DRTS FAMILY

for the testing protective relays, energy meters and transducers

TABLE OF CONTENTS

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1   GENERAL

The digital relay and meters test system type DRTS XX is a programmable and automatic current and voltage source, that permits for the automatic test of digital protection relays, such as those used in Medium and High voltage networks, and of energy meters, power quality meters and transducers.

The test set can be controlled locally, without the connection to a PC, by means of a graphical color display, a keypad, a rotary switch and function keys. The unit can be controlled also by and advanced test software running on a PC.

Current and voltage amplifiers are linear, class AB types: this ensures the best, noiseless output quality.

DRTS 66 is the top of the family, that includes also DRST 64 (6 currents and 4 voltages), DRTS 34 (3 currents and 4 voltages), and DRTS 33 (3 currents and 3 voltages).

	ATTENTION: In the following, all specifications, unless differently specified, apply to all models

The DRTS 66 version offers the following characteristics:

- Current outputs: 6x32 A
- Current power: 6x430 VA at 32 A
- Voltages outputs: 6x300V
- All outputs: 32 bit control; accuracy ±0,04% of reading ±0,015% of range. This implies the capability of testing Class 0,1 energy meters
- All outputs: Digital to Analog Converters operate at the sample frequency of 50 kHz: this ensures a superior waveform design and therefore a much better angle accuracy and distortion control
- Local control with a 5,7" colour screen, plus digital wheel with switch, 12 input buttons and 5 function select buttons
- Voltage outputs are isolated from current outputs
- Amplitudes, angles and frequencies: each output is independently controlled. All the generators can be activated at the same time
- 12 digital inputs, up to 300 V, standard; 10 digital inputs, up to 600 V, with the "Transcope" option
- 10 analogue inputs "Transcope" option, up to 600 V
- Extended diagnostic features
- Pen drive interface, to upload or download test parameters and results
- USB and ETHERNET interface to the PC. Wireless interface provided optionally
- Certified IEC 61850-8 features
- Certified IEC 61850-9 features

The DRTS XX is housed in a case 3 U high that contains: the power supply, the interface circuits, the control boards, the voltage and current amplifiers. The set is housed into an aluminium container with handle for ease of transportation; the instrument is supplied with a plastic bag for protection during transit.

The TDMS software, running on the PC, allows the user to:

- Control all current and voltage outputs, for the simulation of all types of faults: in particular, faults that are produced on a distribution network with the neutral connected to ground
- Change the outputs (V, I) as ramp or step mode, increasing or decreasing amplitude, frequency or angle at the same time
- Define the state of inputs and outputs between two fault simulations
- Simulate stable faults or faults with complex evolution that change during the test (dynamic or transient faults)
- Display waveforms and digital inputs of the test (Manual Control or automatic software)

The following image exhibits the front panel:
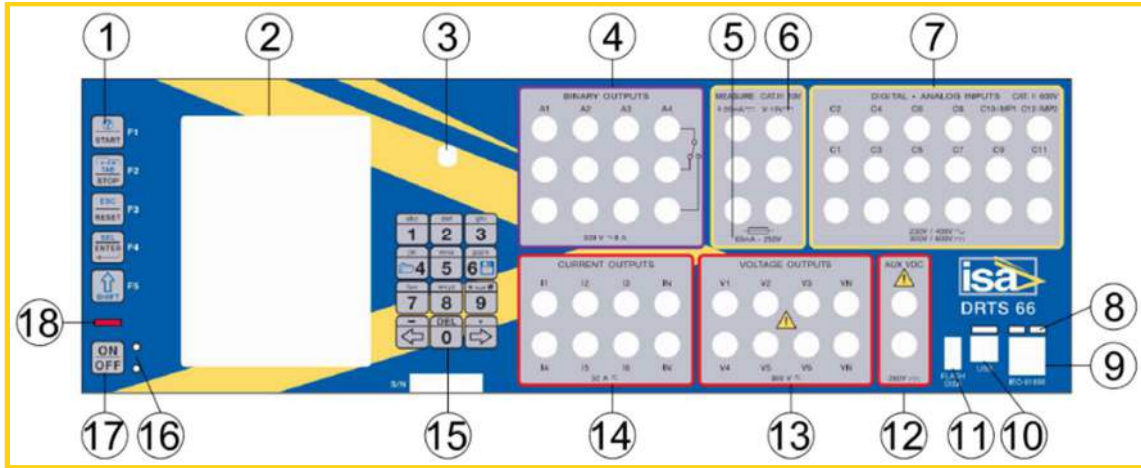
Figure 1 - Front panel

The following table lists the components of the front panel:

ITEM	Component
1	Local control function keys
2	Color display
3	Digital input knob with switch
4	Safety sockets of auxiliary contacts A1÷A4
5	Fuses to protect the analog measurement inputs, type T63mA 250 V
6	Safety sockets of voltage and current measurement inputs
7	Safety sockets of trip inputs C1÷C12, with six isolated references. They include the Imp1 and Imp2 counting inputs
8	Lights confirming the interface connections
9	IEC61850-8 connector (option)
10	USB interface connector
11	USB flash disk connector
12	DC voltage safety sockets
13	Voltage output safety sockets: all phases have two common neutrals (VN), isolated from IN. DRTS 66 has 6 sockets, DRTS 64 and 34 have four sockets and DRTS 33 has three sockets
14	Current output safety sockets: all phases have two common neutrals (IN), isolated from VN. DRTS 66 and 64 has 6 sockets, DRTS 34 and 33 have three sockets
15	Twelve keys keyboard, for the local control
16	Power-on alarm lights (ground missing, supply too high)
17	Power-on push-button
18	Power-on light

Table 1 - Front panel components

The following image exhibits the rear panel:
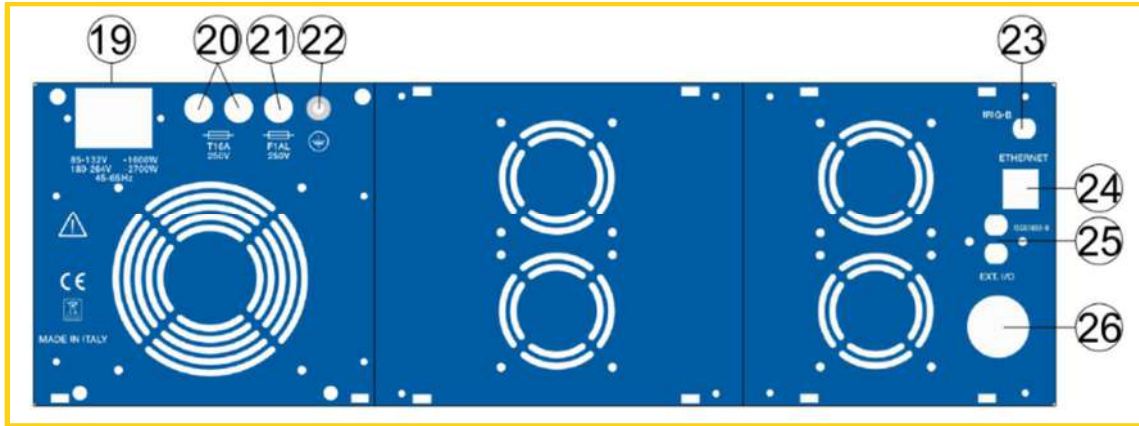
Figure 2 - Rear panel

The following table lists the components of the rear panel:

ITEM	Component
19	Power supply socket
20	Mains supply fuses (P and N), type T16AH, 250 V
21	Auxiliary DC supply fuse, type T1AL 250 V
22	Ground socket
23	IRIG-B optical interface connector
24	ETHERNET interface connector
25	IEC61850-9 optical cable interface connectors
26	External amplifiers and I/O expansion, low level outputs and digital outputs 32-way multipole connector

Table 2 - Rear panel components

The following table lists the optional modules of the DRTS XX:

Item	Option	Code	Description
1	TRANSCOPE	82170	Analog/Digital recorder and measurement module
2	IEC61850-8	83170	Protocol Interface - Goose
3	IEC61850-9	89170	Protocol Interface – Sampled values
4	External GPS	10161	External module with antenna and cable
5	SH-2003	20162	Energy meter universal scanning head
6	IN2-CDG	98156	Current Booster for 1 A rated high burden relay
7	IRIG-B	87170	Synchronization and outputs extension module
8	Internal GPS	88170	Receiver with antenna and cable
9	HPB 400 HPB 600	70170 71170	Current boosters
10	Line synchronizer	72170	Power Line synchronizer with optical fiber output
11	DRTS9		Three phase current extension module
12	AMI 332	80170	Three phase current amplifier
13	AMI 632	81170	Six phase current amplifier
14	IO-66		Input/output expansion module
15	PLCK	41175	Polarity checker
16	Relay connection cables	15170	Complete set of cables
17	Transit cases	85170 17170 18170	Heavy duty transport case (Discovery type) Aluminum transport case Soft carrying bag
18	Stand-up support	19170	Support for test set in stand-up position
19	NTP / IEEE1588 synchronizer	34186	External module for test set synchronization to substation time reference
20	Wireless	16183	Device for wireless connection to a PC

Table 3 - Optional modules

	ATTENTION: Internal GPS, IEC61850-9-2, zero power set cables and external amplifiers require code 87170- IRIG-B and output extension module

The following table lists the DRTS XX modules:

Item	Module	Code	Description
1	DRTS 66	45170	6I/6V
2	DRTS 64	35170	6I/4V
3	DRTS 34	22170	3I/4V
4	DRTS 33	10170	3I/3V
5	DRTS 66	40170	6I/6V - with IRIG-B and output expansion module
6	DRTS 64	30170	6I/4V - with IRIG-B and output expansion module
7	DRTS 34	20170	3I/4V - with IRIG-B and output expansion module

Table 4 – DRTS XX modules

2   APPLICABLE STANDARDS

The test set conforms to the EEC directives regarding Electromagnetic Compatibility and Low Voltage instruments.

The following table lists the standards related to the EMC Directive, 2014/30/EC:

Standard	Title	Requirement
EN 61326	Electrical equipment for measurement, control and laboratory use. EMC requirements. General requirements	
IEC EN 61000-3-2:	Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)	Harmonic content of power supply Acceptable limits: basic
IEC 61000-3-2	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection	Limitation of voltage fluctuations and flicker Acceptable limits: basic
CISPR 16-1	Specification for radio disturbance and immunity measurement apparatus and methods	Acceptable limits for conducted emission: • 0,15÷0.5 MHz: 79 dB pk; 66 dB avg • 0,5÷5 MHz: 73 dB pk; 60 dB avg • 5÷30 MHz: 73 dB pk; 60 dB avg Acceptable limits for radiated emission: • 30÷230 MHz: 40 dB (30 m) • 230÷1.000 MHz: 47 dB (30 m)
IEC EN 61000-4-2	Electromagnetic compatibility (EMC)- Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test	Immunity tests for ESD Test values: 8 kV in air; 4 kV in contact
IEC EN 61000-4-3	Electromagnetic compatibility (EMC)- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	Immunity tests for radio frequency interference Test values (f= 900 ± 5 MHz): field 10 V/m, modulated AM 80%; 1 kHz
IEC EN 61000-4-4	Electromagnetic compatibility (EMC) - Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test	Immunity tests for high speed transients (burst) Test values: 2 kV peak; 5/50 ns
IEC EN 61000-4-5	Electromagnetic compatibility (EMC)- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test	Immunity tests for surge Test values: 1 kV peak differential mode; 2 kV peak common mode; 1.2/50 us
IEC EN 61000-4-6	Electromagnetic compatibility (EMC) - Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields	Immunity to low-voltage sinusoidal waveform Test values: 0.15-80 MHz, 10 Vrms, 80% AM 1 kHz
IEC EN 61000-4-8	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test	Immunity tests for low frequency magnetic fields. Test values: 30 Arms/m
IEC EN 61000-4-11	Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests	Immunity test for power supply drops. Test value: 1 cycle; 100% drop

Table 5 – Standards related to the EMC Directive

The following table lists the standards related to the LV Directive, 2014/35/EC:

Standard	Title	Requirement
IEC EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements	Applicable standard, for a class I instrument, pollution degree 2, installation category II: CEI EN 61010-1. • Dielectric Rigidity: 1,4 kV AC, 1 minute • Isolation resistance: > 2 MΩ • Earth resistance: < 0,1 Ω • Dispersion current: < 5 mA • Inputs/outputs protection: IP 2X - IEC 60529 • Operating temperature: (0÷55) °C; storage: (-25÷70) °C • Operating relative humidity: 5÷95%, without condensing • Altitude: less than 2.000 m • Noise: less than 75 dB
IEC 60068-2-6	Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)	Vibration: 20 m/s^2 at 10÷150 Hz
IEC 60068-2-27	Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock	Shock: 15 g; 11 ms; half-sine

Table 6 - Standards related to the LV Directive

3   CHARACTERISTICS

3.1   Foreword

This section resumes the characteristic and the performances of the instrument. Listed characteristics are all used when the instrument is connected to a computer, with the corresponding commands.

When the instrument is turned on it performs a self-diagnostic check of all of the logic and analog circuits. During the use, the instrument watches continuously the outputs, checking that they do not deviate from the nominal, and records transient problems in a non-volatile memory.

The principal operations are as follows:

- Power-on
- Connect DRTS 66 to the relay that is to be tested. The input trip contacts can be either clean or with voltage, polarized using the DC voltage output, or the DC voltage of the site
- If you want, connect DRTS 66 to the portable PC, else, proceed with the local controls
- Execute the test. During PC operation, output values are displayed on the screen
- Test results are examined one at a time on the screen of the test set or of the PC, and printed later on, after they have been saved

3.2   The TDMS software

All controls of the instrument are performed by the software TDMS (running under Windows© 7 64bit, 8 , 10 or 11). The following table lists the possible relays to test using the TDMS software (it is also possible to test transducers, energy meters, and quality meters):

Relay type	IEEE No.	DRTS model
Distance relay	21	ALL
Synchronizing device	25	ALL
Under/over-voltage relay	27/59	ALL
Directional Power relay	32	ALL
Field relay	40	ALL
Reverse phase current relay	46	ALL
Phase sequence voltage relay	47	ALL
Incomplete sequence relay	48	ALL
Instantaneous over-current relay	50	ALL
Breaker failure relay	50BF	ALL
Inverse time over-current relay	51	ALL
Voltage-restrained over-current relay	50V/51V	ALL
Voltage controlled over-current relay	51/27C	ALL
Power factor relay	55	ALL
Voltage balance relay	60	ALL
Ground detector relay	64	ALL
Directional over-current relay	67	ALL
Phase angle out of step relay	78	ALL
Automatic reclosing relay	79	ALL
Frequency relay and ROC (df/dt)	81	ALL
Pilot wire receiver relay	85	ALL
Lockout relay	86	ALL
Differential protection relay (transformer, generator, line, busbar)	87	DRTS 64, 66
Voltage directional relay	91	ALL
Power directional relay	92	ALL
Tripping relay	94	ALL

Table 7 - Possible relays to test using the TDMS software

Besides, it is also possible to create test plans that can test multi-function relays with the settings user defined.

With the corresponding options, above relays can be tested also if they have the IEC 61850-8 interface, or if they accept digital current and voltage measurement information, as per the standard IEC 61850-9. It is also possible to completely test a substation which has adopted the IEC 61850-8 interface.

In the following list the most important executables of the TDMS platform:

- Manual control
- Sequencer
- Distance 21
- Phase overcurrent 50/51/67
- Earth overcurrent 50N/51N/67N
- Differential transformer 87T
- Differential line 87L
- Differential generator 87G
- Playback waveform
- Harmonics
- Synchrocheck 25
- Power swing 68
- Energy Meters
- Transducers
- PQMeters

And special plug-in for distance or differential relays, for example:

- ABB REL650
- ABB REL670
- ABB RAZOA
- ALSTOM / AREVA / SCHNEIDER P436-P438
- ALSTOM / AREVA / SCHNEIDER P441-P442-P444
- ALSTOM / AREVA / SCHNEIDER P443-P445-P446
- GE D60-D90
- SIEMENS SIPROTEC4 7SA51X
- SIEMENS SIPROTEC4 7SA52X
- SIEMENS SIPROTEC4 7SA61X
- SIEMENS SIPROTEC5 7SA61X
- SEL 421
- ABB RET650
- ALSTOM / AREVA / SCHNEIDER P63X
- GE T60
- SIEMENS SIPROTEC4 7UT61X
- SIEMENS SIPROTEC5 7UT8X
- SEL 387
- SEL 587
- SEL 787

And many others. It is possible to import the relay settings in formats RIO, XRIO, XML, TXT or CSV.
Here below two screenshots of TDMSpro (distance 21):
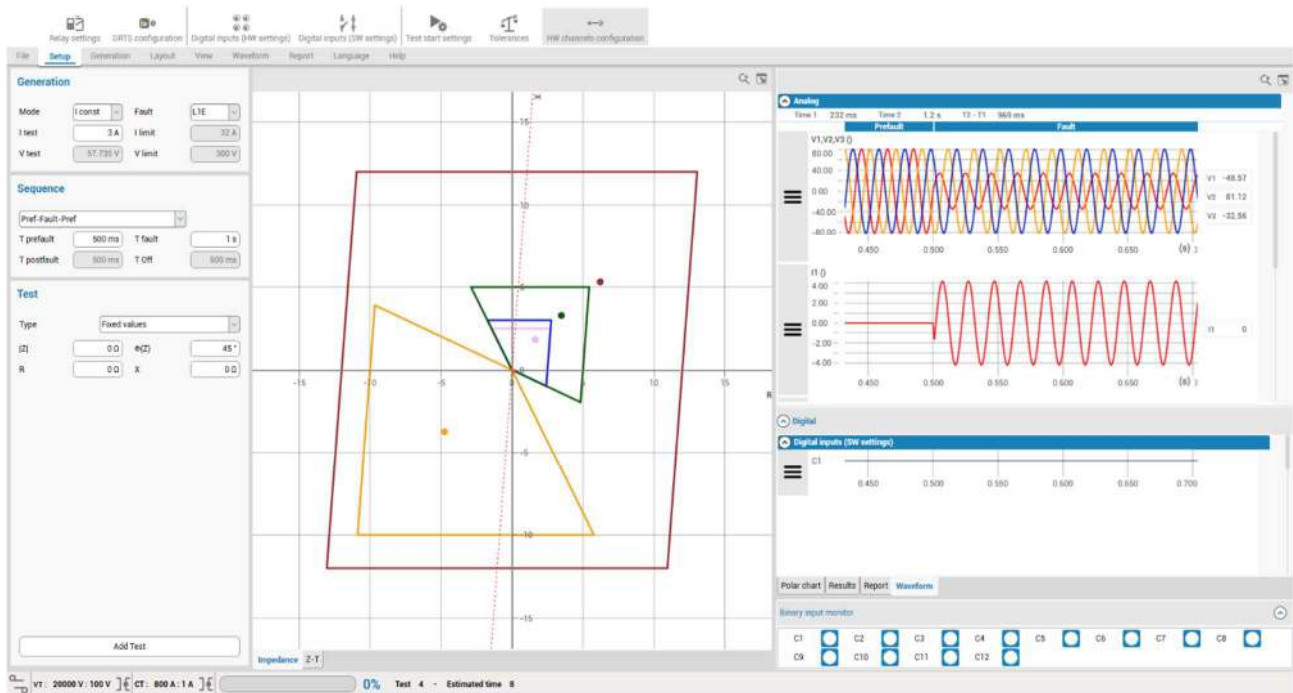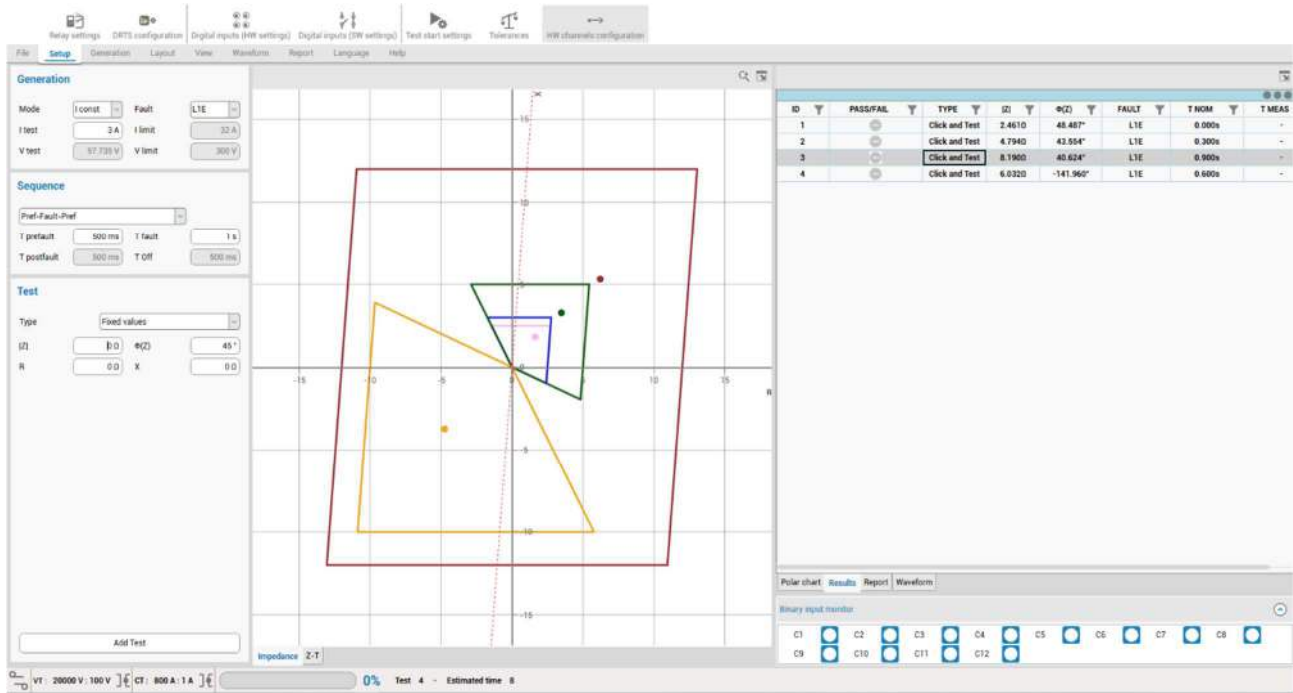
Figure 3 - Example of TDMSpro : Distance 21 screenshots

Two different licences are available for TDMSpro , Standard and Advanced. For both, it is possible to select a Single or a Corporate version. With the Corporate version it is possible to install on all PCs of a company the TDMSpro using the same licence; the PCs can be interfaced with all the DRTSxx under the Corporate licence.

All executables of TDMS generate professional reports that can be customized and exported in MS Word, MS Excel and PDF format that can be used in a database or an historical list of the tests executed.

Note: Windows is a trademark of Microsoft Corporation

3.3 Six phase current generator

The main characteristics are the following:

- Six independent current sources, with a common neutral (3 with DRTS 34)
- Type of connection: safety banana sockets
- Output ranges (rms), and corresponding power (rms) and resolution

The following table lists the characteristics for DRTS 66 and DRTS 64:

Range	Output	Connection	Current [A]	Power [VA]	Z max [Ω]	Resolution [mA]
1	6 X	Direct	0÷32 AC	430 @ 32 A	0,4 @ 32 A	0,1
2	3 X	2 in parallel	0÷64 AC	860 @ 64 A	0,2 @ 64 A	0,2
3	2 X	3 in parallel	0÷96 AC	1.000 @ 64 A	0,24 @ 64 A	0,3
4	1 X	All in parallel	0÷128 AC	650 @ 128 A 650 @ 96 A	0,039 @ 128 A 0,07 @ 96 A	0,6
5	3 x	Direct	0÷32 AC	430 @ 32 A	0,4 @ 32 A	0,1
6	1 X	All in parallel	0÷85 DC	630 @ 85 A	0,09 @ 85 A	0,6
7	1 X	2 in series	0÷.32 AC	820 @ 32 A	0,8 @ 32 A	0,1

Table 8 - Characteristics for DRTS 66 and DRTS 64

	ATTENTION: The following notes apply:
	- For 6X mode, the power is available on any two outputs at the meantime - For the 3X mode, two outputs are put in parallel; the power is available on any output pair at a time - For the 2X mode, three outputs are put in parallel; the power is available on any three outputs at a time - For the 1X mode, at the maximum current (128A) the maximum duration is 10 s - With all outputs in phase, the maximum current per phase is 21 A - When the operation is three-phase, the maximum power is available on any output at a time, and at the meantime - In DC current mode all outputs are in parallel - In this mode, any two outputs, in opposition between them, are put in series: the current is the same, the power is doubled

The following table lists the characteristics for DRTS 34 and DRTS 33:

Range	Output	Connection	Current [A]	Power [VA]	Z max [Ω]	Resolution [mA]
1	3 X	Direct	0÷32 AC	430 @ 32 A	0,4 @ 32 A	0,1
2	1 X	All in parallel	0÷96 AC	1.000 @ 84 A	0,14 @ 84 A	0,3
3	1 X	All in parallel	0÷85 DC	450 @ 85 A	0,06 @ 85 A	0,3
4	1 X	2 in series	0÷32 AC	820 @ 32 A	0,8 @ 32 A	0,1

Table 9 - Characteristics for DRTS 34 and DRTS 33

The above power is available when the test set generates only currents; the contemporary generation of AC and DC voltages implies a power reduction as a function of the total output power.

In particular, the total power absorbed by the test set is limited to 1.600 VA when it is supplied at 115 V. As a consequence, when generating currents only, power changes as follows (above notes apply):

Range	Output	Connection	Current [A]	Power [VA]	Z max [Ω]
1	6 X	Direct	0÷32 AC	430 @ 32 A	0,4 @ 32 A
2	3 X	2 in parallel	0÷64 AC	560 @ 64 A	0,13 @ 64 A
3	2 X	3 in parallel	0÷96 AC	630 @ 64 A	0,12 @ 64 A
4	1 X	6 in parallel	0÷96 AC	530 @ 96 A	0,055 @ 96 A
5	3 x	Direct	0÷32 AC	200 @ 32 A	0,2 @ 32 A
6	1 X	All in parallel	0÷85 DC	600 @ 85 A	0,08 @ 85 A
7	1 X	2 in series	0÷32 AC	580 @ 32 A	0,56 @ 32 A

Table 10 - Characteristics for DRTS 66 and DRTS 64 (generating currents only)

	ATTENTION: The available power changes as a function of the output current. The duration of current generation is a function of the current and of the total generated power

The following characteristics apply to the instrument family:

- Type of amplifier: linear, class AB. This ensures extremely low noise
- Independent adjustment of current outputs
- Waveform resolution: 32 bit (16 for the amplitude, 16 for the shape)
- Waveform construction: generation DAC's operate at 50 kHz: this ensures superior waveform design, angle accuracy and distortion control
- Output frequency: 0 to 3 kHz; 5 kHz on reproductions
- Output adjustable from zero to the maximum value
- Possibility of step changing the value of the output within 0,2 ms
- Oscillation after the step change: maximum 10% of the peak
- Possibility of current ramping. The rate of change is programmable between ±0,01 A/s and ±999 A/s. The amplitude change is implemented every 100 μs. At the maximum rate of 999 A/s, the maximum step is 99,9 mA/100 μs
- The specified output power is available at 25°C maximum of external temperature. For higher temperatures, the maximum power decreases of 2 VA/°C
- The following table lists the output accuracy and frequency response, at 25 °C ±2 °C, resistive load, burden less than 20% of the maximum, currents up to 16 A (with currents up to 32 A, errors are twice as bigger):

Range	45 to 65 Hz	0 to 45 Hz	1 kHz	3 kHz
Typical	±0,02% of rdg ±0,01% of range	±0,2% of rdg ±0,1% of range	N/A	N/A
Maximum	±0,04% of rdg ±0,01% of range	±0,4% of rdg ±0,1% of range	Attenuation: 3% (0,3 dB)	Attenuation: 6% (0,6 dB)

Table 11 - Output accuracy and frequency response

- Temperature coefficient: ±0,01%/°C, at 50 to 60 Hz; ±0,02%/°C, for other frequencies
- Influence of power supply variation on the accuracy: zero
- Accuracy with: inductive burden with power factor from 1 to 0,8, and power consumption from 0% to 100%: maximum twice the above values
- Gradient accuracy: ±0,5% of the selected value
- Distortion, with: resistive load, power consumption less than 20% of the maximum: 0,05% typical, 0,15% maximum
- Distortion, with: inductive burden with power factor from 1 to 0,8, and power consumption from 0% to 100%: 0,5 % maximum
- Automatic protection for overloads (including open circuit). In this case, the output is opened, and the operator is warned
- The display shows the programmed output currents

3.4   Six phase voltage output

The main characteristics are the following:

- Six independent voltage sources, with a common neutral (4 with DRTS64 and DRTS34, 3 with DRTS33)
- Type of connection: safety banana sockets
- The following table lists the output ranges (rms), and corresponding power (rms) and resolution for DRTS 66:

Range	Output	Connection	Voltage [V]	Power [VA]	Z min [Ω]	Resolution [mV]
1	6X	Direct	0÷300	50 @ 125÷300 V	1.800 @ 300 V	10
2	6X	Direct	0÷12,5	5	30	0,4
3	4X	Direct	0÷300	85 @ 125÷300 V	1.060 @ 300 V	10
4	3X	Direct	0÷300	100 @ 125÷300 V	900 @ 300 V	10
5	1X	2 in series	0÷600	200 @ 250÷600 V	1.800	20
6	3X	2 in parallel	0÷300	200 @ 125÷300 V	450 @ 300 V	10
7	1X	2+2 in parallel	0÷±300 DC	300 @ ±125÷±300 V	1.200 @ ±300 V	10

Table 12 - Output range, power and resolution for DRTS 66

ATTENTION: The following notes apply:

- For 6X mode, the specification applies to two symmetrical three-phase outputs
- For the 4X mode, three output make one symmetrical three-phase system; the fourth one is in any phase relationship with the three phases
- When the operation is three-phase, the maximum power doubles (DRTS 66)
- In this mode, two outputs, in opposition, are put in series: voltage and power are doubled
- In this mode, two outputs, in phase, are put in parallel: the voltage is the same, the power doubles
- In DC current mode all outputs, with the same polarity, are put in parallel

- The following table lists the output ranges (rms), and corresponding power (rms) and resolution for DRTS 64 and DRTS 34:

Range	Output	Connection	Voltage [V]	Power [VA]	Z min [Ω]	Resolution [mV]
1	4X	Direct	0÷300	85 @ 125 ÷300 V	1.060 @ 300 V	10
2	4X	Direct	0÷12,.5	5	30	0,4
3	3X	Direct	0÷300	100 @ 125÷300 V	900 @ 300 V	10
4	1X	2 in series	0÷600	200	1.800	20
5	2X	2 in parallel	0÷300	200 @ 125÷300 V	450 @ 300 V	10
6	1X	2+2 in parallel	0÷±300 DC	300 @ ±125÷±300 V	1.200 @ ±300 V	10

Table 13 - Output range, power and resolution for DRTS 64 and DRTS 34

- The following table lists the output ranges (rms), and corresponding power (rms) and resolution for DRTS 33:

Range	Output	Connection	Voltage [V]	Power [VA]	Z min [Ω]	Resolution [mV]
1	3X	Direct	0±300	100 @ 125±300 V	900 @ 300 V	10
2	1X	2 in series	0±600	200	1.800	20
3	1X	2 in parallel	0±300	200 @ 125±300 V	450 @ 300 V	10

Table 14 - Output range, power and resolution for DRTS 33

The specified power is available in continuous mode and on all outputs at the meantime.

The total power sunk by the test set is limited to 1.600 VA when it is supplied at 115 V.

The following characteristics apply to the instrument family:

- Type of amplifier: linear, class AB. This ensures extremely low noise
- Independent adjustment of voltage outputs
- Waveform resolution: 32 bit (16 for the amplitude, 16 for the shape)
- Waveform construction: generation DAC's operate at 50 kHz: this ensures superior waveform design, angle accuracy and distortion control
- Output frequency:
    - 0 to 3 kHz @ 60 V
    - Up to 2 kHz @ 100 V
    - Up to 700 Hz @ 300 V
    - 5 kHz on reproductions, for outputs up to 100 V
    - 1 kHz on reproductions, for outputs up to 300 V
- Output adjustable from zero to the maximum value
- Possibility of step changing the value of the output within 0,15 ms
- No oscillation after the step change
- Possibility of ramping the voltage. The rate of change is programmable between ±0,01 V/s and ±999 V/s. The amplitude change is implemented every 100 µs. At the maximum rate of 999 V/s, the maximum step is 99,9 mV/100 µs
- The following table lists the output accuracy and frequency response, at 25 °C ±2 °C, resistive load, burden less than 20% of the maximum:

Range	45 to 65 Hz	0 to 45 Hz	1 kHz	3 kHz
Typical	±0,02% of rdg ±0,01% of range	±0,2% of rdg ±0,1% of range	N/A	N/A
Maximum	±0,04% of rdg ±0,01% of range	±0,4% of rdg ±0,1% of range	Attenuation: 3% (0,3 dB)	Attenuation: 15% (1,5 dB)

Table 15 - Output accuracy and frequency response

- Temperature coefficient: ±0,01%/°C, at 50 to 60 Hz; ±0,02%/°C, for other frequencies
- Influence of power supply variation on the accuracy: zero
- Accuracy with: inductive burden with power factor from 1 to 0,8, and power consumption up to the maximum: maximum twice the above values
- With a three phase current and voltage generation (I1-I3, V1-V3), symmetrical vectors, 25 °C ±2 °C, resistive load, burden less than 20% of the maximum, p.f. = 1, voltages more than 50 V, currents more than 1 A and less than 10 A, the total power error is 0,05% typical, 0,1% maximum. The total power error doubles with:
    - The total current and voltage range
    - Inductive burden with power factor from 1 to 0,8
    - Power consumption up to the maximum

For p.f. different from 1, the active power accuracy changes as follows:

p.f.	1	0,8	0,5	0,1	0
Max error	0,1	0,125	0,135	0,55	Infinite

Table 16 - Active power accuracy with p.f. ≠ 1

- Voltage gradient accuracy: ±0,5% of the selected value
- Distortion, with: resistive load, power consumption less than 20% of the maximum: 0,015% typical; 0,03% maximum
- Distortion, with: inductive burden with power factor from 1 to 0,8, and power consumption from open circuit to minimum impedance: 0,5% maximum
- Automatic protection for overloads (short circuit included). In this case, the output is opened, and the operator is warned
- The display shows the programmed output voltages

3.5 Voltage output V4

The voltage output V4 can be selected via software to act as the following:

- Fourth voltage output V4
- Zero-sequence component **V0** of the other three voltages **V1, V2 V3**. Via software the output can be selected to be: **V0** = (**V1**+**V2**+**V3**)/3 or **V0** = (**V1**+**V2**+**V3**)/1.73 (bolded stays for vector sum). Note that with the second selection the zero sequence component is limited to 300 V
- For the zero-sequence output, the guaranteed output accuracy is: ±0,5% of the value ±0,1% of the range

	ATTENTION: This output is not available on the DRTS33 model

3.6 Battery simulator

The main characteristics are the following:

- Output connection: two safety banana sockets
- Output voltage: 12 to 260 V DC
- Output resolution: 127 mV
- Possibility of stepping the selected value

	ATTENTION: The velocity of variation is affected by the capacitance of the load, which is charged with the current output of 1 A maximum

- Possibility to ramp the voltage. Velocity of variation is between ±0,1 V/s and ±999 V/s
- Output power: 50 W, continuous duty, or 1 A, whichever greater
- Output accuracy: ±2 % of the regulated value ±0,2 % of the full scale, with load up to 100%
- Gradient accuracy: ±2 % of the nominal, with a minimum of ±200 mV/s
- Current limited in case of an overload greater than 50 W

3.7 Angles

The main characteristics of all current and voltage generators are the following:

- All angles are referred to the same absolute reference
- Possibility to set independently the angle of all outputs: V1; V2; V3; V4; V5; V6; I1; I2; I3; I4; I5; I6, in the field between zero and ± 360,000° (phase angle)
- Possibility of slewing all the angles. Variation range: ±0,1 °/s to ±999 °/s. The angle change is implemented every 100 μs. At the maximum rate of 999 °/s, the maximum step is 0,0999 °/100 μs
- Angle resolution: 0,001°
- Angle accuracy (50 and 60Hz); resistive burden, less than 20% of the maximum: ±0,01° typical; ±0,02° maximum
- Angle accuracy (40 to 60 Hz); resistive burden, less than 20% of the maximum: ±0,05° typical; ±0,1° maximum
- Angle accuracy (40 to 60 Hz); burden with p.f. down to 0,8 and value up to the maximum: ±0,2° maximum
- Angle accuracy (5 to 40 Hz): maximum ±1°
- Angle accuracy (60 Hz to 3 kHz): maximum ±5°
- Possibility to define the angle of the waveform to be generated (point on wave)
- Point on wave value selectable between 0° and 360°, on any output
- Point on wave accuracy: maximum ±2°

3.8 Output waveform

The main characteristics are the following:

- Besides the sinusoidal waveform, it is possible to generate waveforms with harmonic distortions
- Each harmonic can have any amplitude and any phase with respect to the fundamental
- Fundamental frequency: selectable from 5 Hz to 60 Hz, in steps of 0,1 Hz. Maximum frequency error: 0,1 Hz
- Selected harmonics: from the second to the 100th

3.9 Transient files reproduction

The main characteristics are the following:

- Possibility to reproduce transient or dynamic faults that has been recorded with a COMTRADE or format, by means of the software TDMS
- Maximum recording dimension: 16 bits word; 640 kWord per channel on 6 channels
- Maximum sampling frequency: 100 kHz; maximum reproduction frequency: 50 kHz
- Transient files bandwidth: 0 to 5 kHz
- Key features of the program: repeat recording infinite times, glue records, change phase angle for any trace, change the amplitude for any portion of any trace

3.10 Output frequency

The main characteristics of all current and voltage generators are the following:

- Possibility of selecting the output frequency between 0,0000 and 2.999,9999 Hz (see the limitations on voltage outputs). Transients reproduction: 5 kHz
- Possibility to program 12 different frequencies on all outputs
- Maximum frequency error: 0,5 ppM (25 µHz @ 50 Hz)
- Temperature drift (or deviation) of the oscillator frequency: 0,1 ppM/°C
- Resolution: <5 µHz
- Possibility of step switching the output frequencies, separately or together with the amplitude change
- Possibility of slewing the frequencies, with a slope from ±0,001 Hz/s to ±999,999 Hz/s. Resolution: 0,001 Hz/s. The frequency change is implemented every 100 µs. At the maximum rate of 999 Hz/s, the maximum step is 99,9 mHz/100 µs. A frequency ramp can be executed at the same time of an amplitude ramp
- Slew accuracy: 0,01 Hz/s, with a minimum of 0,1 Hz/s
- The display shows the programmed output frequencies

3.11 Time measurements and counting

The main characteristics are the following:

- Digital inputs: 12 inputs, either clean or with voltage, from 4,5 to 300 V DC (24 to 230 V AC), divided in six groups of two inputs each, with six common points isolated among them. This feature allows the measurement of polarized trip contacts with six different zeroes that can't be put in common. All of them perform time measurements; two (called IMP1 and IMP2) measure also the time taken by a programmable number of impulses
- All inputs are protected against spikes. Maximum input voltage: 300 V AC
- If the TRANSCOPE option is present, the maximum operating voltage is 600 V DC (425 V AC), and the number of inputs is reduced to 10. All inputs are protected against spikes. Maximum input voltage: 510 V AC
- Sampling frequency: 10 kHz
- Connections: to safety banana sockets, marked C1-C9, C10-IMP1, C11 and C12-IMP2
- For each input, the display shows when the input is closed (or the voltage is applied)
- Selection of the type of input: Voltage clean; 5 V; 24 V; 48 V; >100 V; software controlled. The selection clean/voltage is shown on the display (one per group)
- For all selections, inputs are protected against voltages up to the maximum specified above
- Anti-noise and programmable de-bounce functions. De-bounce range: from 40 µs to 2 ms
- Selections: Close (N.O.), Open (N.C.)T
- Time measurements available:
  - Timing from the start of the test (injection) until the AND or OR of Close or Open of the selected inputs
  - Timing from any selected input to the AND o OR of Close or Open of the selected inputs
  - Recording mode. In this mode, all transitions occurring on the selected inputs are recorded and displayed in a graphical form
- Timer range: 0 to infinite; resolution: 0,01 ms. Cycles measurement, with resolution of 0,01 cycles, both at 50 Hz or 60 Hz

- Timer accuracy: 0,001% of the measure ±0,1 ms, for input changes lasting more than 1 ms
- Impulse time measurements available on IMP1 and IMP2 independently:
    - Count of transitions in a given time
    - Time corresponding to N transitions; N programmable from 1 to 9.999.999
- Frequency range for impulses: 0 to 100 kHz

3.12 Auxiliary outputs

The main characteristics are the following:

- Four auxiliary relay contacts (A1, B1, C1, D1), timed, voltage clean, whose make and break terminations are connected to safety banana connectors
- The open or closed state of the relay is shown on the display
- Characteristics of the contacts with a resistive load:
    - AC: 300 V; 8 A; 2.400 VA
    - DC: 300 V; 8 A; 50 W
- Range of programmable delay with respect to test start: from 0 to 999.999,999 s
- Contact time: <11ms
- Bounce time: <4ms
- Maximum time constant of the circuit connected to the binary outputs: 5ms
- Maximum DC load breaking capacity: 200mA @300Vdc , 300mA @125Vdc, 1.5A @50Vdc
- Mechanical endurance: >10x10^6 operations
- Current overload: max 50A for 30ms

3.13 Current and voltage measurements

Connections: to safety banana plugs.

The following measurements are available:

- DC Current measuring Inputs
    - Measuring range: ±5 mA DC and ±20 mA DC
    - Resolution: 10 nA
    - 5 mA range accuracy: ±0,05% of value ±0,02% of range
    - 20 mA range accuracy: ±0,02% of value ±0,01% of range
    - Input impedance: 200 Ω
- DC Voltage measuring input
    - Measuring range ±10 V DC
    - Resolution: 10 µV
    - Accuracy: ±0,02% of value ±0,01% of range
    - Input impedance: 400 kΩ

🛈	ATTENTION: Specifications apply at 25 °C ±2 °C. Temperature drift: ±0,001%/°C. AC currents and voltages cannot be measured

3.14 Interface connections

Available interfaces: USB and ETHERNET.

- Characteristics of the USB interface (B type): Transmission rate: 3x minimum
- Characteristics of the ETHERNET interface: Connector type: RJ-45

For each type of interface is provided a 2 meters cable.

3.15 Internal memory

The test set has an internal memory of 256 Mbytes; it hosts approximately up to 2.000 test results.

3.16 Pen drive interface

It allows connecting a standard USB pen drive, for the saving and restoring of test set-up and test results.

3.17 Local test set control

The test set is locally controlled via a digital knob, keys and display. The test selection is performed via menu, which selects the control parameters: voltage, current, angle, frequency, and also the impedance parameters for the distance relay tests. During the test, all output values are displayed.

Characteristics of the devices:

- Digital knob: digital encoder with switch
- Keyboard: 12 keys. Data input as with mobile phones
- Function keys: five
- Display: 256 colors, type TFT, graphic, 320 x 240 pixel; dimension 5,7"

The following image exhibits the main page of the Manual Control:

Figure 4 - Main page of the Manual Control

3.18 Sequence of commands

The elementary operations which compose all tests are the following:

- Measurement of the time delay from test start, i.e. when parameters change from pre-fault to fault values
- Search of the threshold, slewing parameters and memorizing the value at the instant of the tripping of the input
- Generation of parameters during a fixed time, reporting inputs that have changed their state

When connected to a PC, tests are executed in the following way:

- The PC defines the parameters to inject or change
- At the command of the operator, parameters are transmitted to DRTS 66 via the interface connection
- DRTS 66 generates the specified values, waits for the trip of the selected input contacts, and then transmits the results to the PC by the same interface. During this time, DRTS 66 continuously informs the PC about the generated outputs, so that values on the display are refreshed in real time
- The PC examines the results and displays them to the operator; then, it performs calculations and issues a new test command

During the execution of the test DRTS XX is self-controlled and does not depend on the PC communication.

The simulation of the fault can be made of single or multiple tests (case of evolving failures). The tests are fully controlled by hardware in order to avoid uncertain status between a cycle and another one, as displayed in this example below:
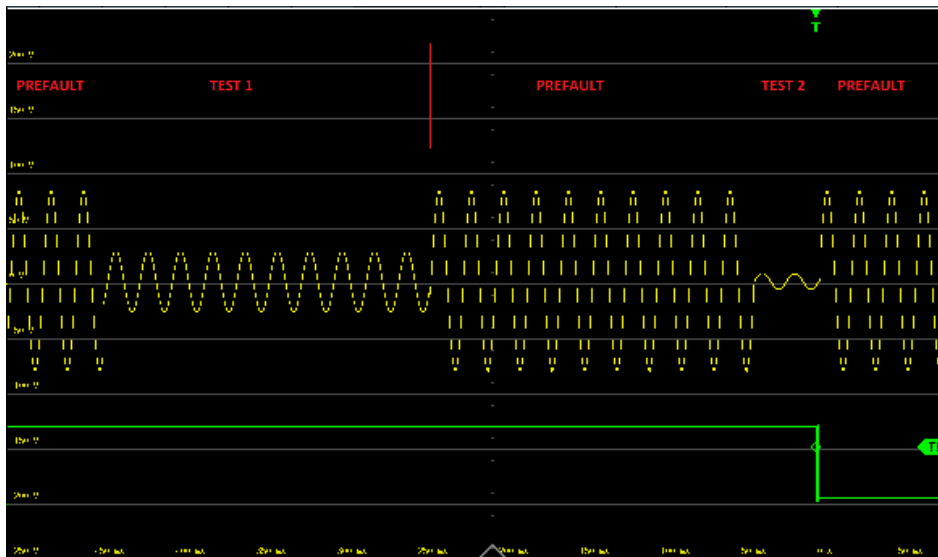

Figure 5   Example of evolving fault simulation. C1 = voltage V1   C2 = relay trip

Between two simulations parameters may return to zero, return to the healthy value or maintain the last injected value.

- Maximum number of elementary tests (cycles) in a multiple test: 499
- Duration of the cycle: from 5 ms to 999.999,999 s
- Accuracy of the cycle duration: 2 ms
- Delay between two cycles: 2 ms maximum

3.19 Protections

The main characteristics are the following:

- Fuse on the mains supply
- Protected against too high voltage supply, from 275 V up to 400 V. In this situation the test set gives an alarm message, and turns on an alarm light
- Protection against the lack of ground connection. In this situation the test set gives an alarm message, and turns on an alarm light
- Electronic protections on the internal DC supplies of the instrument and alert to the operator
- Electronic protection for overload on the current (open circuit) or voltage outputs (short circuit), with immediate release of the outputs and warning message to the operator. The program resets the fault condition
- Electronic protection in case of counter-feed of current or voltage outputs. If a voltage is applied to output sockets, the circuit opens, and the counter-feed alarm is displayed
- Protection against over-temperature, on all outputs
- If an output is diagnosed as faulty, the test set allows the operator to un-select it, and to select another, healthy, output in its place
- Diagnostic messages for the setting of wrong data, mistakes on the inputs etc.
- Diagnostic data logging
- In case of fault, the faulty module is indicated to the operator at an accuracy of more than 95%
- The test set measures the power sunk from the supply, and limits it, giving an alert message to the operator
- The resident program (firmware) can be updated to the latest issue, which is freely available on the ISA WEB site. www.altanova-group.com

3.20 Power supply

The main characteristics are the following:

- Mains power supply: 85 to 132 and 180 to 264 V AC, sinusoidal, single phase
- Frequency: 45 to 65 Hz
- Power consumption:
  - At rest: less than 150 W
  - Maximum load, 115 V supply: 1.600 W
  - Maximum load, 230 V supply: 2.700 W
- Connection: standard 20 A AC plug

Power supply cables and connectors are marked "KEMA IEC 60320".

3.21 Enclosure

The instrument enclosure is a 3U rack, in Aluminum, with carrying handle. The instrument may be operated in the horizontal or vertical positions. Degree of protection: IP2x .

3.22 Accessories

The following items are supplied with the DRTS 66:

- Protection bag
- Mains supply cable
- USB and ETHERNET cables
- Relay connection cables kit: 12 in all, 4 red, 4 black, 2 blue, 2 yellow; length 2 m, cross section 2.5 mm^2
- High current connection cables: no. 2, 2 m long, 6 mm^2
- Ground connection cable: 2 m, yellow/green, terminated with crocodile clamp

3.23 Weight and dimensions

Weight: 20 kg (DRTS 66); 20 kg (DRTS 64); 18 kg (DRTS 34); 16 kg (DRTS 33)

Dimensions: 150 (h) x 466 (w) x 423 (d) mm

4 OPTIONS

4.1 Analog measurements TRANSCOPE (code 82170)

The test set can be provided with the feature of measuring up to 10 voltage inputs, and to act as one of the following:

- Multimeter: voltages, currents (with external shunts), phase angles, wattmeter, frequency meter
- Oscilloscope
- Data logger
- Oscilloperturbographic recorder

This option is to be specified at order.

The connection is performed to ten of the C1-C12 inputs. Option characteristics:

- Ten input sockets: C1, C2; C3, C4; C5; C6,C9; C10, C11; C12, divided in five isolated groups of two each, with 5 isolated zero references
- Measurement ranges: 0,14; 1; 14; 140; 600 V DC, corresponding to 0,1; 1; 10; 100; 425 V AC (RMS values)
- Phase angle range: 0,0° to 360,0°
- Frequency range: 48,00 to 62,00 Hz
- Input impedance: 500 kΩ, 50 pF
- Overload protection
- Measurement accuracy, at 25 °C ±2 °C: 0,06% of range typical, 0,15% of range guaranteed, unless for the 100 mV range, where the accuracy is 0,15% of range typical, 0,3% of range guaranteed
- Bandwidth (-3 dB): 10 kHz, at 50 kHz of sampling frequency
- Temperature drift: ±0,005 %/°C
- Phase angles between inputs. Maximum phase error, with inputs more than 10% of the selected range, sinusoidal waveform, frequency 48 to 62 Hz: 0,2°
- Frequency. It is computed on the selected input. Maximum frequency error, with inputs more than 10% of the selected range, sinusoidal waveform, frequency 48 to 62 Hz: 10 mHz
- Computed measurements; errors at 25 °C ± 2 °C
- Current AC or DC, once it is specified the shunt value or the clamp ratio V/A, primary or secondary side. Measurement error is the error of the shunt or of the current clamp plus the voltage measurement error
- Active and reactive power. Maximum measurement error, with p.f. more than 0,8, sinusoidal waveform, frequency 48 to 62 Hz: ± 0,2% of the reading ±0,1% of the range ± the shunt or current clamp error
- Harmonic content. Measurements of the Total Harmonic Distortion, and of the distortion of all harmonic components up to the 40th. Accuracy, sinusoidal waveform, frequency 48 to 62 Hz: ±0,5% of the reading ±0,2% of the range.
- Oscilloscope feature: it is possible to select the trace to be viewed, and to view it on the display. The oscilloscope can be triggered on any trace
- Recording feature: it is possible to use the test set as an oscilloperturbograph
- Triggering capability: on a logic input, plus positive and negative trigger thresholds on any of the voltage or current inputs
- Sampling frequency: 500 Hz, 1 kHz, 2 kHz, 5 kHz, 10 kHz, 20 kHz, 50 kHz, software selection
- The maximum product of: (sampling frequency) X (number of channels) is 50 kHz
- Total buffer size: 4 Mbytes, corresponding to 2 Mwords. At 5 kHz sampling frequency, it corresponds to a total recording length of: 40 s on 10 channels, 60 s on 6 channels, 200 s on 2 channels, 400 s on one channel. The sampling duration is inversely proportional to the sampling frequency. The following table lists the recording duration as a function of the sample frequency and number of channels:

Frequency [kHz]	1 channel	2 channels	3 channels	6 channels	10 channels
	Recording duration [s]	Recording duration [s]	Recording duration [s]	Recording duration [s]	Recording duration [s]
5	400	200	120	60	40
10	200	100	60	-	-
20	100	50	-	-	-
50	40	-	-	-	-

Table 17 - Recording duration as a function of sample frequency and number of channels

Optionally, ISA can provide a clip-on current transformer (code PII29166), with the following characteristics:

- Metering: AC and DC currents
- DC measurement null with a knob
- Ranges: 10 mV/A, 80 A DC, 40 A AC maximum, and 1 V/A, 2 A DC, 1,5 A AC maximum
- Low battery indicator
- External field zeroing knob
- Measurement errors: 4% of reading +20 mA for the 80 A range; 2% of reading +5 mA for the 2 A range
- Phase angle reproduction error (up to 65 Hz): maximum 1°
- Maximum working voltage: 600 V rms
- Power supply: alkaline 9 V battery, type 6 LR 61
- Service life: 70 h typical
- Maximum cable diameter: 10 mm
- Weight: 330 g
- Dimensions: 65 mm wide (clamp closed); 36 mm thick; 230 mm long

4.2   IEC61850-8 option (code 83170)

The IEC61850-8 Interface option for DRTS XX allows the following:

- Testing relays with IEC 61850-8 based substation communication protocol
- Publishing messages, assigning the selected GOOSE any binary output, and checking the system response
- Subscribing messages, assigning data attributes to GOOSE/GSSE messages and therefore validating the system
- Publishing messages, as MMS commands and checking the system response
- Subscribing messages, assigning data attributes inside a dataset of an MMS report (DATA REPORT), and therefore validating the system

The option, and the associated software, have been certified by a recognized International Certification Committee, at level A1, according to IEC 61850-10, Procedures 2.3, TPCL version 1.7.7.

This option is to be specified at order.

The option, and the associated software, provides the following features:

- Capability of monitoring the Goose List and the Goose details transmitted by the relay under test. The grid displays for each Goose:
    - Source Mac Address: physical address of the generator of the message
    - Destination Mac Address: physical address of the destination of the message
    - Goose ID: Identifier of the Message
    - Data Set Reference: Identifier of the type of message created by the IED and its change of status.
    - Event Time Stamp: Universal Time that identifies the Goose
- Capability of filtering Gooses, based upon IED or TIMESTAMP
- During the test, the option allows to define up to 32 Virtual Contacts, i.e. Gooses that will be captured in real time: the test set will measure and display the corresponding timing of the status change from test start. A virtual contact is identified by the following:
    - Name: it can be given by the user by editing the relative box in the grid. The same name will appear in the lower frame that represent the Trip condition for the Virtual contact
    - Dataset Reference: it represents the exact goose that serves as the basis for the virtual contact. The same device produces more than one Goose ID, so in order to set the virtual contact it is not enough to define the Goose ID, but the selection has to be made on the Dataset Reference
    - Type: it can be Boolean, BitString, Unsigned, Signed, Float or UTCTime
    - Condition: depending on the type of the data it can be: Equal to, Less than, Greater than or Not Equal to. It is set by default to Equal to, but it can be changed according to the data type. Select the appropriate condition form the menu that appears when clicking on the condition column
    - Value: together with the condition field, it defines the actual condition of the Virtual Contact. In case of data type Boolean, it can only assume value True or False

- Time: represents the actual 'trip time' of the virtual contact, or the time interpreted from the goose that the device produces when the condition is verified. It cannot be modified, it is automatically set by the software when a test is performed and a virtual contact has tripped.
- Capability of publishing Gooses. The operation is the following:
  - Capture a Goose (during exploring, or after test start) that you want to modify, or select it from the Substation file, and send into the network
  - Edit the message. Up to 64 messages can be published
  - Select the publish mode as Continuous or During test. In continuous mode, during the program running the instrument starts sending messages every 5 s. If the selection is During Test, the publishing will be synchronized to the fault development when a test is performed
- Capability of validating GOOSEs. All details of the GOOSEs and of their sequences are monitored and certified.
- Performance : Type 1A , class P2/3 (IEC61850-5 ed. 1 or IEC61850-10 ed. 2)
- Capability of monitoring an MMS report and MMS details transmitted by the relay under test and their change of status and the timestamp.
- During the test, the option allows to define up to 32 Virtual Contacts, i.e. data inside a dataset that will be captured in real time: the test set will measure and display the corresponding timing from test start. A virtual contact is identified by the following:
  - Name: it can be given by the user by editing the relative box in the grid. The same name will appear in the lower frame that represent the Trip condition for the Virtual contact
  - Dataset Reference: it represents the exact data that serves as the basis for the virtual contact.
  - Type: it can be Boolean, Float
  - Condition: depending on the type of the data it can be: Equal to, Less than, Greater than or Not Equal to. It is set by default to Equal to, but it can be changed according to the data type. Select the appropriate condition form the menu that appears when clicking on the condition column
  - Value: together with the condition field, it defines the actual condition of the Virtual Contact. In case of data type Boolean, it can only assume value True or False
  - Time: represents the actual 'trip time' of the virtual contact, or the time interpreted from the MMS report that the device produces when the condition is verified. It cannot be modified; it is automatically set by the software when a test is performed and a virtual contact has tripped
- Capability of issuing commands using MMS protocol. The operation is the following:
  - Select the logical node: single commands and double commands are supported
  - Select control model: all control models defined by the standard (Direct Operate, Direct Operate with Enhanced Security , Select Before Operate (SBO) and SBO with Enhanced Security) are supported; Optional Interlocking, Synchrocheck and Test conditions are also available
  - Select final value of the transition (ON or OFF)
  - Associate this configuration with a Virtual output, that can be used:
    - At the beginning of a Fault step (Simulation of the fault)
    - At the beginning of a custom step of a precise sequence

The Ethernet connector type RJ-45 for the IEC61850 Interface is mounted directly on the front panel of the DRTS XX.

The option comes with two ETHERNET cables: one, direct, for the connection to the station bus; the other one, crossed, for the connection to the relay under test.

4.2.1   IEC61850-8 Advanced SW features option (part 1)
This Advanced SW option for IEC61850-8 part 1 allows the following functions:

- Discover feature: analyze the IEC 61850-8 model by either connecting live to the protection or opening and SCD/CID/IID/ICD file; model shown as a tree
- Advanced analyzing feature for GOOSE messages: record GOOSE transmission to be saved later in a file, increased number of filters (IED NAME, LN NAME, IED IP, IED MAC ADDRESS, VLAN ID etc.)
- File transfer: Connect to the IED and download files using the MMS file protocol
- SCL files comparison to check differences between two SCD/IID/ICD/CID files and to show them.

4.2.2   IEC61850-8 Advanced SW option (part 2)

This Advanced SW option for IEC61850-8 part 2 allows the simulation of an MMS Server and/or a GOOSE publisher by importing an SCD file

4.3   IEC61850-9 option (code 89170)

The IEC 61850-9 option allows generating measurement messages on the system bus. The option, and the associated software, have been certified as 9-2LE by an authorized International Certification Committee.

The option has to be specified at order.

The option, and the associated software, provides the following features.

- Possibility to inject Sampled Values on the system bus, corresponding to CT and VT measurements
- Possibility to test relays connected to the system bus, by the generation of Sampled Values and the monitoring of the relay tripping
- The test software operates as usual, providing the same results as when currents and voltages are generated

The connection is performed via an optical fiber connector, mounted on the rear of the test set.

The option comes with the IRIG-B synchronization module.

4.4   External GPS synchronizer (code 10161)

The GPS synchronizer is an external module that allows to synchronize test start of two DRTS.6.

Features are the following:

- 1 digital output 0÷24 V DC, for synchronization
- 1 selector to program the following pulse intervals: 5 s; 10 s; 20 s; 30 s; 40 s; 60 s
- Maximum timing error with respect to nominal value: 2 µs
- Lights to confirm: power-on; Locked; Pulse available
- 1 START and STOP push-button
- Power supply: 110/220 V AC
- The option includes:
    - The antenna
    - An extension cable for the antenna, 20 m long
    - Two cables, red and black, 2 m long, with banana terminations, for the connection to the test set trip input
    - The power supply cable.
- Weight: 1,7 kg
- Dimensions: 150 mm (width) x 100 mm (height) x 240 mm (depth)
- Realisation: aluminium case

Two test sets synchronized with GPS produce the maximum error of 10 µs.

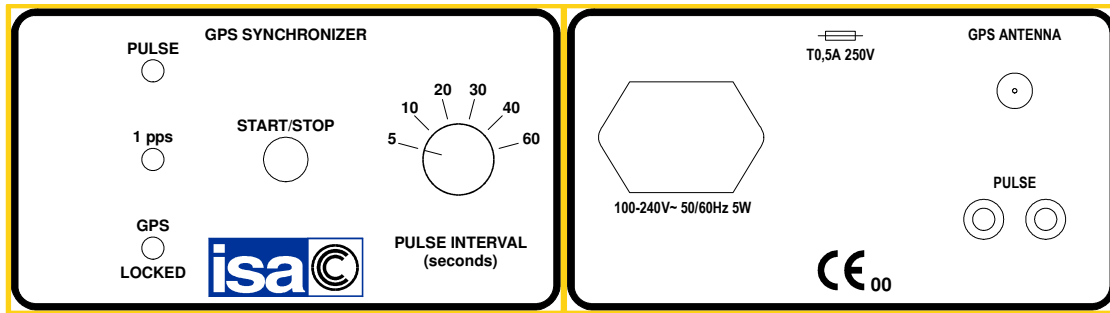The following image exhibits the front and back panels of the GPS synchronizer:

Figure 6 - Front and back panels of GPS synchronizer

4.5 SH-2003 energy meters universal scanning head (code 20162)

SH-2003 is a scanning head that eases the test of energy meters. It is a universal scanning head because it can be used both with LED impulse electronic meters and Ferraris rotating disk meters; selection is performed via a switch located on the scanning head. In addition to this, a knob allows to adjust the sensitivity of the head.

With rotating disk the sensor uses a green light beam that optimizes the recognition of red or black or gloss marks.

With LED recognition the following specification applies:

- Impulse duration: more than 60 μs
- With an LED signal having a space ratio 1:2, the frequency must be less than 500 Hz
- Light wavelength: 500 to 960 nm (red)

The option includes the following:

- The support that allows to keep the scanning head in front of the energy meter: maximum height 175 mm
- The cable, 2 m long, from the scanning head to DRTS 66
- The power supply transformer, for the power of 220 V AC, to supply the scanning head
- Two safety banana plugs for the connection to DRTS XX

4.6 IN2-CDG current booster (code 98156)

The following image exhibits the IN2-CDG option, available for test 1 A rated relays and for the CDG relay of GE:
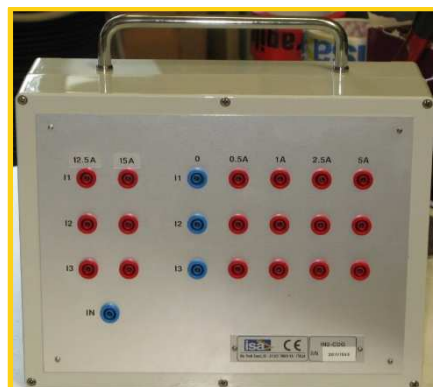

Figure 7 - IN2-CDG option

The option IN2-CDG has three current transformers, with the following characteristics:

- Primaries: 12,5 A and 15 A
- Secondary: 0,5 A; 1 A; 2,5 A; 5 A
- Nominal power: 100 VA
- Power loss: 30 VA at the maximum current
- Current ratio error: 0,2

Connections:

- Seven primary side sockets (I1, I2, I3, IN)
- Three independent outputs, with one socket per current range
- Ease of connecting outputs in star or delta configuration
- For the single phase test of the CDG relay it is possible to have three times the above power, connecting current outputs in series

Dimensions: 30 x 23 x 11 cm. Weight: 11 kg. Case: plastic.

The option includes four connecting cables to DRTS XX current outputs, 1 m long, 6 mm² cross section. Outputs are do not have a common neutral; this eases the star or delta connection. Included is a bridge for star connection.

🛈	ATTENTION: The software takes into account the transformers ratio

4.7 IRIG-B synchronization and output extension module (code 87170)

The option has to be specified at order. The module provides the following features:

- Test sets synchronization

  Two different units can be synchronized for a point to point test using the optional IRIG-B built-in interface or the optional internal/external GPS module. Characteristics of the IRIG-B connection:

    - Possibility to set the time (hour, minutes and seconds) at which the test will be performed
    - Time accuracy between two test sets: 10 µs
    - Fiber optic connector, ST type

- Binary outputs, transistor

  Four transistor open collector outputs, voltage clean, connected to a dedicated connector.

  The open or closed state of the transistor is displayed on the screen.

  Characteristics of the outputs: 24 V, 5 mA.

  Short circuit protection.

  Protection for voltages higher than 24 V.

  Range of programmable delay: from 0 to 999.999,999 s.

  Timing accuracy with respect to test start: less than 50 µs.

- Low level voltage outputs/Zero power outputs

  The purpose of these low level voltage outputs is to allow testing newest protection relays with low voltage inputs with simulation of non-conventional current and voltage transformers, including linear and Rogowsky transformers. The dedicated multipole connector carries six analog signals, which correspond to the three voltages and to the three currents. When these outputs are selected, power outputs are not generated.

  The low level voltage outputs are insulated and independent from the generated current and voltage.

  Number of outputs: 6.

  Connection: multipole connector.

  Full range voltage output: 7,26 Vrms = 10,24 Vpeak (temperature range: 25 ± 2 °C; frequency range 40 to 70 Hz).

  Full range current output: 7,26 Vrms = 10,24 Vpeak (temperature range: 25 ± 2 °C; frequency range 40 to 70 Hz).

  Output current: 5 mA max.

  Resolution: 0,43 mV (temperature range: 25 ± 2 °C; frequency range 40 to 70 Hz).

  Accuracy: 0,015% of range typical, 0.05% of range guaranteed (temp. range: 25±2 °C; frequency range 40÷70 Hz).

  Distortion: 0,1%.(temperature range: 25 ± 2 °C; frequency range 40÷70 Hz).

  Frequency bandwidth: 0 to 20 kHz.

  Output accuracy; full temp. range, frequency 0÷40 Hz: ±0,2% of the regulated value, ±0,04% of the full scale range.

  Output accuracy; full temperature range, 1 kHz maximum attenuation: 1% (0,3 dB).

  Output accuracy; full temperature range, 3 kHz maximum attenuation: 3% (0,5 dB).

  The display shows the programmed output values.

- Connection to external modules AMI332, AMI632, I/O EXP

4.8   Internal GPS option (code 88170)

The Internal GPS option allows synchronizing the outputs generation with a GPS system which is embedded into the instrument for a line point to point test with two different DRTSxx.

The option has to be specified at order.

The option, and the associated software, provides the following features.

- Possibility to set the time (hour, minutes and seconds) at which the test will be performed. The delay between a sequence of tests can be defined.
- Time accuracy between two test sets: 10 μs
- Maximum timing error with respect to nominal value: ±1 μs

The option includes the antenna and the 20 m long connection cable; the antenna connector is located on the rear of the test set.

The option comes with the IRIG-B synchronization module. The IEC61850-9 option and the internal GPS option can coexist on the same test set.

4.9   External NTP or IEEE1588 (precision time protocol) synchronizer (code PII34186)

The NTP or IEEE-1588 synchronizer is an external module that allows the test start of a DRTS64. The device is synchronized by a PTP Grandmaster or by a NTP Server.   Features:

- 2 ST fiber optical female connector for synchronization to DRTS64 through the IRIG-B input
- 1 BNC out for pps/ppm generation
- Time accuracy between two test sets: 10 μs
- Accuracy of pulse outputs :
  - PTP: +/- 100 ns (relative to the used IEEE 1588 Grandmaster Clock, after initial synchronization phase)
  - NTP: +/- 1 ms (relative to NTP when using a local time server)
- Configuration port
- Power supply 90..264 Vac
- Dimensions 105 mm x 45 mm x 160mm (W x H x D)

All the outputs can be activated at the same time, allowing in this way to synchronize more than one device. The used PTP stack implementation is fully compatible to all IEEE 1588 PTPv2 - systems and supports PTP management messages.

The option includes one fiber optic cable, power supply and a cable for serial interface.

The option comes with the IRIG-B synchronization module.

4.10   External HPB 400 and HPB6 00 booster options (code ZII70170, ZII71170)

The External HPB 400 and HPB 600 booster options allow boosting the output power at reduced currents. They are aimed at testing old electro-mechanical over-current relays; in particular, those rated 1 A. The power output is so high that they allow testing even relays rated less than 1 A.

The options are made of a multi-tapped Current Transformer.

The following image exhibits the HPB 400 option:

Figure 8 - HPB 400 option

HPB 400 option performances are the following:

- Primary current: 32 A
- Secondary currents: 20 A, 4 A, 1 A
- Related output power: 370 VA, 300 VA, 300 VA
- Corresponding maximum voltage: 18,5 V rms; 75 V rms; 300 V rms
- Corresponding maximum impedance: 0,9 Ω; 18.7 Ω; 300 Ω
- Full power generation duration: 3 s at 370 VA; 30 s for the other ranges
- Output accuracy: 0,5% at half burden, 1% at full burden
- Connections: two safety sockets on the primary side; four safety sockets on the secondary side
- Dimensions: 18 x 18 x 9 cm
- Weight: 7 kgThe following image exhibits the HPB 600 option:

Figure 9 - HPB 600 option

HPB 600 option performances are the following:

- Primary current: 2 x 32 A
- Secondary currents: 20 A, 10 A, 4 A, 1 A
- Related output power: 600 VA, 500 VA, 400 VA, 400 VA
- Corresponding maximum voltage: 30 V rms; 50 V rms; 100 V rms; 400 V rms
- Corresponding maximum impedance: 1,5 Ω; 5 Ω; 25 Ω; 400 Ω

- Full power generation duration: 3 s at 600 VA; 30 s for the other ranges
- Output accuracy: 0,5% at half burden, 1% at full burden
- Connections: two safety sockets on the primary side; four safety sockets on the secondary side
- Dimensions: 22 x 22 x 12 cm
- Weight: 13 kg

The software handles the booster ratio: once selected the secondary current connection, the test set generates the corresponding primary current, and the program displays the secondary current.

4.11 Line synchronizer (code 72170)

The option is made of a plug that fits into the mains, and that has an optical fiber output for the connection to the test set IRIG-B input. The purpose is to synchronize the outputs of one or two test sets to the mains: as the synchronisation is repeated every cycle, the test set stays locked to the mains for the infinity. The followings image exhibits the option and of the optical fiber:
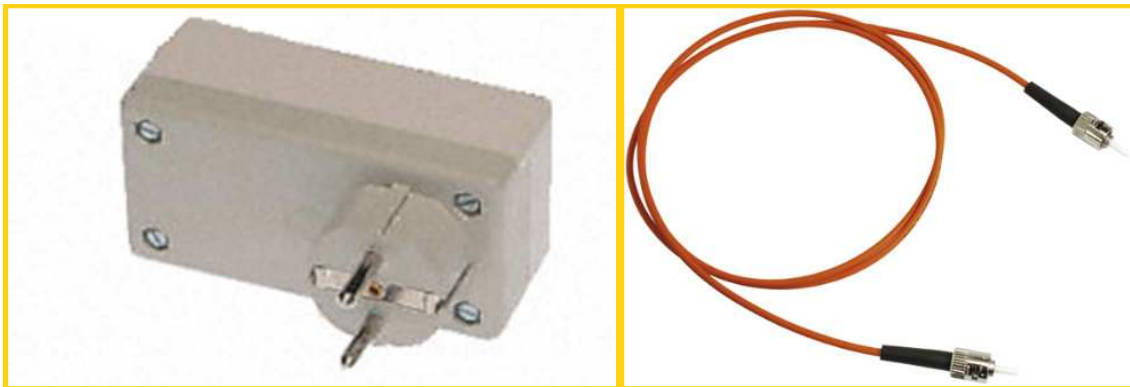

Figure 10 - Option and of the optical fiber

The option includes a circuit that squares the sinusoidal mains waveform; the isolated output is a series of impulses, running at the mains frequency.

There are two instances where the option can be necessary:

- Generating a current (or voltage) into a device that is also taking a signal from the mains
- Synchronizing two test sets to the mains, and then using them to test line differential relays

Option characteristics:

- It stays locked during pre-fault and fault generations
- Angle error with respect to the mains: ±1°
- It operates with all TDMS programs, unless SEQUENCER and COMTRADE
- It performs all type of tests, unless: Frequency; Frequency rate of change; Phase rate of change; Point on wave
- Dimensions: 120 x 65 x 65 mm
- Optical fiber: type multimode, connectors ST – ST, length 2 m

4.12 DRTS9 three phase current extension module

DRTS9 is a three phase current generator, which allows generating nine currents in all from DRTS 64 or 66.

The device is connected to DRTS 64 or 66, and converts three voltage outputs into current outputs. The output current follows the burden; so, it has to be adjusted before testing. The current value is displayed by three current meters. The following image exhibits the option:

Figure 11 – DRTS9 option

The device is housed into a robust plastic case. DRTS9 characteristics:

- Input voltage: 0 to 300 V AC
- Output current: 0 to 10 A AC
- Output power: 20 VA maximum at 10 A
- Phase shift with respect to the input: ±5°
- Output frequency: 40 to 1.000 Hz
- Current meters measurement error: ±0,5% of the output ±0,05 A
- Power supply: 230 V ±20%; 50 to 60 Hz
- Weight: 12 kg
- Dimensions: 18 x 36 x 47 cm

4.13 Three phase current amplifier AMI 332 (code 80170)

The three phase current amplifier AMI 332 is an additional device to the DRTS 66. The option includes three current generators at 32 A each. In connection with the DRTS 66, the option offers the following features:

- Nine currents at 32 A each at the meantime, for the test of two-secondary transformer protection relays
- Three phase generator, at 96 A per phase

The connection between DRTS 66 and AMI 332 is made by a control cable, to be connected to DRTS 66.

All characteristics are the same as the DRTS 34 current generators.

The following table lists the characteristics of AMI 332 with DRTS XX:

Range	Outputs	Connection	Current [A]	Power [VA]	Z max [Ω]	Resolution [mA]
1	9 X	Direct	0÷32	430 @ 32 A	0,4 @ 32 A	1
2	3 X	3 in parallel	0÷96	1.290 @ 96 A	0,13 @ 96 A	3
3	1 X	9 in parallel	0÷192	900 @ 192 A	0,024 @ 192 A	6

Table 18 - Characteristics of AMI 332 with DRTS XX

The accessories supplied with the unit are the following:

- Protective plastic bag
- Mains supply cable
- Interconnecting cable to DRTS XX
- Cable for the connection of current neutrals: 1 m long, 6 mm^2 cross section
- Relay connection cables kit: 8 in all, 4 red, 4 black; length 2 m, cross section 1 sq. mm

Weight: 16 kg.

Dimensions without the handle: 150 (h) x 466 (w) x 423 (d) mm.

4.14 Six phase current amplifier AMI 632 (code 81170)

The six phase current amplifier AMI 632 is an additional device to the DRTS 66. The option includes six current generators at 32 A each. In connection with the DRTS XX, the option offers the following features:

- To control twelve currents at 32 A
- To have a six phase generator at 64 A per phase
- To have a three phase generator at 128 A per phase
- To have a single phase generator at 256 A

The connection between DRTS XX and AMI 632 is made by a control cable, to be connected to DRTS XX.

All characteristics are the same as the DRTD XX current generators.

The following table lists the characteristics of AMI 632 with DRTS XX:

Range	Outputs	Connection	Current [A]	Power [VA]	Z max [Ω]	Resolution [mA]
1	12 X	Direct	0÷32	430 @ 32 A	0,4 @ 32 A	1
2	6 X	2 in parallel	0÷64	860 @ 64 A	0,2 @ 64 A	2
3	3 X	4 in parallel	0÷128	1.720 @ 128 A	0,1 @ 128 A	4
4	1 X	12 in parallel	0÷256	1.200 @ 256 A	0,018 @ 256 A	8

Table 19 - Characteristics of AMI 632 with DRTS XX

The accessories supplied with the unit are the following:

- Protective plastic bag
- Mains supply cable
- Interconnecting cable to DRTS XX
- Cable for the connection of current neutrals: 1 m long, 6 mm^2 cross section
- Relay connection cables kit: 8 in all, 4 red, 4 black; length 2 m, cross section 1 mm^2

Weight: 18 kg.

Dimensions without the handle: 150 (h) x 466 (w) x 423 (d) mm.

4.15 PLCK Polarity Checker module (code 41175)

The following image exhibits the PLCK option:

Figure 12 - PLCK option

Checking the correct connection of CT's and VT's to protection relays is a problem because relays can be hundreds of meters away from the transformer. PLCK easily solves the issue.

When this test is started, DRTS XX generates a special, not sinusoidal waveform, which is injected into the connection cables. The polarity check is easily performed by connecting it at the relay site.

PLCK hast two lights: green and red. The green light turns on when the polarity is correct; the red light turns on when the polarity is wrong.

4.16 Relay connection cables kit (code 15170)

This option includes 31 cables, with different colors, with banana plugs, 2 m long, cross section 2.5 mm^2, that allow for the connection to the relay under test of all test set sockets. Six more cables have a cross section of 6 mm^2. Last, 20 adapters convert from banana to terminator.

Main characteristics:

- Voltage outputs (4 cables: red, yellow, blue, and black)
- Trip inputs (15 cables; 10 red, 5 black)
- Auxiliary outputs (8 cables; 4 black and 4 red)
- Trip inputs commons connection: the six banana connectors cable allows connecting among them the six trip inputs reference sockets
- Three shunting bridges to perform the paralleling of the three current outputs
- Current outputs (6 cables, cross section 6 mm^2)
- 20 banana to terminator adapters: 10 red, 10 black

4.17 Transit cases (code 85170, 17170, 18170))

Two types of transit cases are available: molded and aluminum.

The protection of DRTSxx from delivery problems is provided by this robust transit case, which features the following.

- Molded-case construction. Heavy duty plastic transport case (Discovery type)
- Handle on the top and on the side
- Wheel
- Dimensions: 400 x 580 x 850 mm
- Weight: 15 kg

In alternative to the above, it is possible to use the following aluminum case, which is lighter and smaller.

- Aluminum metal sheet construction
- Handles on the side
- Wheel
- Dimensions: 250 x 580 x 580 mm
- Weight: 9,5 kg

The following image exhibits the molded transit case and the aluminum transit case:

Figure 13 - Molded transit case and aluminum transit case

It is also available the Soft carrying case (code 18170).

4.18 Stand-up support (code 19170)

The stand-up support allows using the test set in a stand-up position. This is very useful in case of too small room or no support for the test set. There is enough room for the power supply cord, and for the cooling air to flow in.

The following image exhibits the closed and opened Stand-up support:

Figure 14 - Closed and opened stand-up support

REVISIONS

The following table lists the revisions of the document:

No.	Date	Description
1	April 2008	Preliminary issue
2	January 2009	Revision of functionality
3	February 2009	Current range review
4	March 2009	Low voltage outputs
5	May 2009	Final issue
6	August 2009	Minor revisions
7	October 2009	Minor revisions
8	December 2009	Minor revisions
9	May 2010	Minor revisions
10	August 2010	Added the internal memory specification
11	September 2010	Added the list of tested relays , the IN-3 CDG option and the stand-up support option
12	October 2010	Improved the specification of ramps
13	November 2010	Minor revisions; chapter 7
14	January 2011	Added the clamp option
15	June 2011	Low level voltage outputs, IRIG-B and expansions are an option
16	September 2011	Minor revisions
17	June 2012	Added the model DRTS33
18	July 2012	Removed the IN-3 CDG option
19	June 2013	Added the Internal GPS option and the external HPB400 booster
20	November 2013	Added the external HPB600 booster
21	March 2014	Added the Line synchronizer option
22	December 2014	Added the DRTS9 option
23	April 2015	Modified next to firmware 1.33 revision
24	July 2016	Complete revision
25	October 2016	Minor revisions
26	June 2020	Added NTP/IEEE1588 external option
27	July 2020	Minor revisions
28	January 2023	General revision – added wireless option, removed I/O66 option

Table 20 - Revisions

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LIST OF FIGURES

LIST OF TABLES

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