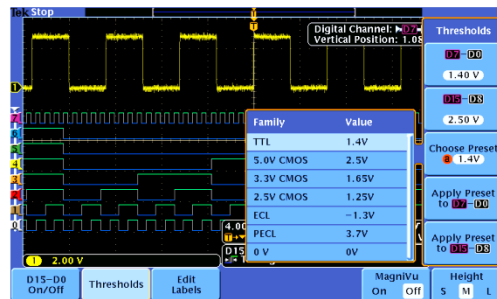
With the MSO/DPO3000 Series, you can choose infinite persistence or variable persistence, determining how long the previous waveform acquisitions stay on-screen. This allows you to determine how often an anomaly is occurring.

Mixed Signal Design and Analysis (MSO Series)

The MSO3000 Series Mixed Signal Oscilloscopes provide 16 digital channels. These channels are tightly integrated into the oscilloscope's user interface, simplifying operation and making it possible to solve mixed-signal issues easily.



The MSO Series provides 16 integrated digital channels enabling you to view and analyze time-correlated analog and digital signals.



With the color-coded digital waveform display, groups are created by simply placing digital channels together on the screen, allowing the digital channels to be moved as a group. You can set threshold values for each pod of eight channels, enabling support for up to two different logic families.

Color-coded Digital Waveform Display

The MSO3000 Series has redefined the way you view digital waveforms. One common problem shared by both logic analyzers and mixed-signal oscilloscopes is determining if data is a one or a zero when zoomed in far enough that the digital trace stays flat all the way across the display. The MSO3000 Series has color-coded digital traces, displaying ones in green and zeros in blue.

Characteristics

Vertical System Analog Channels

Characteristic	MSO3012 DPO3012	MSO3014 DPO3014	MSO3032 DPO3032	MSO3034 DPO3034	DPO3052	MSO3054 DPO3054
Input Channels	2	4	2	4	2	4
Analog Bandwidth (-3 dB)	100 MHz	100 MHz	300 MHz	300 MHz	500 MHz	500 MHz
Calculated Rise Time 5 mV/div (typical)	3.5 ns	3.5 ns	1.17 ns	1.17 ns	700 ps	700 ps
Hardware Bandwidth Limits	20 MHz		20 MHz, 150 MHz			
Input Coupling	AC, DC, GND					
Input Impedance	1 M Ω \pm 1%, 75 Ω \pm 1%, 50 Ω \pm 1%					
Input Sensitivity Range, 1 M Ω	1 mV/div to 10 V/div					
Input Sensitivity Range, 75 Ω 50 Ω	1 mV/div to 1 V/div					
Vertical Resolution	8 bits (11 bits with Hi Res)					
Maximum Input Voltage, 1 M Ω	300 V _{RMS} with peaks \leq \pm 450 V					
Maximum Input Voltage, 75 Ω 50 Ω	5 V _{RMS} with peaks \leq \pm 20 V					
DC Gain Accuracy	\pm 1.5% for 5 mV/div and above \pm 2.0% for 2 mV/div \pm 2.5% for 1 mV/div					
Channel-to-Channel Isolation (Any Two Channels at Equal Vertical Scale)	\geq 100:1 at \leq 100 MHz and \geq 30:1 at $>$ 100 MHz up to the rated BW					

Offset Range

Range	1 M Ω	50 Ω , 75 Ω
1 mV/div to 99.5 mV/div	\pm 1 V	\pm 1 V
100 mV/div to 995 mV/div	\pm 10 V	\pm 5 V
1 V/div	\pm 100 V	\pm 5 V
1.01 V/div to 10 V/div	\pm 100 V	NA

Vertical System Digital Channels

Characteristic	All MSO3000 Models
Input Channels	16 Digital (D15 to D0)
Thresholds	Threshold per set of 8 channels
Threshold Selections	TTL, CMOS, ECL, PECL, User Defined
User-defined Threshold Range	-15 V to +25 V
Maximum Input Voltage	-20 V to +30 V
Threshold Accuracy	\pm (100 mV +3% of threshold setting)
Maximum Input Dynamic Range	50 V _{pp} (threshold setting dependent)
Minimum Voltage Swing	500 mV _{pp}
Input Impedance	101 k Ω
Probe Loading	8 pF
Vertical Resolution	1 bit

Horizontal System Analog Channels

Characteristic	All MSO3000 Models All DPO3000 Models
Maximum Sample Rate (all channels)	2.5 GS/s
Maximum Record Length (all channels)	5 Mpoints
Maximum Duration of Time Captured at Highest Sample Rate (all channels)	2 ms
Time-base Range (s/div)	1 ns to 1000 s
Time-base Delay Time Range	-10 divisions to 5000 s
Channel-to-Channel Deskew Range	\pm 100 ns
Time-base Accuracy	\pm 10 ppm over any \geq 1 ms interval

Horizontal System Digital Channels

Characteristic	All MSO3000 Models
Maximum Sample Rate (Main, all channels)	500 MS/s (2 ns resolution)
Maximum Record Length (Main, all channels)	5 Mpoints
Maximum Sample Rate (MagniVu, all channels)	8.25 GS/s (121.2 ps resolution)
Maximum Record Length (MagniVu, all channels)	10 kpoints centered on the trigger
Minimum Detectable Pulse Width	2.0 ns
Channel-to-Channel Skew	500 ps typical



Current Probes

A621 & A622 Datasheet



- A622
 - AC/DC – 100 kHz
 - 50 mA to 100 A peak
 - For DMMs and oscilloscopes

Applications

- Motor drives
- Inverters
- Power supplies
- Avionics

A621 2000 Amp AC Current probe/BNC

This industrial-style clamp-on probe has a BNC connector and can be used with a shrouded banana plug adapter ¹ so it can be used on digital multimeters, TekMeter, and oscilloscopes. The A621 can measure AC currents from 100 mA to 2000 A peak over a frequency range of 5 Hz to 50 kHz. It provides a 1 mV, 10 mV, or 100 mV output for each Amp measured.

A622 100 Amp AC DC Current probe/BNC

This "long nose" style clamp-on probe uses a Hall Effect current sensor to provide a voltage output to oscilloscopes. It has a BNC connector and can be used with a shrouded banana plug adapter ¹ so it can also be used on digital multimeters, TekMeter, and oscilloscopes. The A622 can measure AC/DC currents from 50 mA to 100 A peak over a frequency range of DC to 100 kHz. It provides 10 mV or 100 mV output for each Amp measured.

DS_FeaturesBenefitsContainer

The A600 Series current probes are specifically designed to support measurements with the TekMeter® or oscilloscope.

Features and benefits

- A621
 - AC – 5 Hz to 50 kHz
 - 100 mA to 2000 A peak
 - For DMMs and oscilloscopes
 - Clamp on

Recommended products

TPS2000, TDS1000B, TDS2000C, and TDS3000C Series oscilloscopes and DMM4020¹, DMM4040¹, and DMM4050¹ digital multimeters.

¹ For instruments with banana jack inputs, Tektronix part number 012-1450-00 Female BNC to banana lead adapter is required.

Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Characteristic	A621	A622
Frequency range	5 Hz to 50 kHz	DC to 100 kHz
Maximum input current	2000 A peak	100 A peak
Output	1 mV/A, 10 mV/A, 100 mV/A	10 mV/A, 100 mV/A
Maximum conductor diameter	54 mm (2.13 in.)	11.8 mm (0.46 in.)
Termination	BNC ¹	BNC ¹
Maximum bare-wire voltage	600 V (CAT III)	600 V (CAT III)
Safety	UL3111-2-032, CSA1010.2-032, EN61010-2-032, IEC61010-2-032	UL3111-2-032, CSA1010.2-032, EN61010-2-032, IEC61010-2-032

Ordering information

A621	2000 A AC Current probe/BNC.
A622	100 A AC/DC Current probe/BNC.

Recommended accessories

012-1450-xx	Adapter, lead; discrete – MLD, 2, 18 AWG, dual insul, BNC, female X 4 mm dual insul; banana jack X dual insul plug, shield banana
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Options

Service options

Opt. R3	Repair Service 3 Years (including warranty)
Opt. R5	Repair Service 5 Years (including warranty)



Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

Zero crossing detecting circuit (SIEMENS 3RF2050-1AA02)

SIEMENS

Product data sheet

3RF2050-1AA02



SEMICOND. RELAY 3RF2,
1-PHASE WIDTH 45 MM,
50 A 24-230 V / 24 V DC SCREW TERMINAL

General technical data:

product brand name	SIRIUS	
product designation	solid-state relay	
Product function	zero-point switching	
Number of poles / for main current circuit	1	
Protection class IP	IP20	
Ambient temperature		
• during operating	°C	-25 ... +60
• during storage	°C	-55 ... +80
Installation altitude / at a height over sea level / maximum	m	1,000
Resistance against vibration / according to IEC 60068-2-6	2g	
Resistance against shock / according to IEC 60068-2-27	15g / 11 ms	
Item designation		
• according to DIN 40719 extendable after IEC 204-2 / according to IEC 750	K	
• according to DIN EN 61346-2	Q	
Number of NC contacts / for auxiliary contacts	0	
Number of NO contacts / for auxiliary contacts	0	
Number of change-over switches / for auxiliary contacts	0	

Main circuit:

3RF2050-1AA02
Page 1/5

03/06/2013

subject to modifications
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Number of NO contacts / for main contacts		1
Number of NC contacts / for main contacts		0
Operating current		
• at AC-1 / at 400 V / rated value	A	50
• at AC-51 / rated value	A	50
Operating current / minimum	mA	500
Operating voltage		
• at 50 Hz / at AC / rated value	V	24 ... 230
• at 60 Hz / at AC / rated value	V	24 ... 230
Working area related to the operating voltage		
• at 50 Hz / for AC	V	20 ... 253
• at 60 Hz / for AC	V	20 ... 253
Operating frequency		
• rated value	Hz	50 ... 60
Relative symmetrical tolerance / of the operation frequency	%	10
Insulation voltage / rated value	V	600
Voltage slew rate / at the thyristor / for main contacts / maximum permissible	V/ μ s	1,000
Block voltage / at the thyristor / for main contacts / maximum permissible	V	800
Reverse current / of the thyristor	mA	10
Derating temperature	$^{\circ}$ C	40
Active power loss / total / typical	W	66
Resistance against the impulse current / rated value	A	600
I²t-level / maximum	A ² ·s	1,800

Control circuit:






Type of voltage / of the controlled supply voltage		DC
Control supply voltage / 1		
• for DC		
• initial rated value	V	15
• final rated value	V	24
Control supply voltage		
• for DC / final value for signal<0>-recognition	V	5
Relative symmetrical tolerance / of the supply voltage frequency	%	10
Control current		
• at minimum control supply voltage / for DC	mA	2
• for DC / rated value	mA	15
Fuse assignments	https://www.automation.siemens.com/cc-static/material/info/3RF20_eng.pdf	

Installation/mounting/dimensions:		
Type of mounting		screw fixing
Type of fixing/fixation / series installation		Yes
Design of the thread / of the screw for fastening of the operating resource		M4
Tightening torque / of the screw for fastening of the operating resource	N·m	1.5
Width	mm	45
Height	mm	58
Depth	mm	48

Connections:		
Design of the electrical connection / for main current circuit		screw-type terminals
Design of the thread / of the connection screw / for main contacts		M4
Tightening torque / for main contacts / with screw-type terminals		
• minimum	N·m	2
• maximum	N·m	2.5
Tightening torque (lbf·in) / for main contacts / with screw-type terminals		
• minimum	lbf·in	7
• maximum	lbf·in	10.3
Type of the connectable conductor cross-section		
• for main contacts		
• solid		2x (1.5 ... 2.5 mm ²), 2x (2.5 ... 6 mm ²)
• finely stranded		
• with conductor end processing		2x (1 ... 2.5 mm ²), 2x (2.5 ... 6 mm ²), 1x 10 mm ²
• for AWG conductors		
• for main contacts		2x (14 ... 10)
• for auxiliary and control contacts		1x (AWG 20 ... 12)
• for auxiliary and control contacts		
• solid		1x (0.5 ... 2.5 mm ²), 2x (0.5 ... 1.0 mm ²)
• finely stranded		
• with conductor end processing		1x (0.5 ... 2.5 mm ²), 2x (0.5 ... 1.0 mm ²)
• without conductor final cutting		1x (0.5 ... 2.5 mm ²), 2x (0.5 ... 1.0 mm ²)
Conductor cross section that can be connected		
• for main contacts		
• solid	mm ²	1.5 ... 6
• stranded wire		
• with conductor end processing	mm ²	1 ... 10
• for auxiliary and control contacts		

• solid	mm ²	0.5 ... 2.5
• stranded wire		
• with conductor end processing /	mm ²	0.5 ... 2.5
• without conductor final cutting	mm ²	0.5 ... 2.5
AWG number / as coded connectable conductor cross-section / for main contacts		14 ... 10
Design of the electrical connection / for auxiliary and control current circuit		screw-type terminals
Design of the thread / of the connection screw / of the auxiliary and control pins		M3
AWG number / as coded connectable conductor cross-section		
• for auxiliary and control contacts		20 ... 12
Skinning length / of the cable / for main contacts	mm	10
Skinning length / of the cable / for auxiliary and control contacts	mm	7
Tightening torque / for auxiliary and control contacts		
• with screw-type terminals	N·m	0.5 ... 0.6
Tightening torque (lbf-in) / for auxiliary and control contacts		
• with screw-type terminals	lbf-in	4.5 ... 5.3

Certificates/approvals:

General Product Approval	EMC	Declaration of Conformity	Test Certificates
 CSA	 UR	 EG-Konf.	Type Test Certificates/Test Report
 GOST	 C-TICK		

other

[Environmental Confirmations](#)

Further information:

Information- and Downloadcenter (Catalogs, Brochures,...)

<http://www.siemens.com/industrial-controls/catalogs>

Industry Mall (Online ordering system)

<http://www.siemens.com/industrial-controls/mall>

CAX-Online-Generator

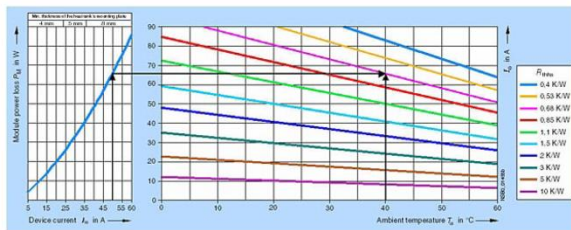
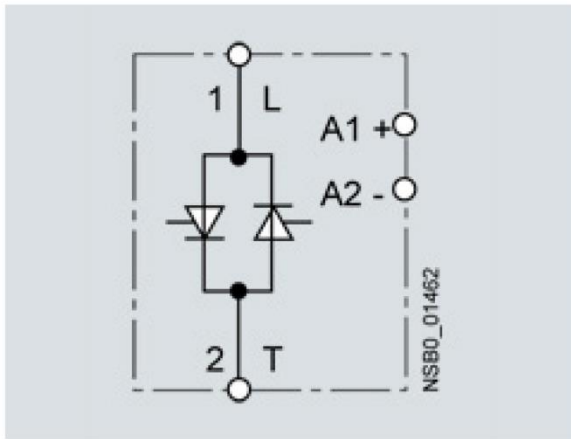
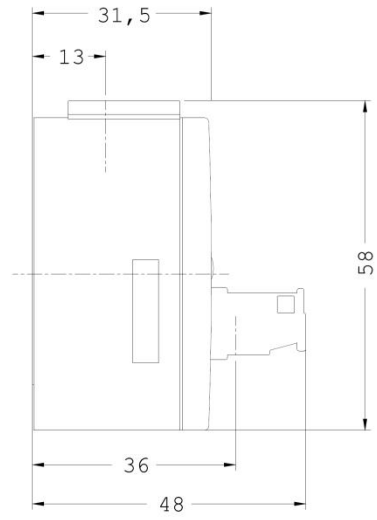
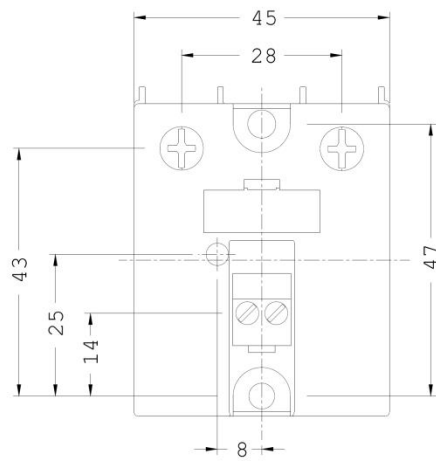
<http://www.siemens.com/cax>

Service&Support (Manuals, Certificates, Characteristics, FAQs,...)

<http://support.automation.siemens.com/WW/view/en/3RF2050-1AA02/all>

Image database (product images, 2D dimension drawings, 3D models, device circuit diagrams, ...)

http://www.automation.siemens.com/bilddb/cax_en.aspx?mifb=3RF2050-1AA02



last change:

Mar 4, 2013

Sound level measuring meter (Extech SL130G)



PRODUCT DATASHEET

Sound Level Alert with Alarm

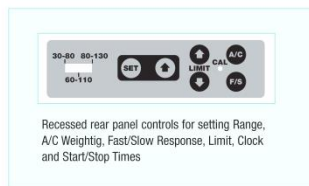
Built-in LEDs alert user when sound level is too high or too low
LEDs can be read from 30m (100ft)

Features:

- Ideal for industrial, hospital, auditoriums, schools and other areas where there is a need for being alerted when sound level reaches set point
- Meets ANSI Type 2 and EN 60651 accuracy specs compliant to OSHA
- User settable high or low limit (30 to 130dB) indication with output to drive external relay module
- Microphone rotates 180° for desired placement. Optional 5m (15ft) microphone extension cable for remote monitoring
- Complete with 100-240V AC 50/60Hz adaptor, microphone windscreen, and built-in wall, desk and tripod mount (optional Tripod TR100)

Applications:

- Industrial, Hospitals, Classrooms, and special quiet zones – When the sound level exceeds the HI set point the RED LEDs flash and can be seen from 30m 100ft.
- Speakers/Educators/Instructors, Auditoriums and Theaters – The user can set the SL130 so the RED LEDs flash when the sound level is below the LO set point where people in the audience may not be able to hear. When the sound level is above the LO set point, the GREEN LEDs indicate the sound level is acceptable. The user can reverse the Red and Green LEDs activation per user color preference.



Recessed rear panel controls for setting Range, A/C Weighting, Fast/Slow Response, Limit, Clock and Start/Stop Times

Specifications	
Display	4.6 x 3.125" multifunction LCD
Frequency bandwidth	31.5 Hz to 8 kHz
Microphone	0.5" Electret Condenser Microphone (removable)
Measurement ranges	30 to 80dB, 60 to 110dB, 80 to 130dB
Frequency weighting	'A' and 'C' (Programmable)
Response time	Fast (125ms) / Slow (1s) (Programmable)
Resolution	0.1dB
Alarm output	3.5mm Mono Phone Plug, Maximum: 3.4mA @ 5 VDC
Minimum Output	Voltage: 2.5 VDC
Power	AC/DC Adaptor for full functions; 8xAA batteries for monitoring function only without LED alert
CE/Warranty	CE approved/ 1 year warranty
Dimensions / Weight	8.75 x 7.1 x 1.25" / 0.63 lbs. (22 x 18 x 3.2mm / 285g)

Ordering Information:

- SL130G Sound Level LED Alert
- SL130G-NIST SL130G with Calibration Traceable to NIST.
- SL125 Remote Microphone Cable 15'
- TR100 Tripod (for meters with Tripod mount feature)
- 407766 Sound Level Calibrator, 94/114dB



www.extech.com

Specifications subject to change without notice.
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4/8/14 - R1

Measuring equipment (WT230/WT210)

YOKOGAWA 

ENERGY SAVING TOOLS
Digital Sampling Power Meters
with Superior Cost Performance

Digital Power Meters

WT 210/WT 230



- Basic power accuracy: 0.1%
- DC measurement, 0.5 Hz to 100 kHz power frequency range
- Compact design (half-rack size)
- 5 mA range for very low current measurements (model WT210 only)
- Line filter function
- High-speed data update (as fast as 10 readings per second)
- Harmonic measurement function available
- User calibration capability

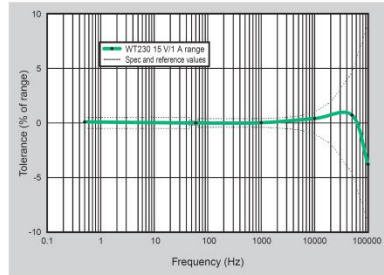
Maximum input with assured accuracy
26A
Maximum Display: 28 A

www.yokogawa.com/tm/
... and subscribe to "Newswave,"
our free e-mail newsletter

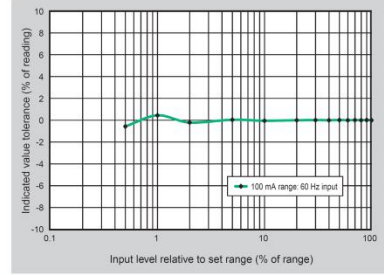
Bulletin 7604-00E

Basic Characteristics

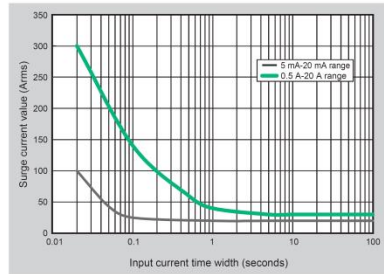
Example of Frequency-power Accuracy Characteristics



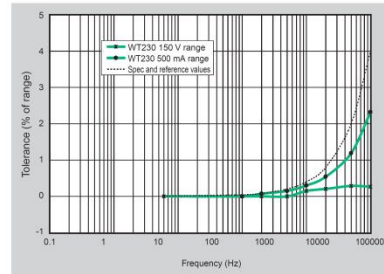
Example of WT210 Current Accuracy



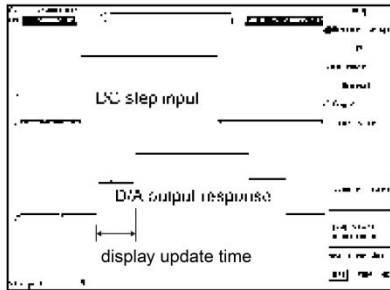
Current Input Surge Withstanding Ability



Example of Influence of Common Mode Voltage



Example of D/A Output Response



Comparison with Former Models

	WT200/WT130	WT210/WT230
Voltage input terminal	Bending post	Plug-in terminal (safety terminal)
External output terminal	Plug-in terminal (safety terminal)	BNC
Voltage and current basic accuracy	0.25% of mg	0.2% of mg
Power basic accuracy	0.3% of mg (WT200) 0.25% of mg (WT130)	0.2% of mg
Frequency range	DC, 10 Hz to 20 kHz	DC, 0.5 Hz to 100 kHz
Assured accuracy range	10% to 130% of range rating	1% to 130% of range rating
Display updating interval	0.25 second (fixed)	0.1/0.25/0.5/1/2/5 seconds
V, A, W display digits	4 digits (WT130) 5 digits (WT200)	5 digits
Line filter function	No	Yes (f _c = 500 Hz)
Frequency filter function	Yes (f _c = 300 Hz)	Yes (f _c = 500 Hz)
Key lock	No	Yes
Harmonic measurement display updating interval	Approximately 3 seconds	0.25/0.5/1/2/5 seconds
Remote signals when comparator is installed	EXT HOLD and EXT TRIG are added. EXT START, EXT STOP, EXT RESET, and INTEG BUSY are not added.	All six signals listed to the left are added. Pin assign is changed.
Online data format	ASCII	ASCII, binary
Wireless data communications output	No	Yes (need HRM)
Addressable mode B for GPRS communications	Yes	No
Display digits (factory default)	4 digits	5 digits
Online output data digits (factory default)	4 digits	5 digits

Functions Included with the WT200 (but Not Included with the WT130) and Included with the WT210/WT230

- MAX hold function
- Moving decimal point display based on integrated power value
- 10,000-hour maximum integration time
- Integration with few data omissions
- Average active power display



WT230



WT210

Specifications

The latest product information is available at our web site <http://www.yokogawa.com/tm/>. Review the specifications to determine which model is right for you.

Input Specifications		
Parameter	Voltage	Current
Input type	Resistance voltage divider	Floating input
Rated values (ranges)	15/30/60/150/300/600 V	Direct input: 5/10/20/50/100/200 mA (WT210 only) ¹ : 0.5/1/2/5/10/20 A (WT210/WT230) External input (optional): 2.5/5/10 V or 50/100/200 mV
Measuring instrument loss (input resistance)	Input resistance: Approximately 2 MΩ Input capacitance: Approximately 13 pF	Direct input: Approximately 500 mΩ + approximately 0.1 μH (5-200 mA; WT210) Approximately 6 mΩ + 10 mΩ (max) ² + approximately 0.1 μH (0.5-20 A; WT230) External input: Approximately 100 kΩ (2.5/5/10 V), approximately 20 kΩ (50/100/200 mV)
Maximum instantaneous allowed input (1 cycle, 20 ms duration)	Peak voltage of 2.8 kV or rms value of 2.0 kV (whichever is less)	0.5-20 A (WT210/WT230): Peak current of 450 A or rms value of 300 A (whichever is less) 5-200 mA (WT210): Peak current of 150 A or rms value of 100 A (whichever is less) External input: Peak value of 10 times range or less
Maximum instantaneous allowed input (1 second duration)	Peak voltage of 2.0 kV or rms value of 1.5 kV (whichever is less)	0.5-20 A (WT210/WT230): Peak current of 150 A or rms value of 40 A (whichever is less) 5-200 mA (WT210): Peak current of 30 A or rms value of 20 A (whichever is less) External input: Peak value of 10 times range or less
Maximum continuous allowed input	Peak voltage of 1.5 kV or rms value of 1.0 kV (whichever is less)	0.5-20 A (WT210/WT230): Peak current of 100 A or rms value of 30 A (whichever is less) 5-200 mA (WT210): Peak current of 30 A or rms value of 20 A (whichever is less) External input: Peak value of 5 times range or less
Maximum continuous common mode voltage (with 50/60 Hz input)	600 Vrms (with output connector protective cover), CAT II / 400 Vrms (without output connector protective cover) CAT II	
CMRR 600 Vrms across input terminal and case	50/60 Hz, -80 dB or higher (±0.01% of range or less) with voltage input terminals shorted and current input terminals open and external input terminals shorted Reference value (up to 100 kHz): ±((Maximum range rating)/(Range rating)) × 0.001 × % of range or less (voltage range and 0.5-20 A current range and external input range) ±((Maximum range rating)/(Range rating)) × 0.0002 × % of range or less (WT210: 5-200 mA range) Note: 0.01% or higher, f is in kHz. 3 Decouple the above-formula about the external input range.	
Input terminal type	Plug-in terminal (safety terminal)	Direct input: Large binding post External input: BNC connector (insulation type)
A/D converter	Simultaneous conversion of voltage and current inputs Resolution: 16 bits Maximum conversion speed: Approximately 20 μs (approximately 51 kHz)	
Range switching	Ranges can be set manually, automatically, or through online controls. Auto-range function Range raising: When a measurement exceeds 130% of the rating, or when the peak value exceeds approximately 300% of the rating Range lowering: When a measurement falls to 30% or less of the rating, and the peak value falls to approximately 300% or less of the rating for the low range	
Measurement mode switching	Any of the following, selected manually or through online controls: RMS (true rms value measurements for both voltage and current), V MEAN (calibration of average-value-rectified rms value for voltage; true rms value measurement for current), DC (simple averages for both voltage and current)	

Note: Current direct input and external sensor input cannot both be used at the same time. When you operate current input terminals and external input terminals, please be careful.
Since these terminals are electrically connected inside the instrument.
1. Connect wires that match the size of the measurement current.
2. Factory setting

Measurement Functions		
Parameter	Voltage/current	Active power
System	Digital sampling, sum of averages method	
Frequency range	DC, and 0.5 Hz to 100 kHz	
Crest factor	3 (with rated input) 300 (with minimum effective input)	
Accuracy (three months after calibration) (Conditions) Temperature: 23±5°C Humidity: 30-75% RH Input waveform: Sine wave Power factor: cosφ = 1 In-phase voltage: 0 V DC Frequency filter: ON at 200 Hz or less Scaling: OFF Display digits: 5 digits After CAL is executed	DC: ±(0.2% of rdg + 0.2% of rng) [*] 0.5 Hz ≤ f < 45 Hz: ±(0.1% of rdg + 0.2% of rng) 45 Hz ≤ f ≤ 66 Hz: ±(0.1% of rdg + 0.1% of rng) 66 Hz < f ≤ 1 kHz: ±(0.1% of rdg + 0.2% of rng) 1 kHz < f ≤ 10 kHz: ±((0.07 × f) of rdg + 0.3% of rng)	DC: ±(0.3% of rdg + 0.2% of rng) [*] 0.5 Hz ≤ f < 45 Hz: ±(0.3% of rdg + 0.2% of rng) 45 Hz ≤ f ≤ 66 Hz: ±(0.1% of rdg + 0.1% of rng) 66 Hz < f ≤ 1 kHz: ±(0.2% of rdg + 0.2% of rng) 1 kHz < f ≤ 10 kHz: ±(0.1% of rdg + 0.3% of rng) 10 kHz < f ≤ 100 kHz: ±(0.067 × (f-1))% of rdg 10 kHz < f ≤ 100 kHz: ±(0.5% of rdg + 0.5% of rng) ±((0.09 × (f-10))% of rdg)
Note: In the accuracy calculation formula, f is in kHz.	* Add ±10 μA to the current DC accuracy.	
Power factor effect	For cosφ = 0 45 Hz ≤ f ≤ 66 Hz: ±0.2% of VA (VA is a reading value of apparent power) Reference data (up to 100 kHz): ±((0.2 + 0.2 × % of VA) Indicated value tolerance for 0 < cosφ < 1 Add (tanφ × effect when cosφ = 0)% of power reading to the above power accuracy. Note: φ is the phase angle between voltage and current.	
Note: In the accuracy calculation formula, f is in kHz.		
Effective input range	1-130% of voltage/current range rating (for accuracy at 110-130%, add the reading tolerance × 0.5 to the above accuracy)	
Accuracy (12 months after calibration)	Add the accuracy's reading tolerance (three months after calibration) × 0.5 to the accuracy three months after calibration.	
Line filter function	A low-pass filter can be inserted in the input circuit for measurement. The cutoff frequency (fc) is 500 Hz.	
Accuracy with line filter on	Voltage and current: Add 0.2% of rdg at 45-66 Hz. Add 0.5% of rdg below 45 Hz. Power: Add 0.3% of rdg at 45-66 Hz. Add 1% of rdg below 45 Hz.	
Temperature coefficient	±0.03% of range/°C at 5-18°C and 28-40°C.	
Display updating intervals	0.1/0.25/0.5/1/2/5 seconds	
Lead/lag detecting	Lead/lag is detected correctly when phase difference equal to or greater than ±5° with both voltage and current inputs as sine waves equal to or greater than 50% of rated range-value, and the frequency is between 20 Hz to 2 kHz.	
Measurement lower limit frequency	Data updating rate: 0.1 second, 0.25 second, 0.5 second, 1 second, 2 seconds, 5 seconds Measurement lower limit frequency: 25 Hz, 10 Hz, 5 Hz, 2.5 Hz, 1.5 Hz, 0.5 Hz	

Frequency Measurements

Measurement inputs: V1, V2, V3, A1, A2, or A3 (select one)
Measurement system: Reciprocal system

Measurement frequency ranges
100 ms: 25 Hz ≤ f ≤ 100 kHz
250 ms: 10 Hz ≤ f ≤ 100 kHz
500 ms: 5 Hz ≤ f ≤ 100 kHz
1 sec: 2.5 Hz ≤ f ≤ 100 kHz
2.5 sec: 1.5 Hz ≤ f ≤ 50 kHz
5 sec: 0.5 Hz ≤ f ≤ 20 kHz

Accuracy: ±(0.06% of rdg)
Conditions: Input equal to at least 30% of voltage/current rated range.
Frequency filter function ON at 200 Hz and below.
Frequency filter cutoff frequency: 500 Hz

Communication Functions (Optional for the WT210)

GP-IB or serial interface (RS-232-C) (select one)

GP-IB
Electrical and mechanical specifications:
Conform to IEEE Standard 488-1978 (JIS C1901-1987).

Functional specifications:
SH1, AH1, T5, L4, SR1, RL1, PR0, DC1, DT1, C0
Protocol: Conforms to IEEE Standard 488.2-1992.
Code used: ISO (ASCII) code
Addresses: 0-30 talker/listener addresses can be set.

Serial interface (RS-232-C)
Transmission mode: Asynchronous
Baud rates: 1200, 2400, 4800, 9600 bps

Specifications

Calculation Functions

	Single-phase 3-wire (2 voltages, 2 currents)	Three-phase 3-wire (3 voltages, 3 currents)	Three-phase 3-wire (3 voltages, 3 currents)	Three-phase 4-wire
Voltage ΣV	$(V1 + V2)/2$	$(V1 + V2 + V3)/3$	$(V1 + V2 + V3)/3$	
Current ΣA	$(A1 + A2)/2$	$(A1 + A2 + A3)/3$	$(A1 + A2 + A3)/3$	
Active power ΣW	$W1 + W2$	$W1 + W2 + W3$	$W1 + W2 + W3$	
Reactive power var, Σvar	$var1 = \sqrt{(VA^2 - W^2)}$	$var1 + var2 + var3$	$var1 + var2 + var3$	
Apparent power VA, ΣVA	$VA = W/V$	$\sqrt{VA^2 + VA3^2}$	$\sqrt{VA^2 + VA2^2 + VA3^2}$	$\sqrt{VA^2 + VA3^2}$
Power factor PF, ΣPF	$PF = W/VA$	$\Sigma W/\Sigma VA$		
Phase angle deg, Σdeg	$deg = \cos^{-1}(W/VA)$	$\cos^{-1}(\Sigma W/\Sigma VA)$		

Notes

- This equipment's apparent power (VA), reactive power (var), power factor (PF), and phase angle (deg) are calculated from voltage, current, and active power. (Therefore, if the input contains a distorted wave, the values may not match those of other measuring instruments based on different measurement principles.)
- If either voltage or current falls to 0.5% of the range rating or less, then the apparent power (VA) and reactive power (var) are displayed as zero, and errors are displayed for power factor (PF) and phase angle (deg).
- The sign of the var of each phase is displayed with + (positive). In the Σvar calculation, the var value for each phase is calculated with a negative sign if the current input leads the voltage input, and with a positive sign if the current input lags the voltage input. Then the value of Σvar may be displayed with - (negative).
- Apparent power (VA) and reactive power (var) cannot be calculated and displayed at the harmonics measurement mode.

Display Functions

Display unit: 7-segment LED (light-emitting diode)

Display areas: 3

Display area	Displayed information
A	V, A, W, VA, var (for each element), integration elapsed time
B	V, A, W, PF, deg (for each element, percentage (content percentage, THD))
C	V, A, W, V/AHz, Vpk, Apk, $\pm Wh$, $\pm Ah$ (for each element), MATH

Measurement parameters	Maximum display	Display resolution
V, A, W, VA, var	99999	0.001%
PF	± 1.0000	0.01%
deg	± 180.0	0.1°
$\pm Wh$, $\pm Ah$	999999	0.0001%
VHz, AHz	99999	Input frequency/20,000

Display digits: 4 or 5 digits (selectable by user).

Factory default setting is 5 digits.

Units:

m, k, M, V, A, W, VA, var, Hz, ht, deg, %

Display updating intervals: 0, 1/10, 25/10, 5/1/2/5 seconds

Response time: Maximum 2 times the display updating interval (time required for display value to enter accuracy range of final value with line filter off, when range rating abruptly changes from 0% to 100%, and from 100% to 0%)

Maximum display: 140% of voltage/current range rating

Minimum display: About Vrms, Arms, and Ah, 0.5% of range rating.

Less than 0.5% is zero suppression.

Display scaling function

Effective digits: Selected automatically according to the digits in the voltage and current ranges.

Setting range: 0.001 to 9999

Averaging function

There are two averaging methods (selectable by user):

Exponential average

Moving average

In cases where response can be set and exponential average is used, the attenuation constant can be selected. In cases where a moving average is used, the number of averages N can be selected from 8, 16, 32, and 64.

Auto-range monitor

An LED turns on when the input value is outside the range set for the auto-range.

MAX hold function: This function can be used to hold V, A, W, VA, var, Vpk, and Apk at maximum values.

MATH functions

System: When a function key on DISPLAY C is pressed to select the MATH functions, it is possible to perform efficiency (WT230 only) and input crest factor measurements, as well as arithmetic calculations on DISPLAY A and B measurements. In addition, it is possible to display average active power for time-converted integrated power.

Integration Functions

Display resolution: The minimum display resolution changes together with the integrated value.

Maximum display: -99999 to 999999 MWh/MAh

Modes: Standard integration mode (timer mode), continuous integration mode (repeat mode), manual integration mode

Automatic integration start/stop based on timer setting.

Timer: Setting range: 0:00 min:00 sec to 10000 h:00 min:00 sec (If the time is set to zero, manual mode is automatically set.)

Count over flow: When the integrated value exceeds 999999 MWh/MAh or falls to at least -99999 MWh/MAh, the elapsed time is saved and the operation is stopped.

Accuracy: \pm (display accuracy + 0.1% of rdg)

Timer accuracy: $\pm 0.02\%$

Remote control: Starting, stopping, and resetting can be controlled through external control signals. This function is only available when option /DA4, /DA12 or /CMP is installed.

Internal Memory Functions

Measurement data

Stored data	Normal measurement	Harmonic measurement
WT210 (760401)	Data for 600 samples	Data for 30 samples
WT230 (760502)	Data for 300 samples	Data for 30 samples
WT230 (760503)	Data for 200 samples	Data for 30 samples

Store interval: Display updating interval and 1 second to 99 hours, 59 minutes, and 59 seconds

Recall interval: Display updating interval and 1 second to 99 hours, 59 minutes, and 59 seconds

Panel setting information: (Both can be set in 1-second increments.) Four different patterns of panel setting information can be written/read.

Harmonic Measurement Function (optional)

System: PLL synchronization

Measurement frequency range: Fundamental frequency in range of 40-440 Hz

Maximum display: 99999

Display digits: 4 or 5 digits (selectable by user).

Factory default setting is 5 digits.

Measurement parameters: V, A, W, deg (WT210), V1, V2, V3, A1, A2, A3, W1, W2, W3, deg1, deg2, deg3 (WT230), individual harmonic levels, rms voltage, rms current, active power, fundamental frequency PF, harmonic distortion rate, individual harmonic content

Measurement element: These parameters can only be measured simultaneously for a single specified input element.

Sampling speed, window width, and analysis orders

The values for these parameters vary according to the input fundamental frequency as shown below:

Fundamental frequency	Sampling speed	Window width	Analysis orders
$40 \leq f < 70$ Hz	$f \times 512$ Hz	2 periods of f	50
$70 \leq f < 130$ Hz	$f \times 256$ Hz	4 periods of f	50
$130 \leq f < 250$ Hz	$f \times 128$ Hz	8 periods of f	50
$250 \leq f \leq 440$ Hz	$f \times 64$ Hz	16 periods of f	30

FFT data length: 1024

FFT processed word length: 32 bits

Window function: Rectangular

Display updating interval: 0.25/0.5/1/2/5 seconds Updating is slower during online output according to the communication speed and the number of parameters transferred.

Accuracy: Add $\pm 0.2\%$ of range to normal measurement accuracy.

Note: For nth-order component input, add ((nth order reading) \times (10/(n+1)))% to the n+1th order and n-mth order.

D/A Output (optional)

Output voltage: ± 5 V FS (maximum approximately ± 7.5 V) for each rated value

Number of outputs: 12 parameters with /DA12 option; 4 parameters with /DA4 option

Output data selection: Can be set separately for each channel.

Accuracy: \pm (equipment accuracy + 0.2% of FS)

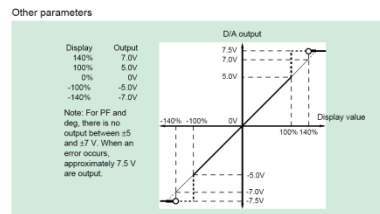
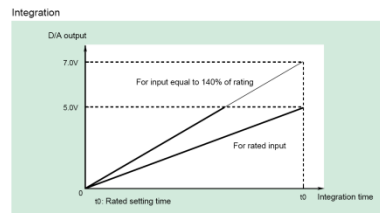
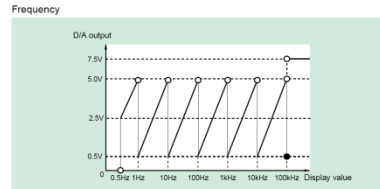
D/A converter: 12-bit resolution

Response time: Maximum 2 times the display updating interval

Updating interval: Same as the equipment's display updating interval

Temperature coefficient: $\pm 0.05\%$ C of FS

Output type



External Input (Optional)

Select either /EX1 or /EX2 for the voltage output-type current sensor.
 /EX1: 2.5/5/10 V
 /EX2: 50/100/200 mV
 Specifications: See the section on input specifications.

Comparator Output (Optional)

Output method: Normal-open and normal-close relay contact output (pair)
 Number of output parameters and settings: Four parameters; can be set separately on each output channel.
 Contact capacitance: 24 V/0.5 A
 D/A output (4-channel); See section on D/A output (optional)

External Control Signal (with D/A or /CMP Option Only)

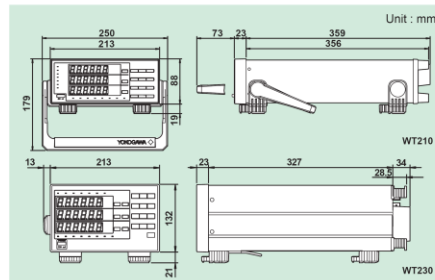
External control signals: EXT-HOLD, EXT-TRIG, EXT-START, EXT-STOP, EXT-RESET, INTEG-BUSY
 Input: TTL level negative pulse

General Specifications

Warmup time: Approximately 30 minutes
 Operating temperature and humidity ranges: 5-40 °C, 20-80% RH (no condensation)
 Storage temperature: -25-60 °C (no condensation)
 Maximum operating elevation: 2000 meters
 Insulating resistance: 50 MΩ or higher at 500 V DC across all of the following areas:
 Voltage input terminals (ganged) and case
 Current input terminals (ganged) and case
 Voltage input terminals (ganged) and current input terminals (ganged)
 Voltage input terminals (ganged) of each element
 Current input terminals (ganged) of each element
 Voltage input terminals (ganged) and power plug
 Current input terminals (ganged) and power plug
 Case and power plug
 Insulating withstand voltage:
 3700 V for one minute at 50/60 Hz across all of the following areas:
 Voltage input terminals (ganged) and case
 Current input terminals (ganged) and case
 Voltage input terminals (ganged) and current input terminals (ganged)
 Voltage input terminals (ganged) of each element
 Current input terminals (ganged) of each element
 Voltage input terminals (ganged) and power plug
 Current input terminals (ganged) and power plug
 1500 V for one minute at 50/60 Hz across case and power plug

Power supply: Free power supply (100-240 V), 50/60 Hz frequency
 Consumed power: Max 35 VA for WT210, max 55 VA for WT230
 External dimensions for WT210: Approximately 213 × 88 × 379 mm (WHD) (excluding projections)
 External dimensions for WT230: Approximately 213 × 132 × 379 mm (WHD) (excluding projections)
 Weight: Approximately 3 kg for WT210, approximately 5 kg for WT230
 Safety standard: Complying standard EN61010-1
 Overvoltage category (Installation category) II
 Pollution degree 2
 Emission: Complying standard EN61326 Class A
 EN61000-3-2
 EN61000-3-3
 AS/NZS 2064 Class A
 Immunity: Complying standard EN61326 Annex A

Exterior View



Model Numbers and Suffix Codes

Model number	Suffix code	Description	
760401		WT210 single-input element model	
Power cord	-D	UL/CSA standard	
	-F	VDE standard	
	-R	AS standard	
	-Q	BS standard	
Options	/C1	GP-IB communication interface	Select one
	/C2	Serial (RS-232-C) communication interface	Select one
	/EX1	External input 2.5/5/10 V	Select one
	/EX2	External input 50/100/200 mV	Select one
	/HRM	Harmonic measurement function	Select one
	/DA4	4-channel DA output	Select one
/CMP	Comparator and D/A, 4 channels each	Select one	

Note: The WT210 communication interface cannot be changed or modified after delivery.

Model number	Suffix code	Description	
760502		WT230 2-input element model	
760503		WT230 3-input element model	
Interface	-C1	GP-IB communication interface	Select one
	-C2	Serial (RS-232-C) communication interface	Select one
Power cord	-D	UL/CSA standard	
	-F	VDE standard	
	-R	AS standard	
	-Q	BS standard	
Options	/EX1	External input 2.5/5/10 V	Select one
	/EX2	External input 50/100/200 mV	Select one
	/HRM	Harmonic measurement function	Select one
	/DA12	12-channel DA output	Select one
	/CMP	Comparator and D/A, 4 channels each	Select one

Standard Accessories

Power cord, Power fuse, Current input protective cover, Rubber feet for the hind feet, 24-pin connector (provided only on options/DA4, /DA12, and /CMP), User's manual

Wiring Types and Model Numbers

Wiring	Model	760401	760502	760503
Single-phase 2-wire		✓	✓	✓
Single-phase 3-wire		-	✓	✓
Three-phase 3-wire (2 voltages, 2 currents)		-	✓	✓
Three-phase 3-wire (3 voltages, 3 currents)		-	-	✓
Three-phase 4-wire		-	-	✓

Rack mounts

Product	Model or part number	Specification	Order quantity
Rack mounting kit	751533-E2	For WT210 EIA standalone installation	1
Rack mounting kit	751533-J2	For WT210 JIS standalone installation	1
Rack mounting kit	751534-E2	For WT210 EIA connected installation	1
Rack mounting kit	751534-J2	For WT210 JIS connected installation	1
Rack mounting kit	751533-E3	For WT230 EIA standalone installation	1
Rack mounting kit	751533-J3	For WT230 JIS standalone installation	1
Rack mounting kit	751534-E3	For WT230 EIA connected installation	1
Rack mounting kit	751534-J3	For WT230 JIS connected installation	1

Ask Yokogawa for information on rack mounts in which WT210 and WT230 are combined.

Accessories (sold separately)

Model number	Description
B9317WD	1.5 mm hex wrench For fastening cable on 758931
B9284LK	External sensor cable For external input; 50 cm