



**Northern Regional Power committee
New Delhi**

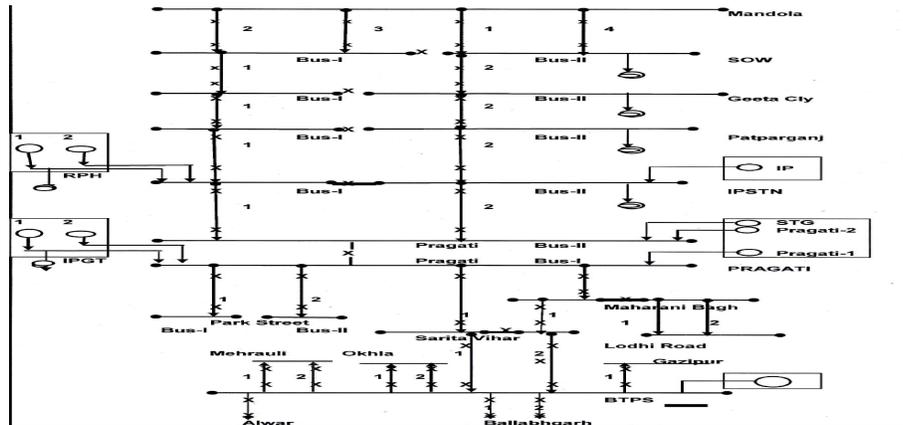
Report on Frequent Tripping of Pragati GT

February 2010

Report of the Sub-Committee to look into the frequent tripping of Pragati GT

1.0 Introduction:

Pragati GT Power Station has 2 GT units of 104.6 MW each and one STG of 121.2 MW. Normally Pragati GT-1 is connected to Bus-1 and GT-2 along with STG is connected to Bus-2 of Pragati sub-station of DTL as shown in the diagram.



The units of IPGT are connected on the bus of Pragati GT-1 through two transformers maintained by DTL. A bus coupler which is generally kept open to split 220 kV system of Delhi has been provided at Pragati DTL substation.

Bus-1 has 4 feeders which are connected to 220 kV lines to Maharani Bagh, Sarita Vihar, Park Street -1 and Park Street -2. Sarita Vihar is further connected to BTPS.

GT-2 and STG is generally connected to Bus-2 to form part of grid connecting through IP station, Patparganj, Geeta Colony to south of Wazirabad and Mandola substation.

During 9th protection sub committee meeting, DTL stated that the behavior of Pragati unit #2 was erratic and this unit trips now and then, whereas other GTs connected to the system do not have such behavior. On earlier occasions also, this Gas Turbine of Pragati Power Corporation Ltd. tripped during the time of disturbances elsewhere in the network. Protection Sub. Committee opined that probably the excitors of the Gas Turbine senses the disturbance elsewhere in the connected network and even though the fault is cleared within the acceptable time by the respective breaker, the excitors continues to sense the fault and subsequently trip the Gas Turbine and was of the view that there could be some problem in the excitation system of the unit and it was decided that PPCL may get their G.T's alongwith excitors be examined.

In the sidelines of discussion NRPC secretariat constituted a Sub Committee to look into this peculiar behavior of sensing of slight disturbance elsewhere in the system and trips undesirably and suggest remedial measures thereto. Following were the constitution of the sub-committee.

1. Sh. KK Arya, SE(P&S), NRPC, New Delhi
2. Sh. PP Francis, AGM, NTPC, New Delhi
3. Sh. A K Arora, DGM, POWERGRID, New Delhi
4. Sh. S R Narasimhan, DGM , NRLDC, Delhi
5. Sh. Prem Prakesh, DGM(Prot), DTL New Delhi
6. Sh. M K Shukla, DGM, IPGCL, New Delhi
7. Sh. Vikram Singh, EE(O), NRPC-Member Convener

2.0 The first meeting of the sub committee took place on 5th Oct 2009, at NRPC to discuss the issue of various tripping in the vicinity of Pragati GT. The second meeting was held on 5th November, 2009 at Pragati GT, where the issue of setting of exciters was discussed.

3.0 Tripping Details

The tripping of Pragati units during last six months were discussed in detail during the first meeting of the sub committee. These incidents are given below:

S. No.	Date	Tripping of Unit (s)	Remarks
1	22-05-2009	GT-2 with STG	System fault, Island did not survive
2.	25-05-2009	GT-1	Fault on 220 kV Pragati – Sarita Vihar feeder, Cleared in Z-I.
3	31-05-09	GT-1	Fault on 220 kV Pragati – Sarita Vihar feeder, Cleared in Z-I.
4	15-06-2009	GT-2	Both circuits of Geeta-colony- Patparganj tripped at Patparganj end. Load generation balance disturbed.
5	06-07-2009	GT- 1	The fault was on 220 KV Mehrauli- BTPS feeder and was cleared in Zone-1 from Mehrauli end and in Zone-2 from BTPS end. Duration of the fault was 540 ms in the system.
6	14-07-09	GT-1 with STG	Bus Bar Protection operated at 220 kV Mandola Substation with fault in 220 kV PPG- GC -I. Fault cleared in Z-I from GC and PPG but overreached at SOW.
7	21-08-09	GT-2 with	Both 220 kV Pragati IP feeders I & II tripped on

		STG	Earth Fault. The fault was probably in the yard at IP generation station. No evacuation path left.
8	02-09-09	GT- 2	Snapping of common jumper of PPG-GC-I feeder and falling on Bus -II of 220 kV PPG s/stn.
9	13-09-09	GT-1, STG, STG 1,2 of IPGT, Unit-4 of IPGT	Snapping of R phase Jumper connected with wave trap of 220 kV Sarita Vihar–Pragati circuit. Broken conductor remained suspended in air and created unbalancing in system. The time setting was low at BTPS end of Sarita Vihar-BTPS circuit and this unbalance was sensed by the earth fault relay at BTPS end. Pragati-Maharani Bagh circuit too was switched off for shutdown. The entire load was on Pragati-Sarita Vihar ckt.
10	17-09-09	GT-1,2 and STG	Bus bar differential operation due to struck up of bus isolator of Pragati -IP ckt-II
11	18-09-09	GT-1,2 and STG	Bus bar differential protection of 220 kV Pragati Bus -2.
12	19-09-09	GT-2 and STG	Bus bar differential protection of 220 kV Pragati Bus-2.
13	30/10/09	GT-2	GT-2 on bus-1 and STG on bus -2. GT-1 under down. Fault in Pragati- Sarita Vihar circuit cleared in Z-I from both ends. BC between Bus I and II was open. Lack of evacuation led to tripping.

4.0 Description of each Incident

The brief description of each incident (tripping) is given below:

4.1 Incident on 22nd May 2009

At the time of incident (1439 hrs) IP units, RPH units, Pragati units (Unit-2 & STG) were connected to Mandola side through 220 kV IP Ext-IP- Patparganj- Geeta Colony- Wazirabad – Mandola Ckts. GT and Pragati (Unit-I) were connected to BTPS side through 220 kV Pragati- Maharani Bagh- Sarita Vihar- BTPS Ckts..

Due to heavy storm, three towers of 220 kV Wazirabad- Kashmiri gate D/C line collapsed and the guard wire fell on 220 kV Wazirabad-Geeta Colony Circuit. The 220kV Wazirabad-K gate ckt I and SOW-GC ckt I operated on distance protection zone I due to falling of towers. At the Wazirabad grid substation, there was a huge sparking on 220kV Bus isolator of Geeta Colony ckt II resulting in Bus bar differential protection operated with Main Zone 2 and check Zone. Also the tripping of 220 kV Mandola-Wazirabad Ckt. I,II,III & IV resulted in the islanding of generating stations namely RPH, IP and Pragati (Unit-II & STG) from the Grid.

At the time of incident SOW was feeding 326 MW to the island through Geeta Colony ckts. and the generation from IP units, RPH units and Pragati Units was 375 MW.

The shortfall of 326 MW was achieved from Under Frequency Relay Load throw of 344MW. During UFR operation the Pragati units tripped. PPCL stated that when the voltage drops to 85% of the rated voltage the unit trips on loss of excitation and Pragati GT Unit-II tripped rightly. The sub committee observes that sensing and tripping by the under frequency relay takes time and in the small island the units can not survive under large load generation mismatch.

4.2 Incident on 25th May and 31th May 2009

The fault was on 220 kV Sarita Vihar-Pragati feeder and was cleared in Zone-1 from both ends. And at same time GT#1 of PPCL tripped on this short duration fault(100 ms apporx.). Perhaps machine failed to stabilize under sub transients' conditions.

4.3 Incident on 15th June 2009

On 15th June, 2009, both circuits of 220 KV Geeta Colony-Patparganj tripped at Patparganj end on under frequency which may be due to mal-operation of UFR scheme. Due to loss of support from Mandola through Geeta Colony, the additional load of about 225 MW came on Pragati GT-2 and other connected generating units. The system voltage started collapsing. The auxiliary voltage dropped to 7.53 kV and Pragati GT#2 instantaneously sensed the voltage dip and it came into "Field Forcing" mode to maintain the Generator voltage. Meanwhile, the outgoing feeders of PPG (66 kV, 33 kV & 11 kV) started getting cut off from the circuit due to under frequency operation (X, Y, Z Group). Operation of UFR at Patparganj sub station gave a relief of 194 MW in a small island resulted in jump in voltage to the tune of 12.53 kV. Pragati GT # 2 which was earlier trying to boost the voltage, suddenly found its terminal voltage to have shot up due to "Load Throw".

The generator terminal voltage shot up to 12.53 kV while frequency was 49.55 Hz. The over flux calculated at these values works out to be 2.67 Weber whereas, the instantaneous Over Flux setting of 99 GT relay in GT #2 of PPCL is 2.66 Weber. Thus, the GT#2 of PPCL rightly tripped on Over Flux protection.

4.4 Incident on 6th July 2009

The fault was on 220 KV Mehrauli- BTPS feeder and fault was cleared in Zone-1 From Mehrauli end and in Zone-2 from BTPS end. At the same time GT#1 of Pragati tripped. Duration of the fault was 540 ms in the system. The sub-committee considered this tripping as unintended and request that matter could be discussed with BHEL (OEM of AVR). It was intimated that AVR was calibrated in the month of March, 2009. The AVR had dynamic voltage regulation (DAVR) limiter. DVR has two auto channels. VT-1 for channel 1 and VT-

2 for channel -2 has been provided. When there is drop in voltage less than 85 % of the rated terminal voltage, control changes from VT- I changes to VT-II and machine senses it as VT fuse fail and trips the field. This is not desirable. Pragati Power Corporation Ltd (PPCL) also discussed this issue with BHEL and they have suggested a time delay of 500 ms in the changeover. The setting has since implemented on 15th Oct 2009. The sub committee opines that the same setting may be incorporated in GT -2 based on the experience of GT-I.

4.5 Incident on 14th July 2009

There was a fault in 200 kV PPG -GC -I, relay gave trip command to breaker in Zone -I from GC end and in Zone 2 from PPG end. Simultaneously, SOW end also tripped in Zone-1 apparently due to overreach. Bus bar protection scheme at Mandola substation also operated with this phase-earth fault in section GC-PPG ckt I. Similar incident of Bus bar operation on 220kV side at Mandola also occurred in the past and needs to be examined by Mandola substation. Isolation of Mandola Bus caused an additional load burden of 396 MW to be compensated by generation from IP, RPH and PPCL units. This shortfall was managed by UFR operation but Island could not survive.

4.6 Incident on 21st August 2009

Due to bad weather, both feeders of 220 kV IP-Pragati tripped on Earth Fault Protection. The generation of GT #2 and STG which was being evacuated through these two feeders got thrown off resulting in over-speeding. Probably there was a fault in IP station yard and both circuits were running in parallel. The over-speeding resulted in tripping of turbine of GT# 2 and STG of PPCL.

The sub committee opines that system strengthening should be done by DTL to increase reliability of the evacuation system of Pragati GTs.

4.7 Incident on 2nd September 2009

It was reported that around 1020 hrs , top R phase common bus to gantry jumper of 220 kV PPG-Geeta colony No.1 got snapped from PG clamp of top of R phase pole of breaker and fell on Bus II of 220kV PPG sub-station. This caused operation of Bus Differential Protection at PPG. The operation of Bus Differential Protection at PPG resulted in isolation IPGCL/PPCL bus from PPG side.

DTL should consider adopting better and improved preventive maintenance practices.

4.8 Incident on 13th September 2009

Again on on 13.09.09 at 09:50 Hrs., a heavy jerk was observed in the system due to snapping of R-ph jumper connected with wave trap of 220kV Pragati-Sarita Vihar

ckt at Sarita Vihar end. It was reported that an emergency shut down was being availed on 220 kV Pragati-Maharani Bagh ckt. As soon as the breaker was made off, the total load of 220 kV Pragati- MB ckt got transferred onto 220 kV Pragati-SV ckt. with a total load of 160 MW, the R-ph jumper of 220 kV Pragati-SV ckt got snapped off and remained suspended in air without touching any other conductor/ground. This was a condition of "Broken Conductor" and the definite time (DT) earth fault feature was enabled in the numerical distance protection relay at BTPS end on 220 KV BTPS-SV ckt. as, such, the fault got cleared from BTPS end after a time delay of around 1 sec. Due to loss of 160MW in island, the jerk was felt by GT # 1 of PPCL and came on Full speed due to No Load (FSNL) and STG of PPCL tripped on Field Failure Protection after the time delays of 2.0 secs.

Also the tripping of PPCL units resulted into a generation loss of 270 MW thereby leading to huge under frequency conditions. Consequently, 160 MVA and 100 MVA transformers of GTPS tripped on under frequency ultimately leading to IPGT # 1 of GTPS coming on part load, IPGT # 3, 4 & 6 of GTPS coming on FSNL and STG 1 & 2 of GTPS tripping on Loss of Field Protection. Despite the load shedding by U/F relays at I.P. Station and RPH, the Load Generation gap could not be met which ultimately led to tripping of Units # 4 of I.P. Station on under voltage.

4.9 Incident on 17th September 2009

At 10:57 Hrs. on 17.09.2009, DTL officials were trying to transfer the load of 220 KV Pragati – IP II circuit from Bus II to Bus I but connected isolator got stuck and failed to open during on load operation. A heavy jerk was observed and the Bus Bar Differential Protection of 220 KV Pragati Sub-station operated. For the same, Bus isolator of 220 KV Pragati – IP II feeder was closed on Bus I. Bus Differential Protection operation resulted in tripping of all three units of PPCL and 160 MVA & 100 MVA transformers of GTPS as these units are directly connected to 220kV Pragati station. The tripping of both the transformers of GTPS caused tripping of units of IPGTs since the major generation of IPGTs (approx. 80 MW) was being evacuated through the two transformers.

4.10 Incident on 18th September 2009

Another incidence of operation of Bus Differential Protection of 220 KV Pragati Substation Bus II was reported at 02:47 Hrs. on 18/09/2009. Consequently, two units of PPCL namely GT # 2 and STG which were running on Bus II tripped on Class A1 protection with Bus Bar Protection. However, the bus did not become dead. Further investigations revealed that 220 KV Pragati – IP II feeder, which was also on Bus II did not trip on Bus Differential Protection thereby justifying the "Live condition of Bus II" even after Bus Bar operation. DTL reported that this

feeder did not operate due to improper isolator auxiliary contact which has since been corrected.

4.11 Incident on 19th September 2009

At 10:20 Hrs. on 19/09/2009, another incidence of operation of bus bar Differential Protection of 220 KV Pragati Sub Station Bus II was reported which happened during the cleaning of Isolator auxiliary contacts by the maintenance staff. Bus bar differential operation led to tripping of two units of PPCL namely GT # 2and STG.

4.12 Incident on 30th October 2009

Pragati GT-1 was on shut down. GT -2 was on Bus -I and STG on Bus -II. Pragati - Maharani Bagh ckt. on shut down and Bus -I was having one radial feeder (park street) and one feeder to Sarita Vihar to evacuate the power. At around 1500 hrs, there was a fault on 220 kV Sarita Vihar – Pragati ckt, which tripped in zone 1 as the fault was within 8-9 km. At this time 220 kV Pragati was drawing 10MW from BTPS. Due to this fault which was cleared in zone I, the connected Pragati GT could not survive. While allowing shut down, SLDC Delhi should have considered closing of the bus coupler breaker at 220kV Pragati under such transient conditions to allow Pragati GT to stabilize.

5.0 Summary of the Findings

5.1 *Islanding of Generators:*

The 220kV side switching arrangement is such that it requires some Pragati Generators be flimsily connected to the 220kV longitudinal system. Pragati units are at one end of the series of 220kV D/C lines while the other end is connecting to the Grid system at Mandola. Any interruption of both circuits anywhere in between results in islanding of Pragati machine on that side of the system and the machine trips on process protection. In spite of UF relaying it is unlikely that the load generation balance is attained and the machines are more likely to trip than survive on the load throw off.

5.2 *Over Fluxing / Differential Protection tripping of transformers*

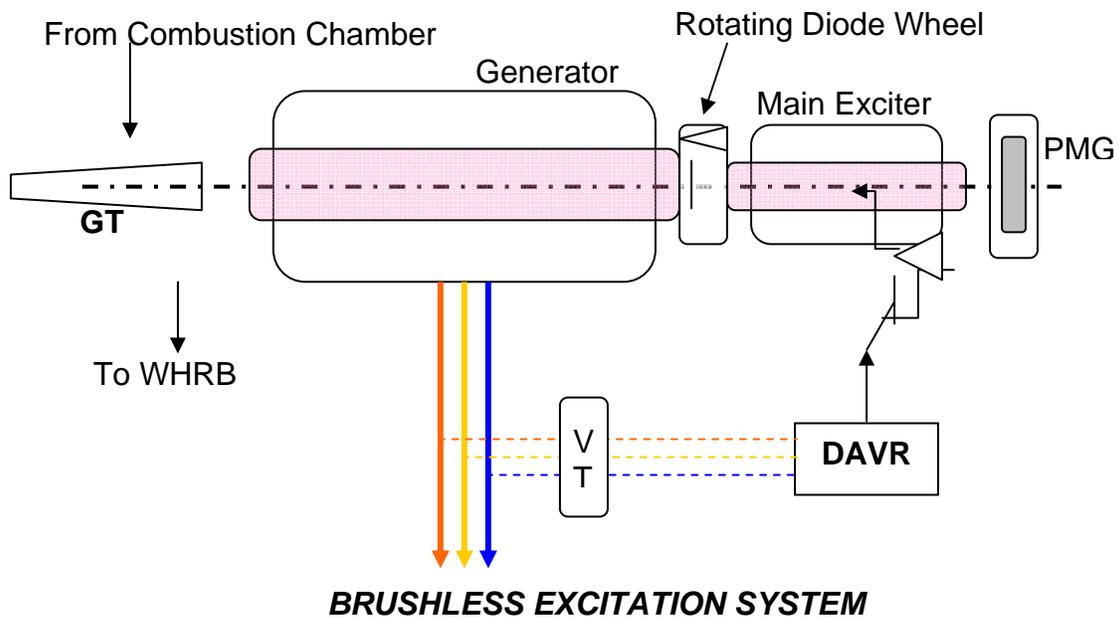
Following a fault in the system which results in the islanding of the GT unit(s), the islanded system may experiences over fluxing. Over fluxing protection is a time delayed protection and will operate only if the situation lasts for some time.

However, some of differential relays applied (DTH of erstwhile EE make) are susceptible to tripping during over fluxing situations i.e incidence of 30.10.2009 also. Some performance improvement can be achieved by adopting a higher percentage bias in the DTH relay, which could reduce the tripping of machines.

Transformer differential relays are prevented from operation during over fluxing conditions (where differential currents do exist, as the magnetizing current flows in only one side) by the application of a restraint using the high fifth harmonic currents associated with the over excitation. In DTH the fifth harmonic current is just by-passed and the fundamental component is enough to cause operation of the relay. In several other relays a 5th harmonic restraint is employed. (See DTH brochure at Annexure-).

5.3 Excitation system of Pragti GT

Pragati GT units are equipped with brushless excitation system. Excitation control being performed by the DAVR (Digital Automatic Voltage Regulator) manufactured by BHEL. In brushless excitation system, excitation power is derived in two stages by two shaft driven auxiliary generators. The former machine a Permanent Magnet Generator (PMG) carries permanent magnets on its rotor. The three phase high frequency AC supply extracted from its stator is rectified in a controlled rectifier and fed to the field winding wound in the stator of the latter machine, the main exciter. The three phase armature winding of the main exciter is wound on its rotor which is rectified in rotating rectifier, mounted on the shaft itself and is fed directly into the field winding of the main generator rotor. The voltage regulation is applied by the DAVR at the controlled rectifier in the field circuit of the main exciter. The block diagram of the arrangement is shown in the sketch below:



DAVR is equipped with dual auto channel control for normal operation. Each auto channel gets its voltage feedback from a separate VT connected to the generator terminals. In the event of a failure of VT signal, detected by a Voltage Balance VT fail detection scheme provided in the GRP (Generator Relay Panel), the control will transfer from Auto Channel-1 to Channel-2 and the machine will continue to operate normally. However, in case there is no real VT failure also, VT fail condition can be detected by the scheme during transient voltage sag and recovery during a close in fault. In such a situation the VT fail condition can be detected by the Voltage Balance Scheme for both AVR VTs for a short while due to the mismatch of VT characteristic and relay operating characteristic. In such cases both auto channels would fail and switch off and the machine would eventually trip on loss of excitation. This is possibility for machines which are susceptible to close in faults which is very much the case with Pragati units.

Suggestions for improvement:

1. Pragati station in consultation with BHEL, has now decided to incorporate a time delay of the order of 500ms in the VT failure detection based channel change-over logic. The sub committee finds merit in the proposal and feels that the time delay may be kept 200ms more than the Zone-2 time delay in DTL system
2. The new DAVR being supplied by BHEL has two additional manual channels inherently and the loss of both auto channels would not result in unit outage.
3. BHEL DAVR is some times equipped with an in built VT failure detection logic. It needs to be confirmed that such a scheme if existing is also having time delay feature.

6.0 Recommendations:

1. Reviewing of Bus split at Pragati GT- Since Bus -II of Pragati S/Stn has only two feeders, in order to increase reliability of supply in the region, the sub committee recommends that SLDC Delhi in consultation with NRLDC should undertake a study to review the 220 kV Bus split at Pragati GT and suggest re- configuration or additional evacuation for Pragati. **[Action – SLDC Delhi/ NRLDC, Time – one month]**

2. Reviewing of setting of excitation system of Pragati Units- Pragati station has in consultation with BHEL, has now decided to incorporate a time delay of the order of 500ms in the VT failure detection based channel change over logic. The sub committee finds merit in the proposal and feels that the time delay may be kept 200ms more than the Zone-2 time delay in DTL system. The same setting may further be extended to unit 2 if found successful. **[Action – PPCL, Time – three month]**

3. Provision of Disturbance recorder on Pragati GTs: The existing DR, (make Hathway) installed on the Pragati GT is not functional for quite some time. Pragati GT Station should have Disturbance recorder for complete analysis of the transient events in the sub-system. **[Action – PPCL, Time – three month]**

4. Improving maintenance practice of DTL system- There have been frequent tripping in DTL system along the network connected with Bus 2 at 220kV Pragati station. The cases of conductor and jumper snapping were also reported. Sub committee recommends that DTL should take appropriate steps to ensure reliability of line loading up to thermal limits and improve the maintenance practices in their sub system. , **[Action – DTL, Time – one month]**

5. Provision of inter trip on the lines and auto reclosure – The sub committee recommends that for faster fault clearance on the short lines, numerical current differential scheme be implanted on all 220 kV lines between Pragati GT and Mandola substation. DTL has already initiated action for provision of line current differential protection scheme. The same needs to be expedited. Also all line connecting to generating stations should have Auto Reclosure facility. **[Action – DTL, Time – Six months]**

Acknowledgment

The Sub-Committee gratefully acknowledges the cooperation extended by the officials of M/S IPGCL, and DTL in providing the inputs for analyzing the incidents of frequent tripping of Pragati GT.

The Sub-Committee places on record its appreciation of the assistance provided by Shri Arif Rahman IPCGL, Shri Hitesh Kumar, Manager, DTL, Shri Rajesh Kumar, Manager, NRLDC and Shri Naresh Kumar, AEE, NRPC in analysing the causes and preparation of the report.

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Type DTH 31, 32 DTTM 11, 12
High Speed Biased Differential Relays

ALSTOM

Type DTH 31, 32 DTTM 11, 12

High Speed Biased Differential Relays

DTH relay
withdrawn from case



Features

- High speed.
- Low burden.
- Immunity to magnetising inrush.
- Immunity to transients and surges
- Compact in size.
- Single pole version with separate flags for differential/highset operation available.

Application

DTH 31 and DTH 32 are triple pole high speed biased differential relays – DTTM 11/DTTM 12 are single pole versions of DTH 31/DTH 32 respectively – designed to protect large power transformers, auto transformers and generator transformers against internal faults. Biased to provide stability during heavy through-faults, the relays utilise second harmonic restraint to prevent operation by normal magnetising in-rush currents produced when the transformer is energised.

In addition, type DTH/DTTM relays employ fifth harmonic by-pass circuit to avoid possible mal-operation under over-excited conditions.

An instantaneous highset circuit overrides the biased differential circuit to clear heavy internal faults in about one cycle.

Type DTH 31/DTTM 11 is applicable for two-winding transformers and type DTH 32/DTTM 12 for three winding transformers.

Extremely low burdens are achieved by the use of input devices which convert current to voltage (transactors). Static circuitry is employed throughout, and a single attracted armature unit provides the output. These relays have the advantage of small dimensions and increased reliability over their electro-mechanical equivalents. Ideally, the CT primary rating should agree with the protected power transformer's full load rating, and with the transformation ratio. This

ensures the secondary currents flowing in the interconnecting pilots are balanced and matched with the relay rating.

When interposing CTs are used for ratio correction, the main CT secondary should preferably be star connected and the phase angle correction whenever necessary should be adopted on the interposing CT by connecting them in star/delta.

Description

DTH 31

Figure 1 – block schematic diagram – shows a typical application with a three-phase two-winding transformer.

Input currents I_2 and I_1 from the power transformer line CTs are added vectorially in the centre tapped restraint bias transactor T_1 . Three taps in each half of the transactor primary enable bias settings of 15%, 30% and 45% to be obtained. The output of T_1 is full wave rectified and smoothed to

obtain the restraint bias voltage level V_B . The centre tap of T_1 is connected to the differential circuit which comprises transactors T_2 , T_3 and current transformer T_4 connected in series. A tuned circuit which includes the secondary of T_2 is arranged to resonate at the second harmonic frequency. The output of this circuit is rectified and smoothed to obtain the harmonic restraint voltage level V_H . In addition, outputs of transactor T_3 and current transformer T_4 are rectified and smoothed to obtain the differential voltage V_D and the highset voltage level V_O respectively.

The greater of the two restraining voltage levels V_B and V_H is detected in one comparator and compared in magnitude with the differential operating voltage level V_D in a second comparator stage. When the operate voltage exceeds the restraining voltage by more than a preset amount, the second comparator produces an output to operate the common relay drive circuit. The highset voltage level V_O operates the relay drive circuit if the differential current exceeds ten times the rated current.

DTH 32

Figure 2 – block schematic diagram – shows an application with a three-phase three-winding transformer. Because current reversal is possible, the three inputs I_1 , I_2 , and I_3 cannot be added vectorially. Consequently, inputs to the DTH 32 are fed to separate transactor/rectifier circuits, and the dc voltage outputs added to produce a bias voltage V_B . All other circuitry is similar to that of the DTH 31 relay.

The DTTM 11/DTTM 12 are similar in operation to DTH 31/DTH 32 respectively.

Technical data

Current ratings

1A or 5A at 50 Hz.

Settings

Operate

The relay operates when differential current exceeds 15% relay rated current (fixed).

Bias

The bias setting is adjustable to 15%, 30% or 45% by plugboard taps.

Thermal ratings

The relay will withstand twice rated current continuously, 40 times rated current for 3 s and 100 times rated current for 1 s. Limiting value is 170 times rated current. The limiting value must not be exceeded and can be withstood for a maximum period of 0.25 s.

Operating time

The relay operating time for differential currents in excess of twice rated current is typically about 45 ms.

Harmonic restraint

Operation is prevented when the second harmonic content of the differential current exceeds 20%.

Burdens

DTH 31/DTTM 11

0.33VA per phase at rated current – 1A relay.

1.0VA per phase at rated current – 5A relay.

DTH 32/DTTM 12

0.39VA per phase at rated current – 1A relay.

1.2VA per phase at rated current – 5A relay.

Highset

DTH 31/DTH 32

The highset circuit operates when the differential current exceeds 10 times the rated current.

DTTM 11/DTTM 12

8, 10, 12, 14, 16 x rated current (recommended setting 10 x rated current).

Contacts

Two pairs of normally open self reset contacts rated to make and carry 7500VA for 0.5 s, with maxima of 30A and 660V.

Auxiliary supply

30, 110/125, 220/250V dc.
Relays for use on 110/125 or

220/250V are supplied with suitable external resistors.

CT requirements

Star connected and delta connected current transformers must have a knee-point voltage given by:

$$V_k = 40 I (R_{CT} + 2 R_L)$$

where V_k = Current transformer knee-point voltage (V).

I = Relay rated current (A).

R_{CT} = Resistance of CT secondary winding (Ohms).

R_L = Resistance of each pilot from the relay to the CTs (Ohms).

Magnetising current

Less than $0.03 \times I$ at $V_k/4$

Operation indicators

Independent flags for differential and highset are provided on types DTTM 11 and DTTM 12, common flag indicator for DTH 31/DTH 32.

Insulation

The relay meets the requirements of IS 3231/IEC 255-5 series C- 2 kV for 1 minute.

Impulse voltage

The relay complies with the requirements of IS 8686/IEC 255-4, Appendix E to class III.

High frequency interference

The relay complies with IS 8686/IEC 255-22-1 Appendix C to class III.

Case

Relays are supplied in drawout case suitable for flush mounting and are finished eggshell black and tropicalised. The drawout feature considerably simplifies maintenance and permits testing to be carried out easily and quickly. A cradle mounted isolating switch is provided which automatically isolates the trip circuit when the cradle assembly is withdrawn from the case for maintenance. This prevents any inadvertent tripping of the circuit breaker. The case is fitted

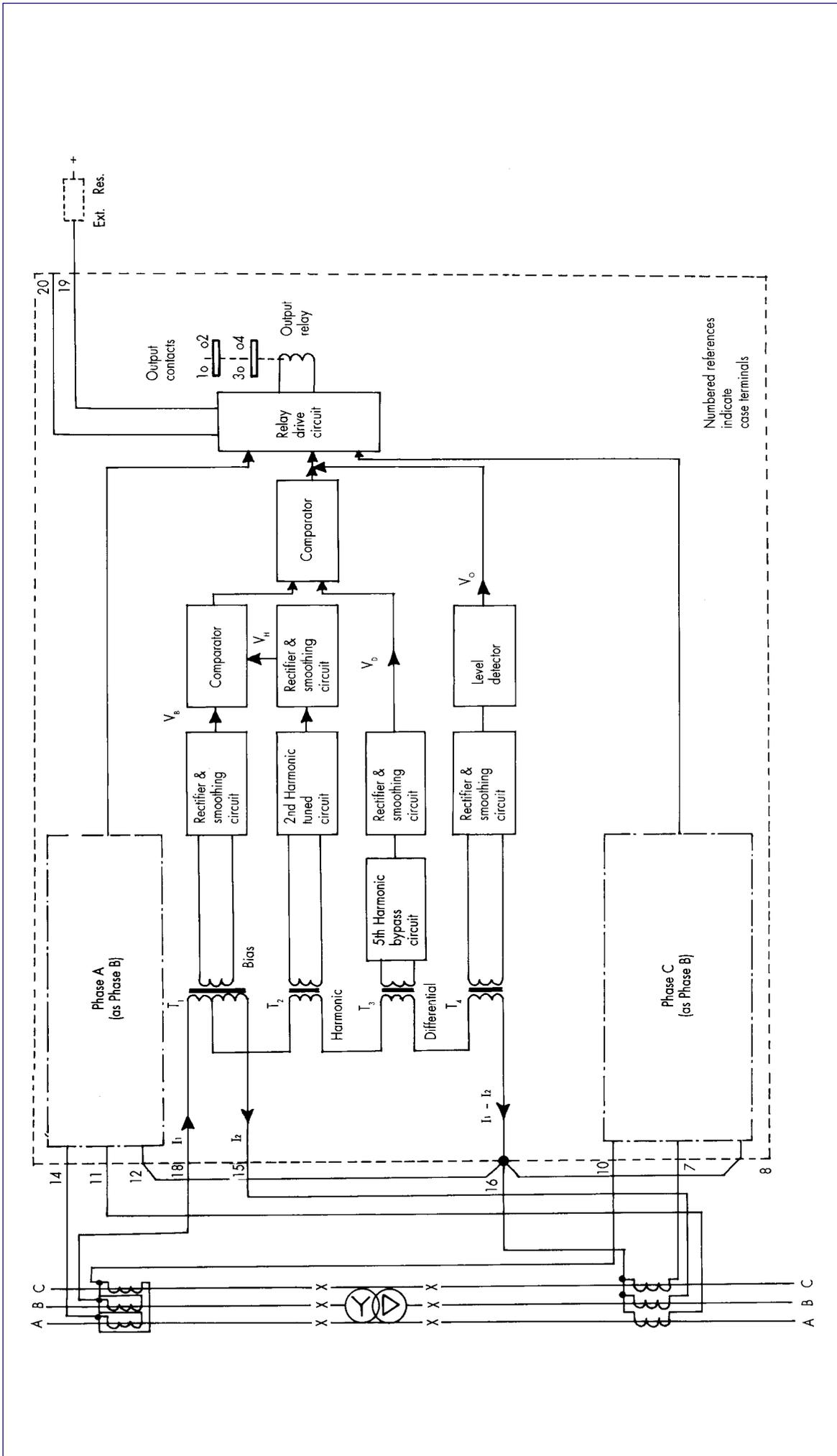


Figure 1:
Block schematic diagram of DTH 31

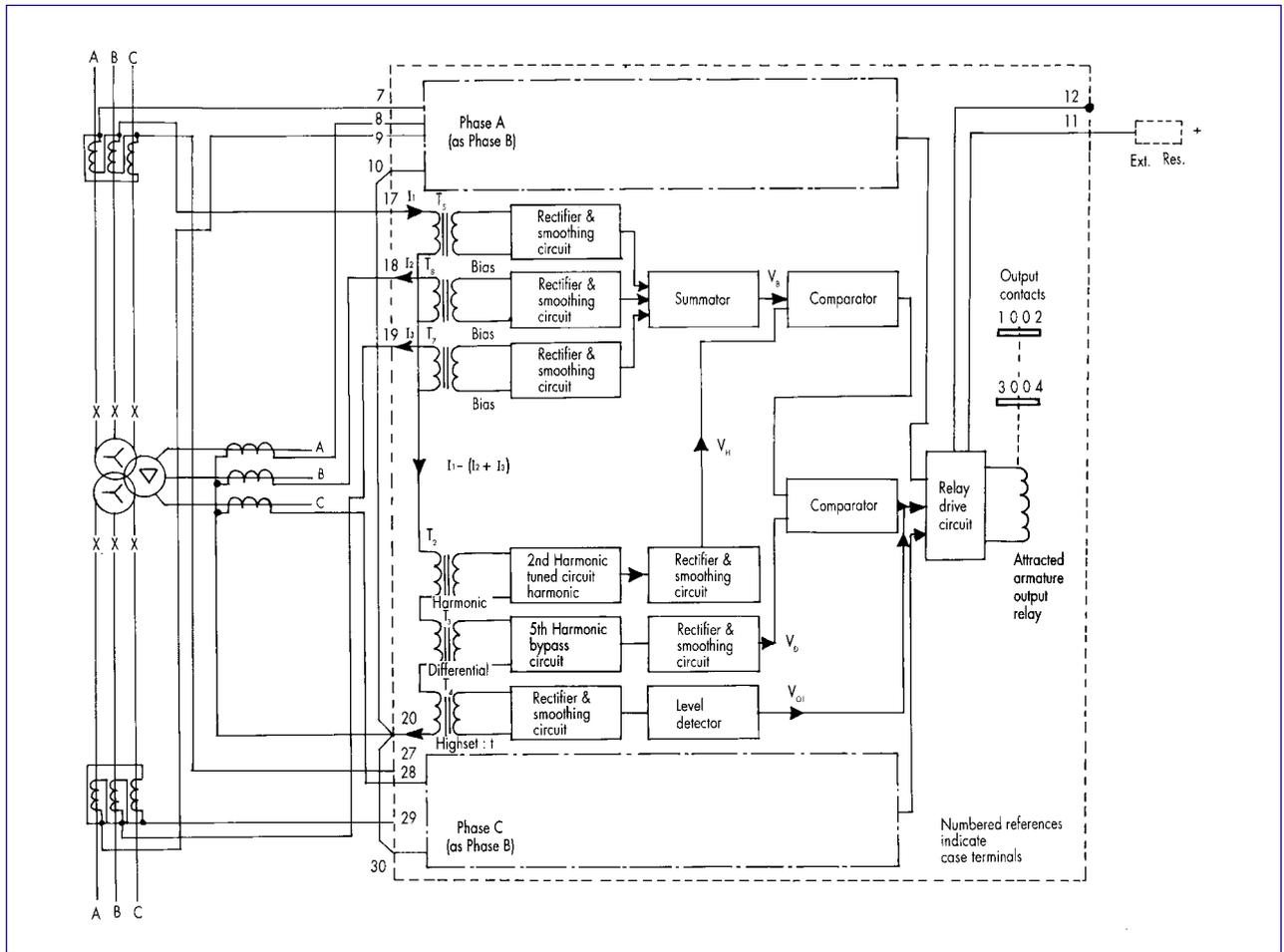


Figure 2:
Block schematic diagram of DTH 32

Dimensions and weights

Relay	Case size	Maximum overall dimensions			Approximate gross weight (Kg.)
		Height (mm)	Width (mm)	Depth (mm)*	
DTH 31	3D Vert.	524	170	203	15
DTH 32	3D Hor.	233	454	203	16
DTTM 11	1½D Vert.	362	170	203	8.3
DTTM 12	1½D Vert.	362	170	203	8.3

* Add 76 mm for maximum length of terminal studs, alternatively, 29 mm for terminal screws.

The approximate gross weights given above are inclusive of cartons, mounting appendages and terminal details.

The relays comply fully with the requirements of IS 3231 and are suitable for use in normal tropical environments.

with CT shorting switches which prevent open circuiting of the CT circuits on withdrawal of the relay unit from the case. A filter breather is fitted which equalises pressure inside and outside the case without admitting dust.

DTH 31 and DTH 32 relays are mounted in 3D vertical and 3D horizontal cases respectively.

DTTM 11 and DTTM 12 relays are mounted in 1½D vertical cases.

Information required with order

1. Differential relay type
DTH 31/32
DTTM 11/12
2. Relay current rating
3. Auxiliary voltage



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