

The 745 is a high speed, multi-processor based, 3-phase, two or three winding, Transformer Management Relay™ intended for the primary protection and management of small, medium and large power transformers.

The 745 combines Percent Differential, Overcurrent, Frequency and Overexcitation protection elements along with monitoring of individual harmonics, and THD in one economical package.

The relay provides a variety of adaptive relaying features:

- Adaptive Harmonic Restraint which addresses the problem of false tripping during inrush
- Adaptive Time Overcurrent Elements which will adjust their pickup settings based on the calculated transformer capability when supplying load currents with high harmonic content
- Multiple Setpoint Groups which allow the user to enter and dynamically select from up to four groups of relay settings to address the protection requirements of different power system configurations
- Dynamic CT Ratio Mismatch Correction which monitors the on-load tap position and automatically corrects for CT ratio mismatch
- FlexLogic™ which allows PLC style equations based on logic inputs & protection elements to be assigned to any of the 745 outputs.

The 745 also includes a powerful testing and simulation feature. This allows the protection engineer the ability to test the relay operation based on captured or computer generated waveform data which can be converted to a digitized format and downloaded into the 745's simulation buffer for "playback".

The 745 also provides its own Waveform Capture function which will record waveform data for fault, inrush or alarm conditions.

The Auto-Configuration function eliminates the need for any special CT connections by having all CTs connected in wye.

1.2.1 APPLICABILITY

Transformers:	2 Winding or 3 Winding
Frequency:	50 or 60 Hz nominal (frequency tracking allows operation from 2 to 65 Hz)

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1.2.2 INPUTS

CONTROL POWER (POWER SUPPLY)

Options:	LO/HI (specified when ordering)
LO Range:	DC = 20 to 60 V; AC = 20 to 48 V @ 48 to 62 Hz
HI Range:	DC = 90 to 300 V; AC = 70 to 265 V @ 48 to 62 Hz
Power:	30 VA nominal, 40 VA maximum
Fuse (not accessible):	Hi-Volt: Current rating: 3.15 A Type: 5 × 20 mm Slow-Blow Littelfuse, High Breaking Capacity Model #: 2153.15
	Low-Volt: Current rating: 3.15 A Type: 5 × 20 mm Slow-Blow Littelfuse, High Breaking Capacity Model #: 2153.15

PHASE CURRENT INPUT

Source CT:	1 to 50000 A primary / 1 or 5 A secondary
Relay Input:	1 A or 5 A (specified when ordering)
Burden:	Less than 0.2 VA at rated load per phase
Conversion Range:	0.02 to 46 × CT
Accuracy:	at < 4 × CT: ± 0.25% of 4 × CT (± 0.01 × CT) at ≥ 4 × CT: ± 0.5% of 46 × CT (± 0.2 × CT)
Overload Withstand:	1 second at 80 times rated current 2 seconds at 40 times rated current continuous at 3 times rated current

GROUND CURRENT INPUT

Source CT:	1 to 50000 A primary / 1 or 5 A secondary
Relay Input:	1 A or 5 A (specified when ordering)
Burden:	Less than 0.2 VA at rated load
Conversion Range:	0.02 to 46 × CT
Accuracy:	at < 4 × CT: ± 0.25% of 4 × CT (± 0.01 × CT) at ≥ 4 × CT: ± 0.5% of 46 × CT (± 0.2 × CT)
Overload Withstand:	1 second at 80 times rated current 2 seconds at 40 times rated current continuous at 3 times rated current

VOLTAGE INPUTS

Source VT:	2 to 600 kV / 60 to 120 V
Source VT Ratio:	1 to 5000 in steps of 1
Relay Input:	60 V to 120 V phase-neutral
Burden:	Less than 0.025 VA at 120 V
Max. Continuous:	273 V
Accuracy:	± 1% of 2 × VT (± 0.02 × VT)

LOGIC INPUTS (16)

Dry Contacts:	1000 Ω maximum ON resistance (32 V DC at 2 mA provided by 745)
Wet Contacts:	Inputs 1 to 16: 30 to 300 V DC at 1.5 mA

ANALOG INPUT

Type:	DC mA
Ranges:	0-1 mA, 0-5 mA, 0-10 mA, 0-20 mA, or 4-20 mA (programmable)
Input Impedance:	375 Ω \pm 10%
Conversion Range:	0 to 21 mA
Accuracy:	\pm 1% of full scale (based on input range)

TAP POSITION

Type:	resistance (ohms)
Range:	0 to 500 Ω or 0.5 to 5.0 k Ω
Bias Current:	1 mA or 10 mA (based on input range)
Accuracy:	\pm 1% of full scale (based on input range)

RTD

Type:	3 wire
RTD Type	100 Ω Platinum (DIN.43760) 100 Ω Nickel 120 Ω Nickel

IRIG-B INPUT

Amplitude-Modulated:	1.0 to 10 V pk-pk
DC Shift:	TTL
Input Impedance	70 to 100 k Ω

1.2.3 PROTECTION ELEMENTS**PERCENT DIFFERENTIAL PROTECTION**

Operating Current Pickup:	0.05 to 1.00 in steps of 0.01 x CT
Dropout Level:	97 to 98% of Pickup
SLOPE-1 Range:	15% to 100% in steps of 1
SLOPE-2 Range:	50% to 200% in steps of 1
KP (SLOPE-1 Kneepoint):	1.0 to 20.0 in steps of 0.1 x CT
Harmonic Restraint:	0.1% to 65.0% in steps of 0.1
Operate Time:	Solid State Output: Pickup < 1 x CT: 42 to 52 ms 1 x CT < Pickup < 1.1 x kneepoint: 34 to 44 ms Pickup > 1.1 x kneepoint: 26 to 36 ms
	Relay Outputs 2-5: Pickup < 1 x CT: 46 to 56 ms 1 x CT < Pickup < 1.1 x kneepoint: 38 to 48 ms Pickup > 1.1 x kneepoint: 30 to 40 ms

INSTANTANEOUS DIFFERENTIAL OVERCURRENT

Pickup Level:	3.00 to 20.00 in steps of 0.01 x CT
Dropout Level:	97 to 98% of Pickup
Level Accuracy:	Per current input
Operate Time:	Solid State Output: at 1.2 x pickup: 22 to 30 ms at 2.0 x pickup: 18 to 26 ms at 4.0 x pickup: 11 to 19 ms
	Relay Outputs 2-5: at 1.2 x pickup: 28 to 36 ms at 2.0 x pickup: 24 to 32 ms at 4.0 x pickup: 17 to 25 ms

PHASE / NEUTRAL / GROUND / NEGATIVE SEQUENCE TIME OVERCURRENT

Pickup Level:	0.05 to 20.00 in steps of 0.01 × CT
Dropout Level:	97 to 98% of Pickup
Curve Shape:	ANSI Extremely/Very/Moderately/Normally Inverse; Definite Time (0.1 s base curve); IEC Curve A/B/C and Short; FlexCurve™ A/B/C (programmable curves); IAC Extreme/Very/Inverse/Short
Curve Multiplier Time Dial:	0.5 to 30 for ANSI, IAC & FlexCurves™ in steps of 0.1 s; 0.05 to 100.00 for IEC curves in steps of 0.01
Reset Type:	Instantaneous or Linear
Level Accuracy:	Per current input
Timing Accuracy:	at $\geq 1.03 \times$ pickup: $\pm 3\%$ of trip time or ± 20 ms (whichever is greater)

PHASE / NEUTRAL / GROUND / NEGATIVE SEQUENCE INSTANTANEOUS OVERCURRENT

Pickup Level:	0.05 to 20.00 in steps of 0.01 × CT
Dropout Level:	97 to 98% of Pickup
Time Delay:	0 to 60000 in steps of 1 ms
Level Accuracy:	Per current input
Operate Time:	Solid State Output: at 1.2 × pickup: 22 to 30 ms at 2.0 × pickup: 18 to 26 ms at 4.0 × pickup: 11 to 19 ms Relay Outputs 2-5: at 1.2 × pickup: 28 to 36 ms at 2.0 × pickup: 24 to 32 ms at 4.0 × pickup: 17 to 25 ms

UNDERFREQUENCY (2 ELEMENTS)

Operating Current Pickup:	0.05 to 1.00 in steps of 0.01 × CT
Operating Voltage Pickup:	0.10 to 0.99 in steps of 0.01 × VT
Pickup Level:	45.00 to 59.99 in steps of 0.01 Hz
Dropout Level:	Pickup + 0.03 Hz
Time Delay:	0.00 to 600.00 s in steps of 0.01 s
Signal Source:	Winding 1 phase A current / voltage
Level Accuracy:	± 0.02 Hz
Operate Time:	Solid State Output: at 3% beyond pickup: 120 to 150 ms Relay Outputs 2 to 5: at 3% beyond pickup: 125 to 155 ms (delay set at 0.0 sec.)

FREQUENCY RATE OF CHANGE (4 ELEMENTS)

Operating Current Pickup:	0.05 to 1.00 in steps of 0.01 × CT
Operating Voltage Pickup:	0.10 to 0.99 in steps of 0.01 × VT
Pickup Level:	45.00 to 59.99 in steps of 0.01 Hz
Dropout Level:	Pickup + 0.03 Hz
Rate 1/2/3/4:	0.1 to 5.0 in steps of 0.1 Hz/sec.
Dropout Level:	Pickup + 0.07 Hz/sec.
Signal Source:	Winding 1 phase A current / voltage
Level Accuracy:	± 0.02 Hz
Operate Time:	The operate time of the frequency trend element is variable and is dependent on the decay rate setting and the supervision frequency level.