ENERGY AUDIT AT KWA KADUTHURUTHY WATER TREATMENT & PUMPING STATION

Energy Audit Report

Year: 2020-21

Energy Management Centre – Kerala
Dept of Power, Govt of Kerala.State Designated Agency
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ENERGY AUDIT REPORT

KERALA WATER AUTHORITY PUMPING STATION

KADUTHURUTHY

Energy Audit Report

KERALA WATER AUTHORITY PUMPING STATION-KADUTHURUTHY

Report No: EA 586

2020-October

Energy Audit Team:

Suresh Babu B V, Accredited Energy Auditor, AEA 33
B. Zachariah, Chief Technical Consultant
Abin Baby, Project Engineer
Mahesh Ramachandran E, Project Engineer
Mohammed Aneez, Project Engineer

Accredited Energy Auditor, AEA 33
Bureau of Energy Efficiency
Government of India

Empaneled Energy Auditor, EMCEEA-0211F,
Energy Management Centre
Government of Kerala.

Acknowledgment

We were privileged to work together with the administration and staff of Kerala Water Authority pumping station, Kaduthuruthy for their timely help extended to complete the study and bringing out this report on Energy Audit.

We are happy to acknowledge the help extended by Sri. Suresh Executive Engineer for their quality interactions and advices to make this audit complete.

We thank our consultants, engineers and backup staff for their dedication to bring this report.

Thank you.

B V Suresh Babu
Accredited Energy Auditor
AEA 33, Bureau of Energy Efficiency
For OTTOTRACTIONS

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Certification

This is to certify that

The data collection has been carried out diligently and truthfully;

All data monitoring devices are in good working condition and have been calibrated or certified by approved agencies authorised and no tampering of such devices has occurred;

All reasonable professional skill, care and diligence had been taken in preparing the energy audit report and the contents thereof are a true representation of the facts;

Adequate training provided to personnel involved in daily operations after implementation of recommendations; and

The energy audit has been carried out in accordance with the Bureau of Energy Efficiency (Manner and Intervals of Time for the Conduct of Energy Audit) Regulations, 2010.

SURESH BABU B V
ACCREDITED ENERGY AUDITOR (AEA 33)

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Executive Summary						
Consolidated Cost Benefit Analysis of Energy Efficiency Improvement Projects						
KWA PUMPING STATION, KADUTHURUTHY						
Sl No	Projects	Investment	Cost saving	SPB	Energy saved	
		(Lakhs Rs)	(Rs)/Yr	Months	kWh/Yr	toE/Yr
1	Energy Saving in Lighting by replacing existing 39 No's T12 Lamps to 18W LED Tube	0.14	0.39	4.16	11274	0.97
2	Energy Efficiency in Existing Pumping system by replacing inefficient motor (RWP 1)	8.24	28.66	3.45	451403	38.82
3	Energy Efficiency in Existing Pumping system by replacing inefficient motor (RWP2)	9.13	20.83	5.26	327974	28.21
4	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 1)	14.05	10.18	16.57	160308	13.79
5	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 2)	10.52	13.80	9.15	217248	18.68
6	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 3)	10.24	35.42	3.47	557749	47.97
7	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 4)	9.99	38.66	3.10	608820	52.36
8	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 6)	8.55	13.85	7.41	218124	18.76
9	Energy Saving by arresting leakages in flanges and other joints of the line.	-	-	-	-	-
10	Improve the power factor to unity will save energy cost by getting PF incentives.	-	-	-	-	-
11	Installation of Solar Power Plant (50kWe) on the rooftop and other vacant area to cater lighting loads.	37.5	3.83	117	63875	5.49
Total		**108**	**166**	**19**	**2616776**	**225**

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1

Introduction

A detailed energy audit has been carried out at **KERALA WATER AUTHORITY WATER TREATMENT PLANT AND PUMPING STATION, THYCATTUSSERY** in September 2020. **Energy Management Centre – Kerala (EMC) has entrusted** OTTOTRACTIONS an Accredited Energy Auditor of Bureau of Energy Efficiency and Empaneled Energy Auditor of Energy Management Centre, Government of Kerala to conduct this audit for EMC. The energy audit has identified energy conservation opportunities and recommended projects to improve energy efficiency of the facility.

About EMC-Kerala

Kerala Government has become the first State Government in India to establish an **Energy Management Centre (EMC)** at State level, aiming primarily to remould and instrumentalise energy sector as a catalyst in promoting a development process which is econo-ecologically sustainable. With a view to making energy sector achieve such a lead and catalytic role, EMC has evolved a novel and comprehensive energy management approach and institutional philosophy encompassing management of energy technology systems - both conventional and non-conventional, energy conservation in all sectors of the economy, energy resource management, rural and urban energy systems, energy education and training, energy generation and conservation based employment and poverty alleviation programmes.

India, one of the most affected countries in terms of energy shortage and increasing energy price became one such country in the world to adopt energy management measures at the earliest in all sectors of the economy on a priority basis, including popularising and promoting renewable energy technology and resources.

When liberalization and globalization of economy take effect, energy management aimed at enhancing total energy efficiency in all sectors of the economy becomes a major factor in determining the comprehensive competitiveness of the economy. Giving due consideration to this energy-economy interaction process/scenario, the

Government of Kerala took leadership initiatives for establishing a multi-disciplinary Energy Management Centre under the Department of Power.

This energy audit report complies with the clauses in *Energy Conservation Act, 2001* on mandatory energy audit (**Form 4** [refer regulation 6(2)] guidelines for preparation of energy audit report) and complies with the G.O (Rt) No.2/2011/PD dated 01.01.2011 issued by Government of Kerala on mandatory energy audit.

1.1. General plant/establishment details and descriptions

Kerala water authority was established in first April 1984 under Kerala water and waste water ordinance. The Kaduthuruthy PH Head works subdivision with consumer numbers 10/6011 (1346500013783). It has an installed capacity of 45 MLD (million liters per day) with 365 days working for all four plants together. Capacity Utilistaion is 100%.

Base line Data (Electrical System)

Code	EA 586
Facility	KERALA WATER AUTHORITY, KADUTHURUTHY
Provider	KSEB Ltd
Consumer No	1346500013783
Contract Demand (kVA)	1127
Tariff	HT1(A) Industrial
Energy Charge Rs/ kWh Z1	5.75
Energy Charge Rs/ kWh Z2	8.625
Energy Charge Rs/ kWh Z3	4.312
Demand Charge Rs/ kVA	340
Excess Demand Rs/kVA	170
Energy Bill Analysis interval	2019-20

1.2. Energy audit team

The Energy Audit team is listed below. Besides this list various domine experts also participated in this project.

1. Suresh Babu B V, Accredited Energy Auditor, AEA 33
2. B. Zachariah, Chief Technical Consultant
3. Abhijith M R, Certified Energy Auditor
4. Abin Baby, Project Engineer
5. Mahesh Ramachandran E, Project Engineer
6. Mohammed Aneez, Project Engineer

1.3. Component of production cost

1. Energy (Electricity)
2. Manpower (Permanent & Contract)
3. Consumables
4. Overhead & others

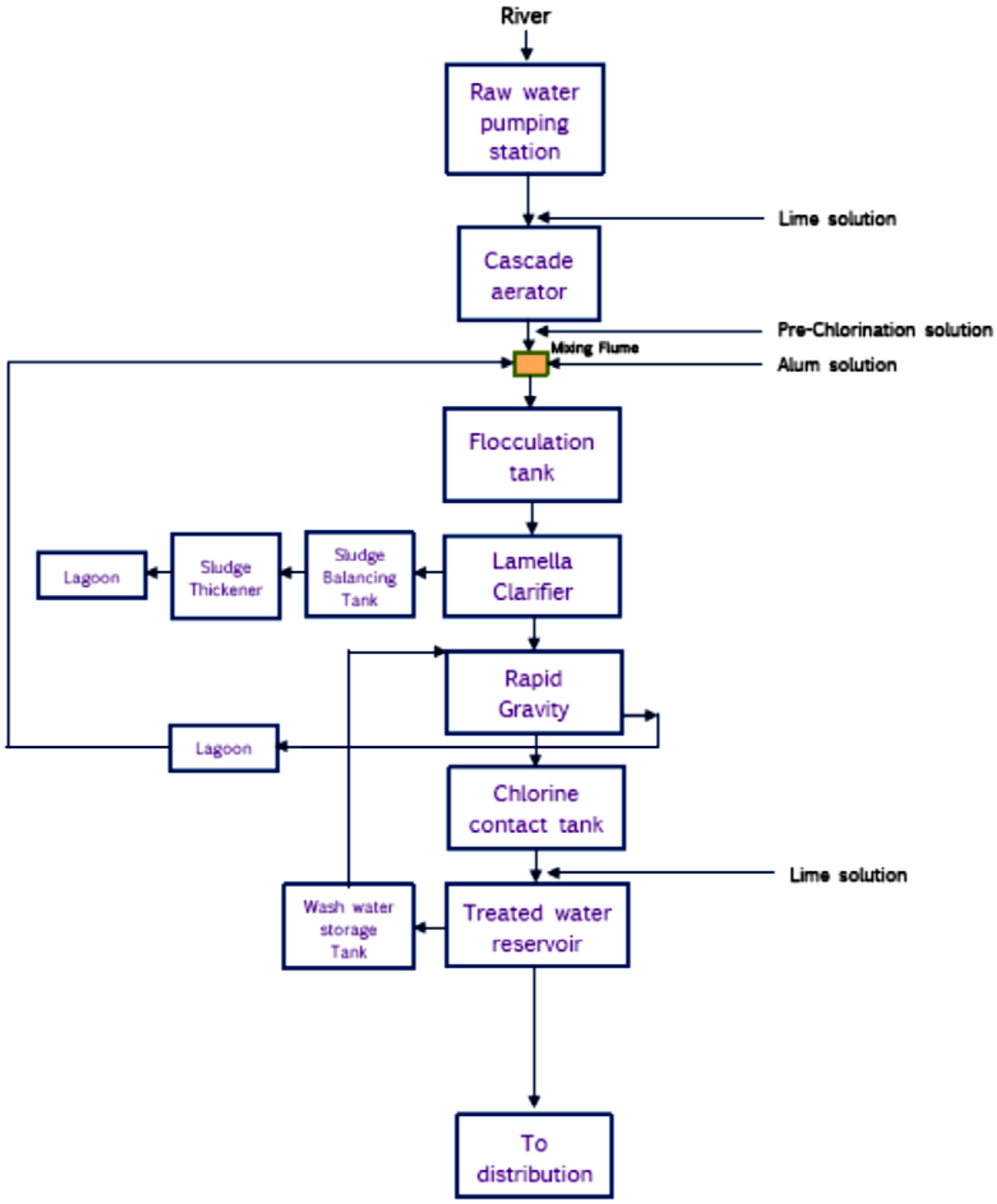
1.4. Major energy use areas

Electricity from KSEB 100% holds the share in the total energy consumed in this facility.

2

Production process description

The Kaduthuruthy head works having one Raw water pump house and two clear water pump houses. The installed capacity of plant is 45MLD the actual production is reduced to 27MLD. The raw water pump house having 3 150HP vertical turbine pumps with motor rating of 110kW. There are two clear water pump house, Old clear water pump house and new clear water pump house. Old clear water pump house having 7 horizontal split casing pumps (180HP*3 +150HP*2+90HP*2). Here the water is treated in the following processes:



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Energy and utility system description

3.1. List of utilities

Electricity is only fuel used in the facility.

3.2 Brief description of each utility

3.2.1 Electricity

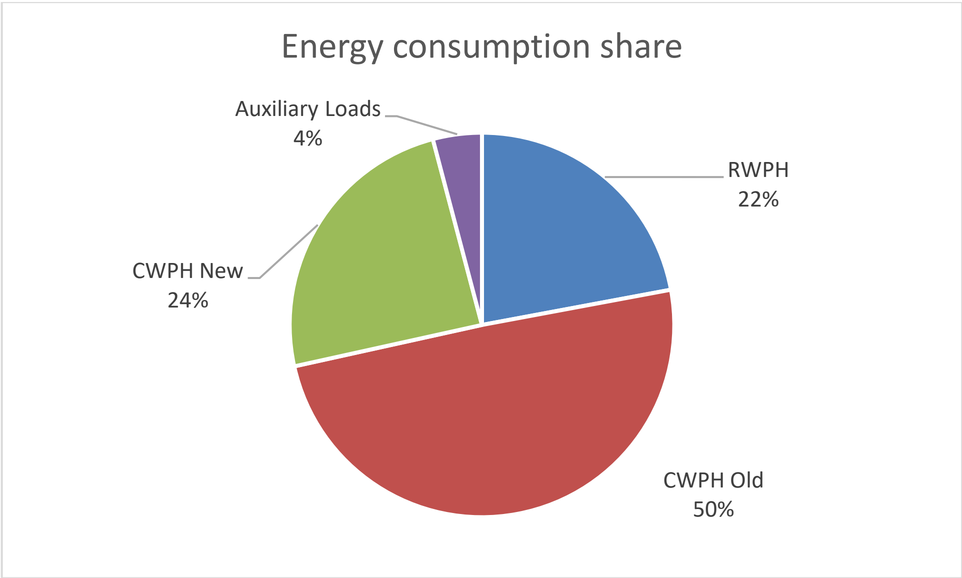
The facility is a consumer of Kerala State Electricity Board (KSEB) under HT – I (A) Industrial Tariff category at 11 kV. The facility having contract demand of 1127. The details of transformer installed in the facility are given below.

Details of Transformers				
Sl.No	Make	Year of manufacturing	Rating (kVA)	Voltage (kV)
1	AMES	2011	1600	0.440
2	AMES	2011	1600	0.440

The power factor is being maintained as 0.95 in this facility. The electrical load study and power quality analysis has been conducted and the results and reports are given in the "Technical Supplement" of this report.

4

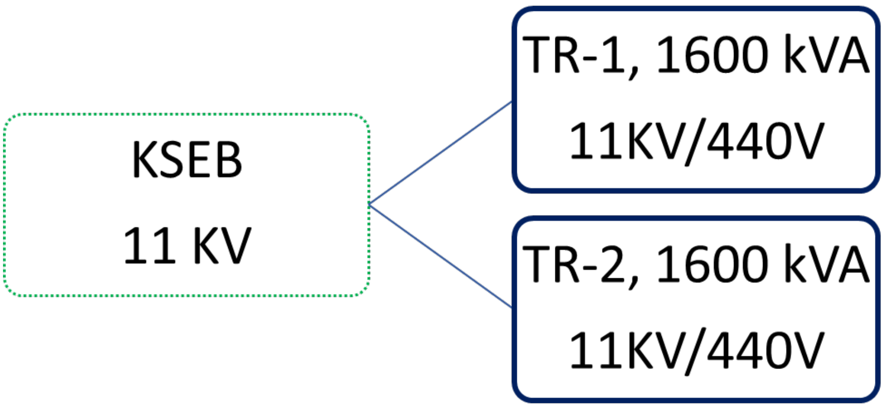
Detailed process flow diagram and energy and material balance

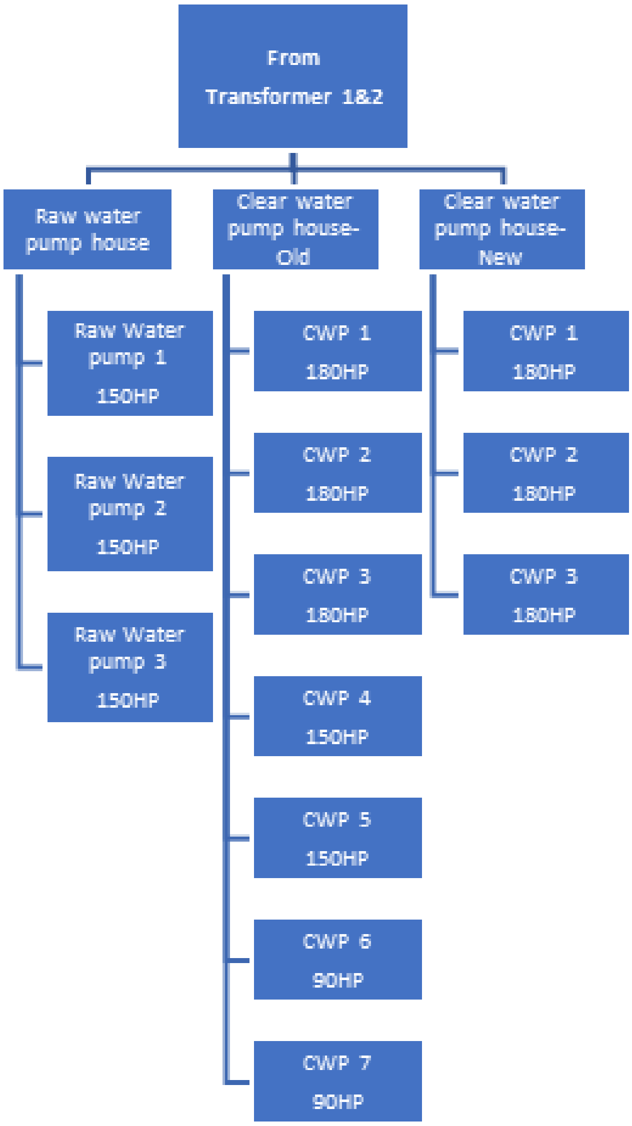


The energy balance of this facility is given above. The auxiliary loads caters 4% of the total load

Plant Operation

The Pumping Station has 2 transformers. The detailed SLD of substations and process are given in this section. The raw water pump 1 having 24hrs operation. raw water pump 2 is operating 12hours to reach the required production




From
Transformer 1&2
Raw water pump house
Clear water pump house-Old
Clear water pump house-New
Raw Water pump 1
150HP
Raw Water pump 2
150HP
Raw Water pump 3
150HP
CWP 1
180HP
CWP 2
180HP
CWP 3
180HP
CWP 4
150HP
CWP 5
150HP
CWP 6
90HP
CWP 7
90HP
CWP 1
180HP
CWP 2
180HP
CWP 3
180HP

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Performance evaluation of major utilities and process equipment's/systems.

5.1. List of equipment and process where performance testing was done.

- Electrical System
- Pumps
- Lighting System
- Renewable Energy

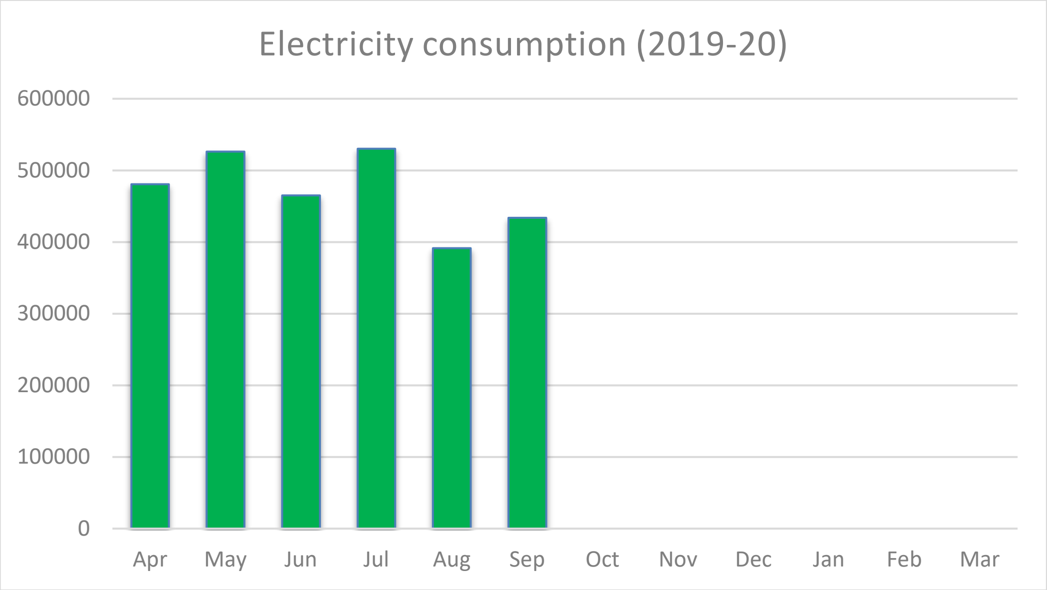
5.2. Results of performance testing

5.2.1. Electrical System

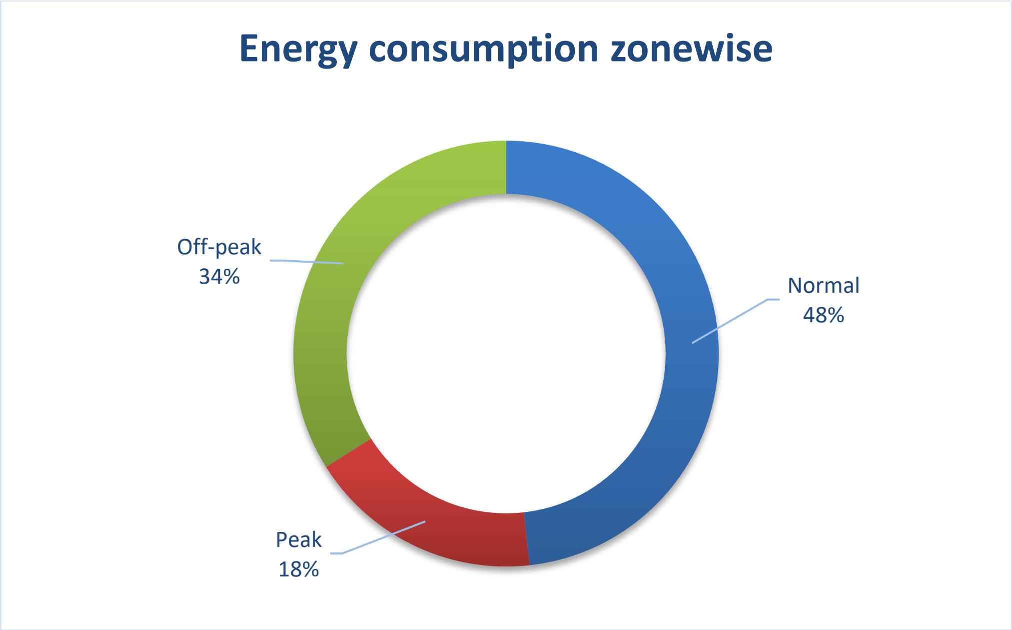
The average unit cost of electricity is **6.35 Rs/kWh**. This is taken as the basis for the financial analysis of electrical energy efficiency projects. The information on average energy consumption is taken from the historical electricity bill analysis. The electricity is fed from centralized substation. The Maximum demand observed during electricity bill analysis was 897 kVA.

Electricity Consumption

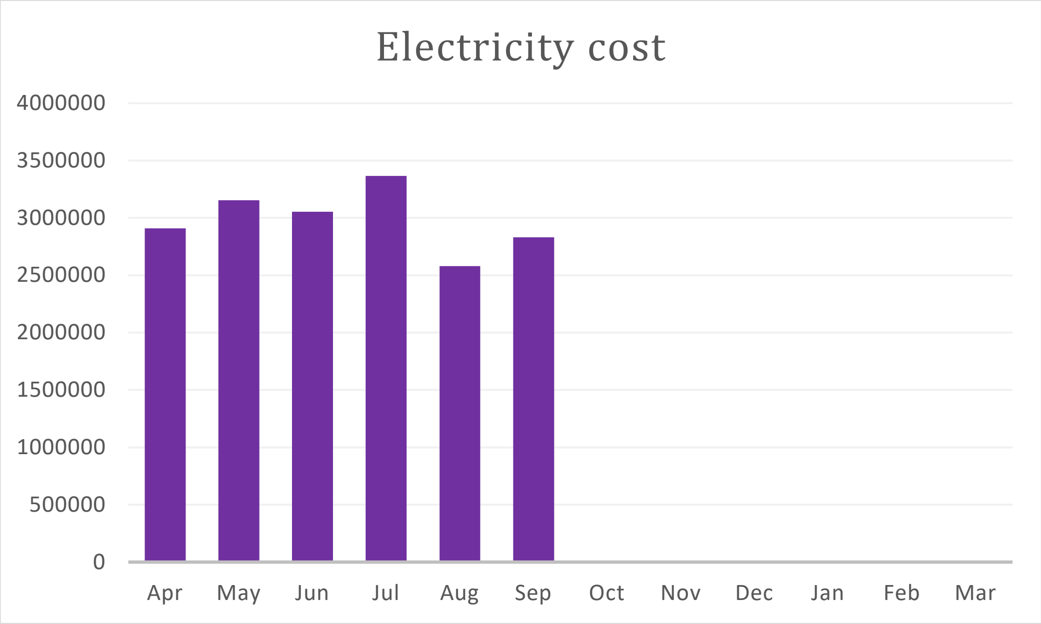
The Electricity consumption details for the financial year 2018-19 is plotted below. The average consumption for a month was found to be 471200 Units.



The Zone wise Energy Consumption Profile is shown below ,which shows 48% of total energy consumption in a day is at normal hours, 18% at peak hours and 34% at non peak hours.

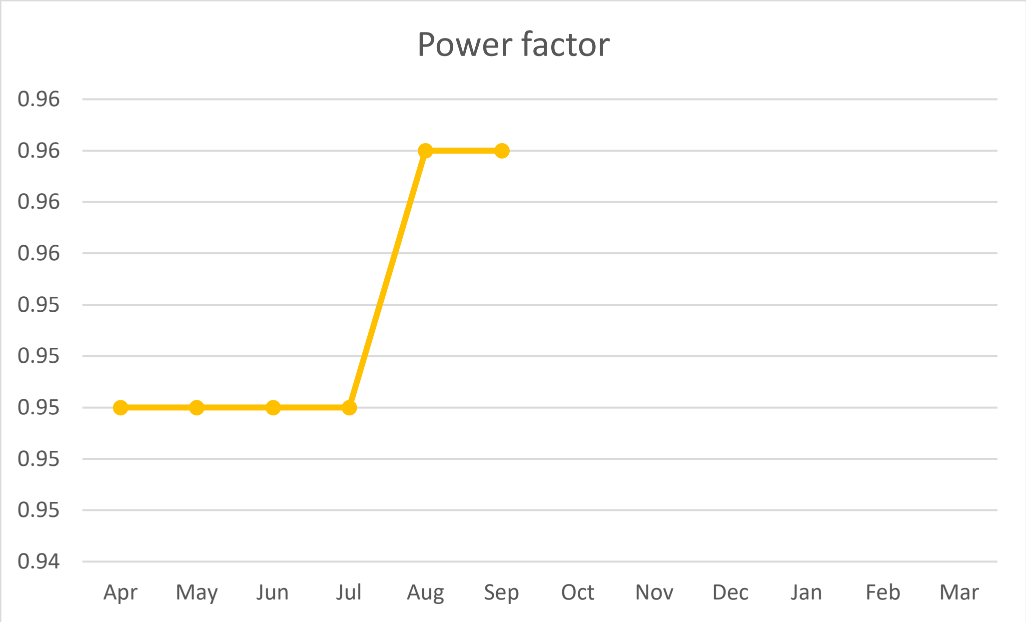


The electricity cost profile for the year 2019-20 is given below.


Electricity cost
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar

Power Factor

The average power factor observed is 0.95 which is very low. It is strongly recommended to add capacitors to improve power factor to unity. The power factor variation for the financial year 2019-20 is shown below.

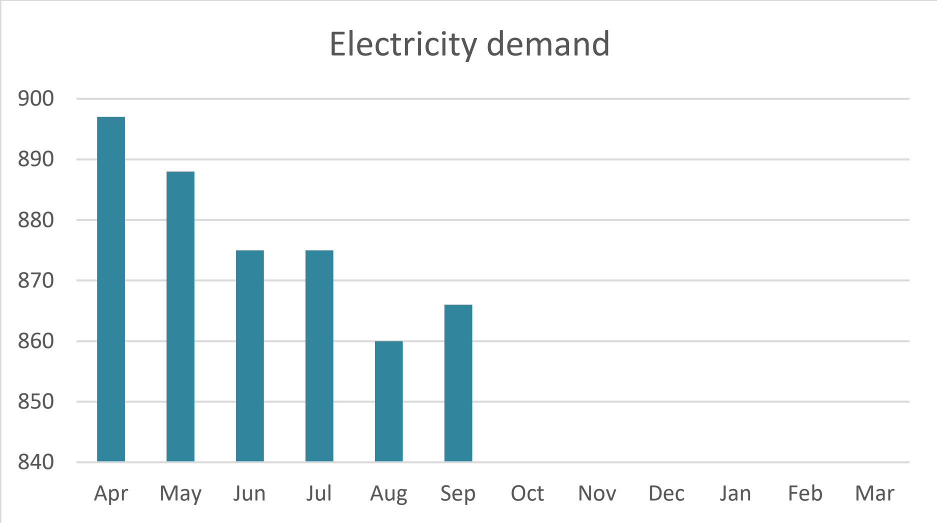


During load study it is observed that the power factor average is 0.93(see technical supplement)

Demand Control

The facility has a contract demand of 2994 kVA and 1887 kVA. As mentioned above the present average power factor of the plant is 0.93. The electricity demand variation for the financial year 2018-19 is shown below.

The demand can be controlled by improving power factor to unity.



5.2.2. Pumps

The list of pumps are given below.

Sl.No	Location		HP	Make	KW (Rated)	kW (Measured)	kVAR	kVA	Pf
1	RWPH	Motor No 1	150	Jyoti	110	78.0		82.5	0.95
2		Motor No 2	150	Jyoti	110	67.0		70.6	0.95
3		Motor No 3	150	Jyoti	110				
4	PWPH (Old)	Motor No 1	180		132				
5		Motor No 2	180		132				
6		Motor No 3	180		132	96.0		128.0	0.75
7		Motor No 4	150		125	102.0		136.0	0.75
8		Motor No 5	150		125				
9		Motor No 6	150		125				
10		Motor No 7	90		67	52.7		74.9	0.70
11		Motor No 8	90		67				
12	PWPH (New)	Motor No 1	180		132	64.0		67.3	0.95
13		Motor No 2	180		132	59.0		62.1	0.95
14		Motor No 3	180		132				

5.2.3. Lighting system

Lighting is one of the major electrical loads connected in the system. T12 and T8 tubes are extensively used in most of the areas and Sodium vapor, Fluorescent etc. in factory/ street lighting. Hardly any LED lights or tubes are used. This is a good component of the load of the facility and replacing these T12 & T 8 tubes with LED tubes can lead to a significant reduction in the load. Good lighting design can reduce costs and have the added benefit of decreasing internal heat gains, thus reducing the need for air conditioning too.

Sl.No.	Location	T12	CF	EF
1	Sand Filtration	32	6	1
2	Clorinator	7		
Total		**39**	**6**	**1**

All T8 and T12 Lamps shall be replaced with LED tubes or even T5 and the existing CFLs may be shifted to LED in phased manner. Since lighting does not have a separate feeder, the voltage stabilizer cannot be used specifically for this purpose.

Power Quality

Power quality is simply the interaction of electrical power with electrical equipment. If electrical equipment operates correctly and reliably without being damaged or stressed, we would say that the electrical power is of good quality. On the other hand, if the electrical equipment malfunctions, is unreliable, or is damaged during normal usage, we would suspect that the power quality is poor.

In any alternating current network, flow of current depends upon the voltage applied and the impedance (resistance to AC) provided by elements like resistances, reactance's of inductive and capacitive nature. Harmonics occurs as spikes at intervals which are multiples of the mains (supply) frequency and these distort the pure sine wave form of the supply voltage & current. The poor power quality end up with power loss.

Power system harmonic distortion is not a new phenomenon - efforts to limit it to acceptable proportions have been a concern of power engineers from the early days of utility systems. At that time, the distortion was typically caused by the magnetic saturation of transformers or by certain industrial loads, such as arc furnaces or arc welders. The major concerns were the effects of harmonics on synchronous and induction machines, telephone interference, and power capacitor failures. In the past, harmonic problems could often be tolerated because equipment was of conservative design and grounded wye-delta transformer connections were used judiciously.

Harmonic distortion

Harmonic distortion problems are not new to utility and industrial power systems. In fact, such distortion was observed by utility operating personnel as early as the first decade of this century. Typically, the distortion was caused by nonlinear loads connected to utility distribution systems. In addition to the increase in harmonic generators and network resonances, electric systems and loads have become no less, and in some cases even more, sensitive to harmonics. There are a number of areas of new and continuing concern

- Computers, computer-controlled machine tools, and various types of digital controllers are especially susceptible to harmonics, as well as to other types of interference.
- Harmonics can cause damaging dielectric heating in underground cables.
- Inductive metering can be adversely affected by harmonics.
- Capacitor bank failures are frequently caused by harmonics.
- Less conservative designs for rotating machines and transformers aggravate heating problems caused by harmonics.
- Harmonics can be especially troublesome to communication systems.

6

Energy efficiency in utility and process system

Specific Energy Consumption (SEC)

OTTOTRACTIONS- ENERGY AUDIT		
Energy Performance Index		
1	Total Production in (MLD)	27
2	Actual annual production M^3	9855000
3	Annual Electricity Consumption (kWh)	5654400
4	**Specific Energy Consumption kWh/m^3**	**0.57**
5	**Specific Energy Consumption m^3/kWh**	1.74

The Energy Performance Index (EPI)

0.57 kWh/m^3

This value may be taken as internal bench mark for future reference and improvement.

7

Evaluation of energy management system

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Energy management policy

There is no written energy policy available. A draft energy management policy is given below. The management may constitute an energy management policy and display the same in the plant to motivate the staff.

KERALA WATER AUTHORITY

PH DIVISION, KADUTHURUTHY

ENERGY POLICY

(Draft)

We are committed to optimally utilize various forms of energy in a cost effective manner to effect conservation of energy resources. We are committed to conserve the energy which is a scarce resource with the requisite consistency in the efficiency, effectiveness in the cost involved in the operations and ensuring that production quality and quantity, environment, safety, health of people are maintained. We are also committed to increase the renewable energy share of the total energy we use.

We are also committed to monitor continuously the saving achieved and reduce its specific energy consumption by minimum of 2% every year.

Date -----------------------

Head of the Institution

7.1. Energy management monitoring system

- **Energy Management Cell** has to be constituted with an objective to revise action plan for energy conservation thereby reducing the production cost.
- Energy conservation tips/ posters are displayed in crucial points.
- Use of renewable energy has to be encouraged.
- Flow meters and energy meters shall be installed in all major pumps. The meter reading shall be recorded in regular frequencies. It is recommended to install meters with communication capability to get real-time energy performance data and monitoring of pump performance.

7.2. Training to staff responsible for operational and Documentation.

- The staff need to be made more aware of the importance of energy saving and management.
- Log books shall be maintained to record Electricity Consumption and Diesel consumption.
- TOD reading shall be taken and compared with KSEB regularly.

7.3. Renewable Energy

- No renewable energy projects implemented.

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Energy Conservation Measures and Recommendations

8.1. Electrical System

- Electrical safety measures have to be implemented.
- As , all pure water and raw water pumps are operating 24hr a day, the scheduling may be done based on the performance test results given in the 5th chapter. The motors with combined efficiency near the design efficiency may be used for regular applications and the lowest performing pumps may be used as standby.
- As per the electrical load studies conducted the capacitance requirement in demand side (motor end) is 1920 kVAR, which may cost around 8 lakhs Rs. For PF improvement. This will help increasing the PF to unity and will get incentives for the same. The demand will also come down due to better power factor.
- **FCMA** starters are used here which are harmonic free, rugged magnetic soft **starters** for motor starting. **FCMA** is an acronym for flux compensated magnetic amplifier which is basically a modulated inductive impedance. When connected in series with the motor the **FCMA** reduces the starting current to a low value. It is advised to switch all the starters to FCMA to save energy as well as to improve Switch gears & starters,
- Sub meters with communication facility shall be implemented for the effective monitoring of energy and water (like SEC)
- Pumping machinery is subjected to wear & tear, erosion and corrosion due to its nature of functioning, and therefore it is vulnerable to failures. Generally, failures or interruptions are mostly attributed to pumping machinery rather than any other component. Therefore, correct operation and timely maintenance and upkeep of pumping stations and pumping machinery are of vital importance. Sudden failures can be avoided by timely inspection, follow up actions on observations of inspection and planned periodical maintenance. Downtime can be reduced by maintaining inventory of fast-moving spare parts. Obviously due attention needs to be paid to all such aspects for efficient and reliable functioning of pumping machinery.

- The carbon emission factor has been taken from the CO2 Baseline Database for the Indian Power Sector User Guide Version 14.0 December 2018 of Central Electricity Authority. The value take for southern grid is 0.83.
- The foundations, descaling of pipes etc. has to be checked regularly for optimizing the efficiency of the pumping system.

OTTOTRACTIONS- ENERGY AUDIT	
Energy Saving Proposal Code EA 586.01	
Energy Saving in Lighting by replacing existing 39 No's T12 Lamps to 18W LED Tube	
Existing Scenario	
There are 39 numbers of T12 lamps installed in this facility. During discussion with officers it is observed that the average utility of these fittings are of 80%.	
Proposed System	
The existing T12 may be replaced to LED tube of 18 W in phased manner and the savings will be of 67 % (inclusive of improved light output and reduced energy consumption)	
Financial Analysis	
Annual working hours (hr)	6570
No of fittings	39
Total load (kW)	2.15
Annual Energy Consumption (kWh)	11274
Expected Annual Energy saving for replacing all fittings (kWh)	6201
Cost of Power	6.35
Annual saving in Lakhs Rs (1st year)	0.39
Investment required for complete replacements [@Rs 350 per fittings](Lakhs Rs)	0.14
Simple Pay Back (in Months)	4.16

Energy Saving Calculation						
Energy Efficiency in Existing Pumping system by replacing inefficient motor (RWP 1)						
Sl No			Description	Unit	Existing System	New System
Design Parameters	Motors	1	Total number of motors to be replaced	1	Standard	IE2
		2	Rated load of the motor	kW	110	40
		3	Efficiency of standard motor	%	93	95
		4	Type of Motor		Standard	IE2
		5	Motor power	kW	78.33	26.80
		6	Efficiency	%	90	95
		7	Combined efficiency of the system (rated)	%	83.7	90
		8	Combined efficiency of the system (measured)	%	31	90
		9	**Head**	**m**	**13**	**13**
		10	**Flow**	**m^3/s**	**0.190**	**0.190**
		11	**Density of water**	**kg/m^3**	**1000**	**1000**
		12	**Gravitational Constant**	**m/s^2**	**9.81**	**9.81**
		13	**Hydraulic Power**	**kW**	**24.23**	**24.23**
	Input	14	Total Electrical Power drawn	kW	78.33	26.80
		15	Unit Cost	Rs./kWh	6.35	6.35
		16	Annual operating Hours	Hours	8760	8760
		17	Annual energy consumption	kWh/year	686171	234768
		18	Annual power Savings, kWh	kWh		451403
		19	Annual Savings	Rs. In Lakhs		**28.66**
		20	Investment for Pumps (as per KWA guideline @15525 per hp)	Rs/kW		20500
		21	Proposed pump load	kW		**40.20**
		22	Investment	Rs. In Lakhs		**8.24**
		23	Simple Payback period	**Months**		**3.45**

Energy Saving Calculation						
Energy Efficiency in Existing Pumping system by replacing inefficient motor (RWP2)						
Sl No			Description	Unit	Old System	New System
Design Parameters	Motors	1	Total number of motors to be replaced	1	Standard	IE2
		2	Rated load of the motor	kW	110	45
		3	Efficiency of standard motor	%	93	95
		4	Type of Motor		Standard	IE2
		5	Motor power	kW	67.14	29.70
		6	Efficiency	%	90	95
		7	Combined efficiency of the system (rated)	%	84	90.25
		8	Combined efficiency of the system (measured)	%	40	90.25
		9	**Head**	**m**	**13**	**13**
		10	**Flow**	**m^3/s**	**0.210**	**0.210**
		11	**Density of water**	**kg/m^3**	**1000**	**1000**
		12	**Gravitational Constant**	**m/s^2**	**9.81**	**9.81**
		13	**Hydraulic Power**	**kW**	**26.78**	**26.78**
	Input	14	Total Electrical Power drawn	kW	67.14	29.70
		15	Unit Cost	Rs./kWh	6.35	6.35
		16	Annual operating Hours	Hours	8760	8760
		17	Annual energy consumption	kWh/year	588146	260172
		18	Annual power Savings, kWh	kWh		327974
		19	Annual Savings	Rs. In Lakhs		**20.83**
		20	Investment for Pumps (as per KWA guideline @15525 per hp)	Rs/kW		20500
		21	Proposed pump load	kW		**44.55**
		22	Investment	Rs. In Lakhs		**9.13**
		23	Simple Payback period	**Months**		**5.26**

Energy Saving Calculation							
Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 1)							
Sl No			Description	Unit	Old System	New System
Design Parameters	Motors	1	Total number of motors to be replaced	1	Standard	IE2
		2	Rated load of the motor	kW	132	69
		3	Efficiency of standard motor	%	93	95
		4	Type of Motor		Standard	IE2
		5	Motor power	kW	64.00	45.70
		6	Efficiency	%	90	95
		7	Combined efficiency of the system (rated)	%	84	90.25
		8	Combined efficiency of the system (measured)	%	64	90.25
		9	**Head**	**m**	**70**	**70**
		10	**Flow**	**m^3/s**	**0.060**	**0.060**
		11	**Density of water**	**kg/m^3**	**1000**	**1000**
		12	**Gravitational Constant**	**m/s^2**	**9.81**	**9.81**
		13	**Hydraulic Power**	**kW**	**41.20**	**41.20**
	Input	14	Total Electrical Power drawn	kW	64.00	45.70
		15	Unit Cost	Rs./kWh	6.35	6.35
		16	Annual operating Hours	Hours	8760	8760
		17	Annual energy consumption	kWh/year	560640	400332
		18	Annual power Savings, kWh	kWh		160308
		19	Annual Savings	Rs. In Lakhs		**10.18**
		20	Investment for Pumps (as per KWA guideline @15525 per hp)	Rs/kW		20500
		21	Proposed pump load	kW		**68.55**
		22	Investment	Rs. In Lakhs		**14.05**
		23	Simple Payback period	**Months**		**16.57**

Energy Saving Calculation						
Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 2)						
Sl No			Description	Unit	Old System	New System
Design Parameters	Motors	1	Total number of motors to be replaced	1	Standard	IE2
		2	Rated load of the motor	kW	132	51
		3	Efficiency of standard motor	%	93	95
		4	Type of Motor		Standard	IE2
		5	Motor power	kW	59.00	34.20
		6	Efficiency	%	90	95
		7	Combined efficiency of the system (rated)	%	84	90.25
		8	Combined efficiency of the system (measured)	%	52	90.25
		9	**Head**	**m**	**70**	**70**
		10	**Flow**	**m^3/s**	**0.045**	**0.045**
		11	**Density of water**	**kg/m^3**	**1000**	**1000**
		12	**Gravitational Constant**	**m/s^2**	**9.81**	**9.81**
		13	**Hydraulic Power**	**kW**	**30.90**	**30.90**
	Input	14	Total Electrical Power drawn	kW	59.00	34.20
		15	Unit Cost	Rs./kWh	6.35	6.35
		16	Annual operating Hours	Hours	8760	8760
		17	Annual energy consumption	kWh/year	516840	299592
		18	Annual power Savings, kWh	kWh		217248
		19	Annual Savings	Rs. In Lakhs		**13.80**
		20	Investment for Pumps (as per KWA guideline @15525 per hp)	Rs/kW		20500
		21	Proposed pump load	kW		**51.30**
		22	Investment	Rs. In Lakhs		**10.52**
		23	Simple Payback period	**Months**		**9.15**

Energy Saving Calculation

Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 3)

Sl No			Description	Unit	Old System	New System
Design Parameters	Motors	1	Total number of motors to be replaced	1	Standard	IE2
		2	Rated load of the motor	kW	132	50
		3	Efficiency of standard motor	%	93	95
		4	Type of Motor		Standard	IE2
		5	Motor power	kW	96.97	33.30
		6	Efficiency	%	90	95
		7	Combined efficiency of the system (rated)	%	84	90.25
		8	Combined efficiency of the system (measured)	%	31	90.25
		9	**Head**	**m**	**73**	**73**
		10	**Flow**	**m^3/s**	**0.042**	**0.042**
		11	**Density of water**	**kg/m^3**	**1000**	**1000**
		12	**Gravitational Constant**	**m/s^2**	**9.81**	**9.81**
		13	**Hydraulic Power**	**kW**	**30.08**	**30.08**
	Input	14	Total Electrical Power drawn	kW	96.97	33.30
		15	Unit Cost	Rs./kWh	6.35	6.35
		16	Annual operating Hours	Hours	8760	8760
		17	Annual energy consumption	kWh/year	849457	291708
		18	Annual power Savings, kWh	kWh		557749
		19	Annual Savings	Rs. In Lakhs		**35.42**
		20	Investment for Pumps (as per KWA guideline @15525 per hp)	Rs/kW		20500
		21	Proposed pump load	kW		**49.95**
		22	Investment	Rs. In Lakhs		**10.24**
		23	Simple Payback period	**Months**		**3.47**

Energy Saving Calculation						
Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 4)						
Sl No			Description	Unit	Old System	New System
Design Parameters	Motors	1	Total number of motors to be replaced	1	Standard	IE2
		2	Rated load of the motor	kW	132	49
		3	Efficiency of standard motor	%	93	95
		4	Type of Motor		Standard	IE2
		5	Motor power	kW	102.00	32.50
		6	Efficiency	%	90	95
		7	Combined efficiency of the system (rated)	%	84	90.25
		8	Combined efficiency of the system (measured)	%	29	90.25
		9	**Head**	**m**	**73**	**73**
		10	**Flow**	**m^3/s**	**0.041**	**0.041**
		11	**Density of water**	**kg/m^3**	**1000**	**1000**
		12	**Gravitational Constant**	**m/s^2**	**9.81**	**9.81**
		13	**Hydraulic Power**	**kW**	**29.36**	**29.36**
	Input	14	Total Electrical Power drawn	kW	102.00	32.50
		15	Unit Cost	Rs./kWh	6.35	6.35
		16	Annual operating Hours	Hours	8760	8760
		17	Annual energy consumption	kWh/year	893520	284700
		18	Annual power Savings, kWh	kWh		608820
		19	Annual Savings	Rs. In Lakhs		**38.66**
		20	Investment for Pumps (as per KWA guideline @15525 per hp)	Rs/kW		20500
		21	Proposed pump load	kW		**48.75**
		22	Investment	Rs. In Lakhs		**9.99**
		23	Simple Payback period	**Months**		**3.10**

Energy Saving Calculation						
Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 6)						
Sl No			Description	Unit	Old System	New System
Design Parameters	Motors	1	Total number of motors to be replaced	1	Standard	IE2
		2	Rated load of the motor	kW	67	42
		3	Efficiency of standard motor	%	93	95
		4	Type of Motor		Standard	IE2
		5	Motor power	kW	52.70	27.80
		6	Efficiency	%	90	95
		7	Combined efficiency of the system (rated)	%	84	90.25
		8	Combined efficiency of the system (measured)	%	48	90.25
		9	**Head**	**m**	**73**	**73**
		10	**Flow**	**m^3/s**	**0.035**	**0.035**
		11	**Density of water**	**kg/m^3**	**1000**	**1000**
		12	**Gravitational Constant**	**m/s^2**	**9.81**	**9.81**
		13	**Hydraulic Power**	**kW**	**25.06**	**25.06**
	Input	14	Total Electrical Power drawn	kW	52.70	27.80
		15	Unit Cost	Rs./kWh	6.35	6.35
		16	Annual operating Hours	Hours	8760	8760
		17	Annual energy consumption	kWh/year	461652	243528
		18	Annual power Savings, kWh	kWh		218124
		19	Annual Savings	Rs. In Lakhs		**13.85**
		20	Investment for Pumps (as per KWA guideline @15525 per hp)	Rs/kW		20500
		21	Proposed pump load	kW		**41.70**
		22	Investment	Rs. In Lakhs		**8.55**
		23	Simple Payback period	**Months**		**7.41**

OTTOTRACTIONS- ENERGY AUDIT						
KWA PUMPING STATION, KADUTHURUTHY						
Greenhouse Gas Mitigation through Major Energy Efficiency Projects						
Sl No	Projects	Energy saved(Yearly)		Sustainability (Years)	First year ton of CO2 mitigated	Expected Tons of CO2 mitigated through out life cycle
		(kWh)	MWh	Years		
1	Energy Saving in Lighting by replacing existing 39 No's T12 Lamps to 18W LED Tube	11274	11.27	10	8.23	82.30
2	Energy Efficiency in Existing Pumping system by replacing inefficient motor (RWP 1)	451403	451.40	10	329.52	3295.24
3	Energy Efficiency in Existing Pumping system by replacing inefficient motor (RWP2)	327974	327.97	10	239.42	2394.21
4	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 1)	160308	160.31	10	117.02	1170.25
5	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 2)	217248	217.25	10	158.59	1585.91
6	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 3)	557749	557.75	10	407.16	4071.57
7	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 4)	608820	608.82	10	444.44	4444.39
8	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 6)	218124	218.12	10	159.23	1592.31
Total		950959.32	950.96	10.00	694.20	6942.00

OTTOTRACTIONS- ENERGY AUDIT			
Implementation Schedule			
KWA PUMPING STATION, KADUTHURUTHY			
Sl No	Projects	SPB	Implementation Schedule
1	Energy Saving in Lighting by replacing existing 39 No's T12 Lamps to 18W LED Tube	4.16	Medium Term
2	Energy Efficiency in Existing Pumping system by replacing inefficient motor (RWP 1)	3.45	Medium Term
3	Energy Efficiency in Existing Pumping system by replacing inefficient motor (RWP2)	5.26	Medium Term
4	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 1)	16.57	Medium Term
5	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 2)	9.15	Medium Term
6	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 3)	3.47	Medium Term
7	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 4)	3.10	Medium Term
8	Energy Efficiency in Existing Pumping system by replacing inefficient motor (PWP 6)	7.41	Medium Term

SPB (Simple Payback) in months

9

Technical Supplement

Electricity Bill Details (2018-2019)													
Month	Name of the Consumer				KWA PH Subdivision, Kaduthuruthy								
	Contract demnad (kVA)		1127 kVA		Consumer number & Section			1346500013783					
	Tariff		HT I (A) INDUSTRIAL					Kaloor					
	kWh				kVA			PF	Power factor		` (Total)	`/kwh	
	Z1	Z2	Z3	Total	Z1	Z2	Z3		Penalty	Incentive			
Apr-18													
May-18													
Jun-18													
Jul-18													
Aug-18													
Sep-18													
Oct-18	226320	71210	125250	422780	866	823	849	0.95		58132	2648172	**6.26**	
Nov-18	211780	69550	128345	409675	877	886	797	0.95		56330	2575342	**6.29**	
Dec-18	228645	77520	135960	442125	874	783	769	0.94		48633	2700519	**6.11**	
Jan-19	231705	78210	131985	441900	864	875	868	0.94		48609	2699578	**6.11**	
Feb-19	200700	73530	129255	403485	874	875	871	0.94		44383	2487719	**6.17**	
Mar-19	247635	82200	168690	498525	891	880	877	0.94		54837	3016965	**6.05**	

Electricity Bill Details (2019-2020)												
Month	Name of the Consumer				KWA PH Subdivision, Kaduthuruthy							
	Contract demnad (kVA)		1127 kVA		Consumer number & Section			1346500013783				
	Tariff		HT I (A) INDUSTRIAL					Kaloor				
	kWh				kVA			PF	Power factor		` (Total)	`/kwh
	Z1	Z2	Z3	Total	Z1	Z2	Z3		Penalty	Incentive		
Apr	234675	72510	173685	480870	897	878	892	0.95		66119	2907874	**6.05**
May	250245	89595	186195	526035	888	886	882	0.95		72329	3153317	**5.99**
Jun	222810	82425	159885	465120	875	872	868	0.95		63954	3052482	**6.56**
Jul	249255	100785	179985	530025	875	873	874	0.95		13422	3365402	**6.35**
Aug	184095	78270	128880	391245	860	859	858	0.96		11248	2580056	**6.59**
Sep	222660	80445	130800	433905	866	861	860	0.96		12474	2831157	**6.52**
Oct				0								
Nov				0								
Dec				0								
Jan				0								
Feb				0								
Mar				0								

HIOKI 9624-50 PQA-HiVIEW PRO	Time Plot Graph Measurement from a HIOKI 3197 PQA	13-09-2020 D:\OT ABIN AUG 2019\Ongoing\EA\KWA HT\EA 586 PS Kadthuruthy\Load study\Tr-1 Mains\B0012301

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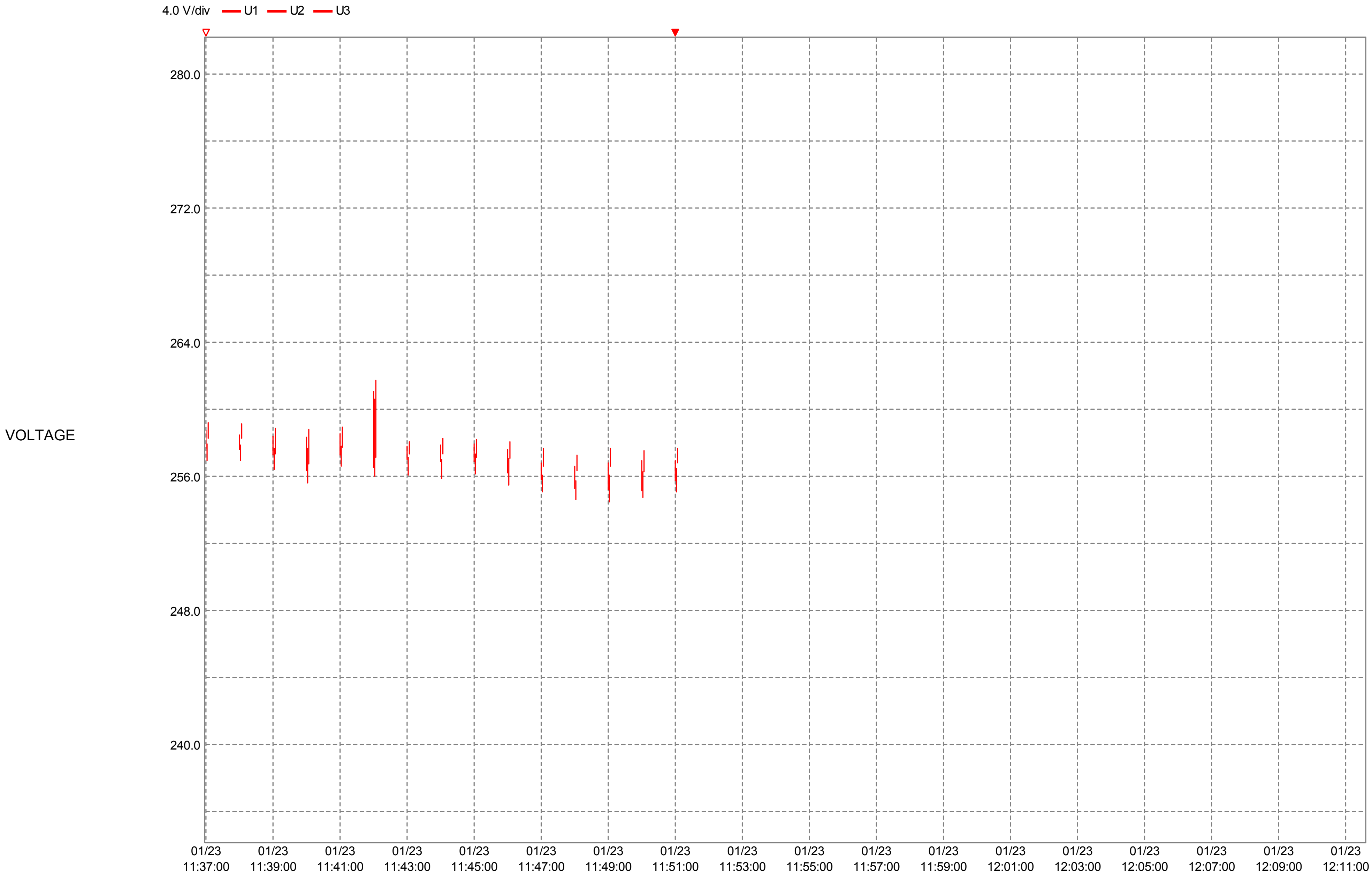

HIOKI 9624-50 PQA-HiVIEW PRO	Time Plot Graph Measurement from a HIOKI 3197 PQA	13-09-2020 D:\OT ABIN AUG 2019\Ongoing\EA\KWA HT\EA 586 PS Kadthuruthy\Load study\Tr-1 Mains\B0012301

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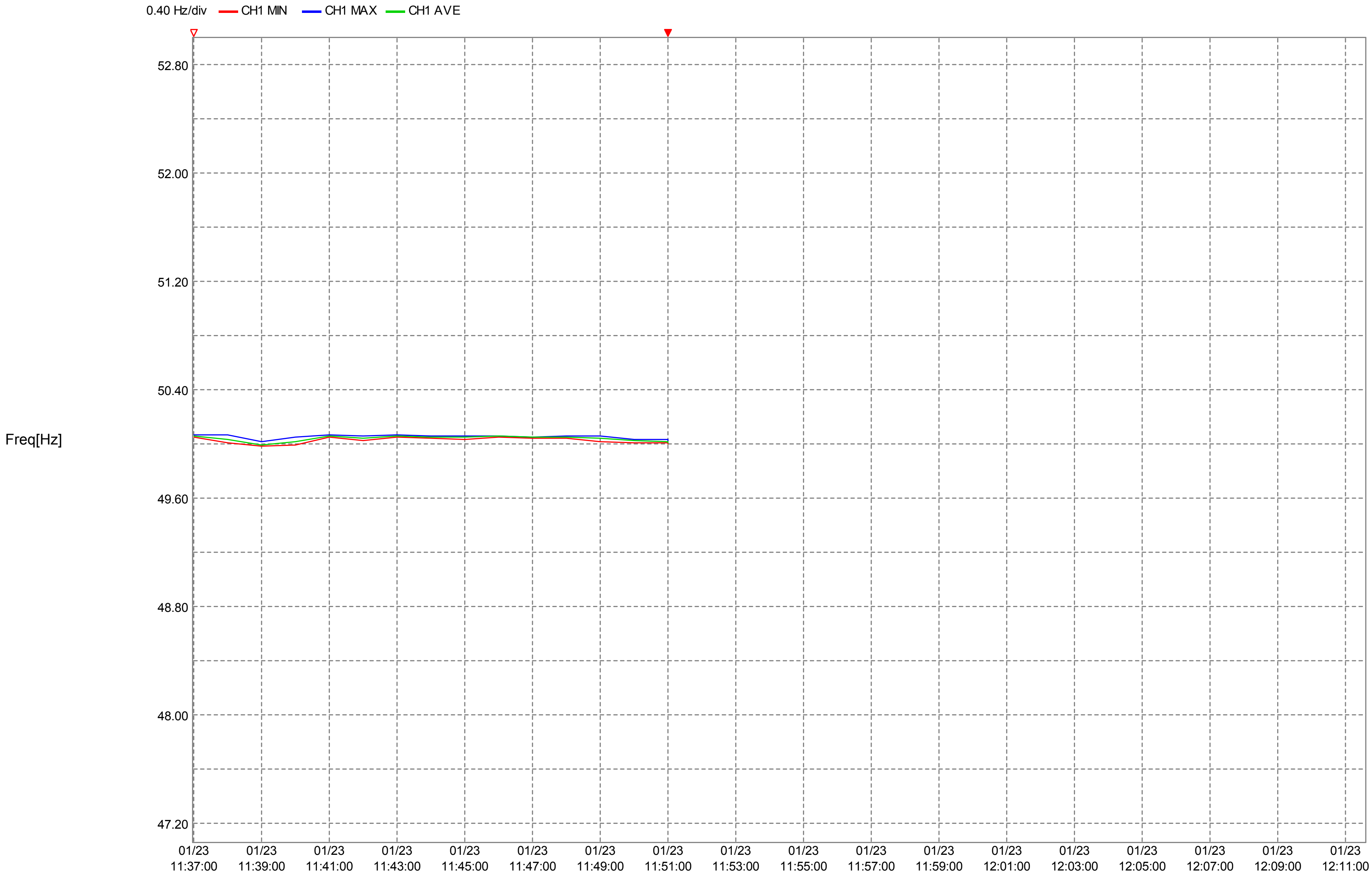

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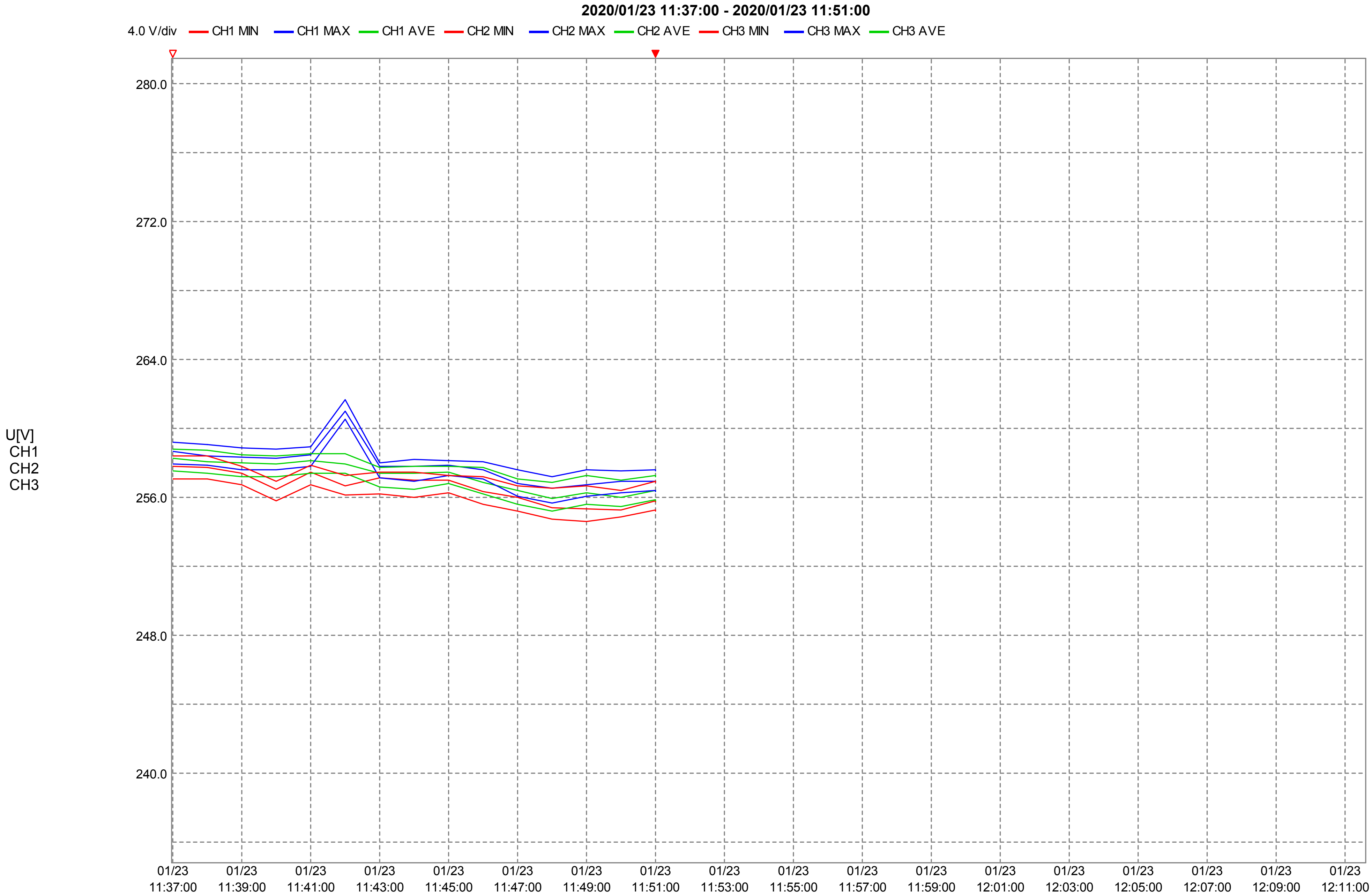

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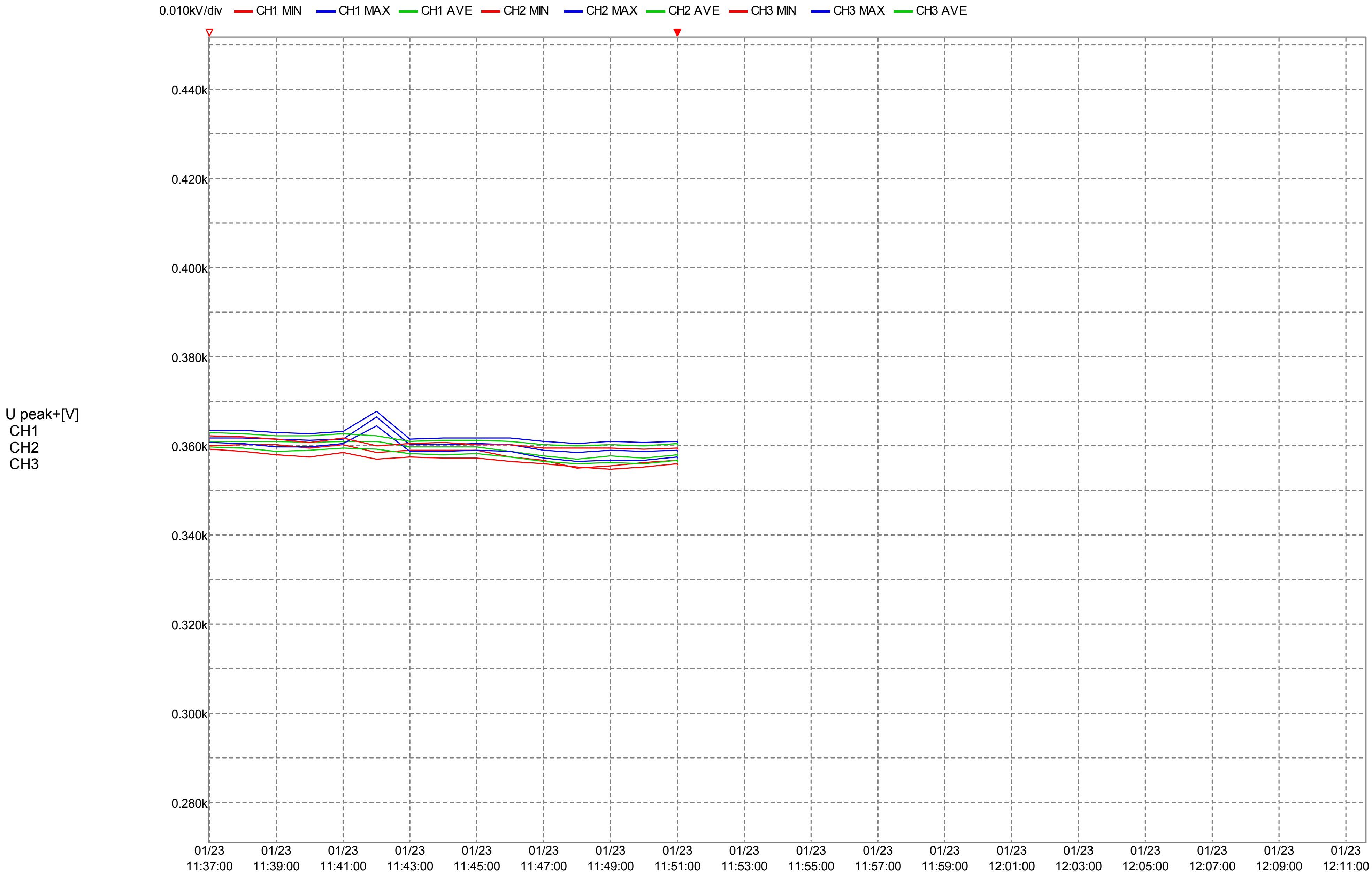

HIOKI
9624-50 PQA-HiVIEW PRO

Time Plot Graph

Measurement from a HIOKI 3197 PQA

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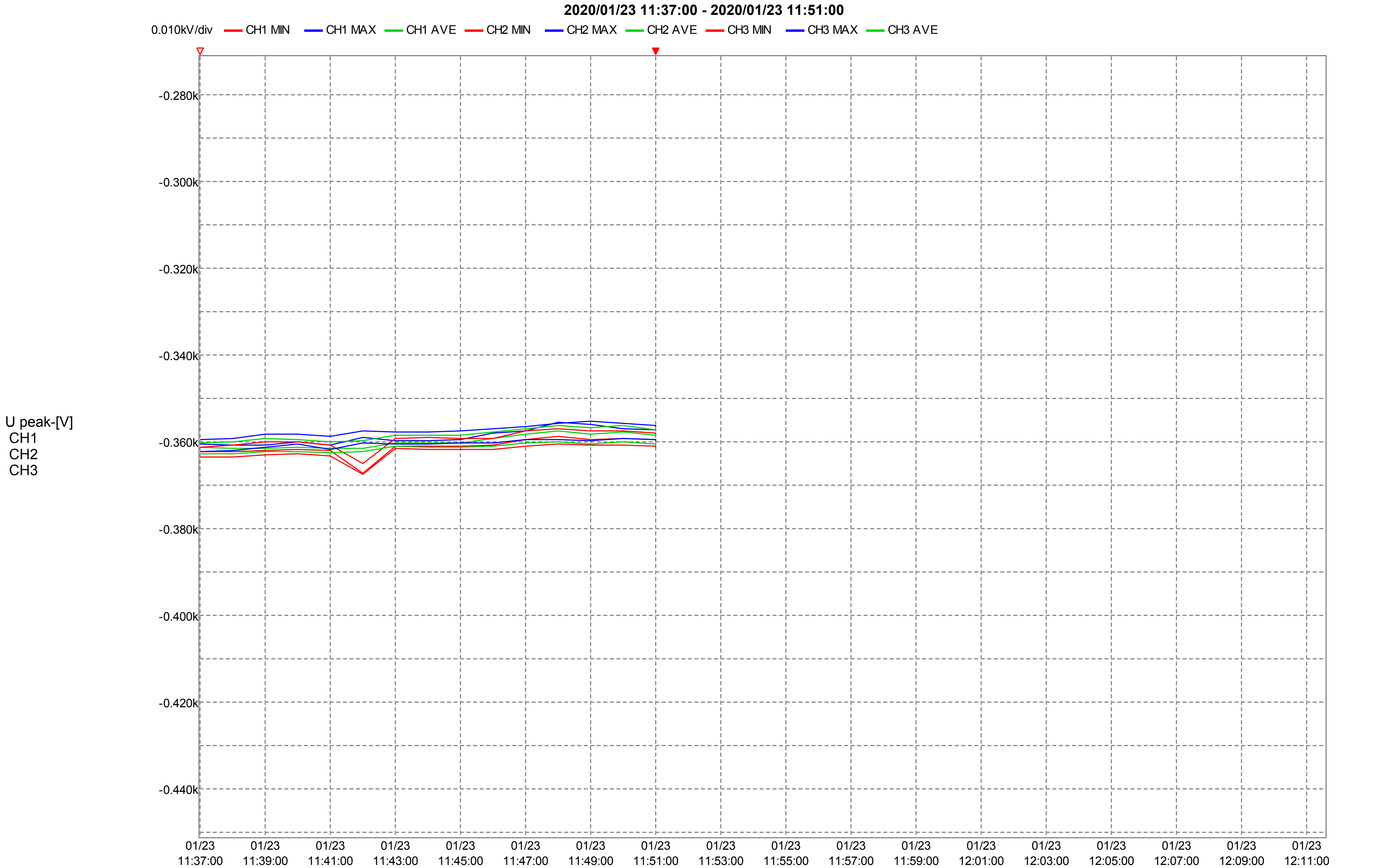

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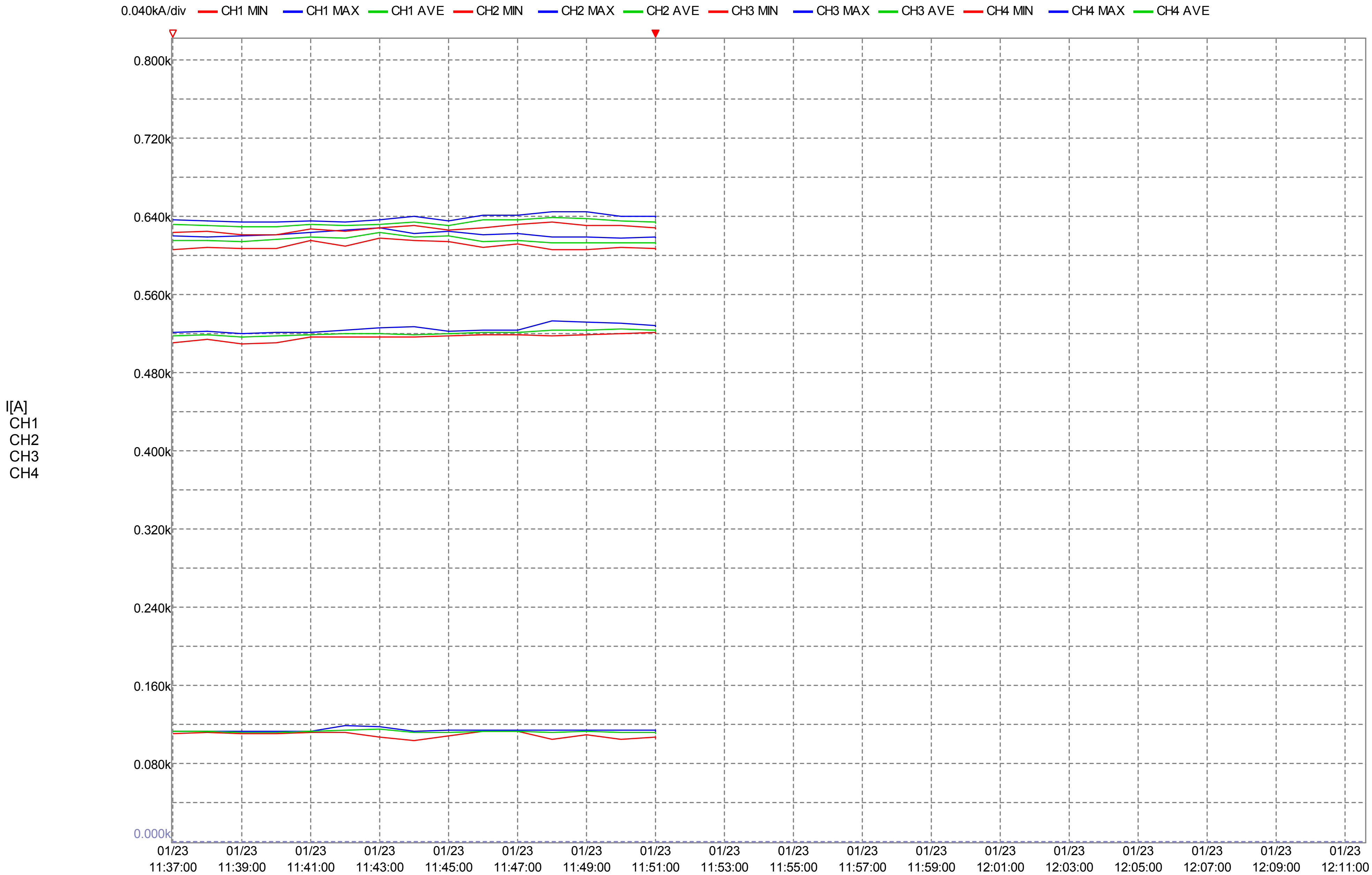

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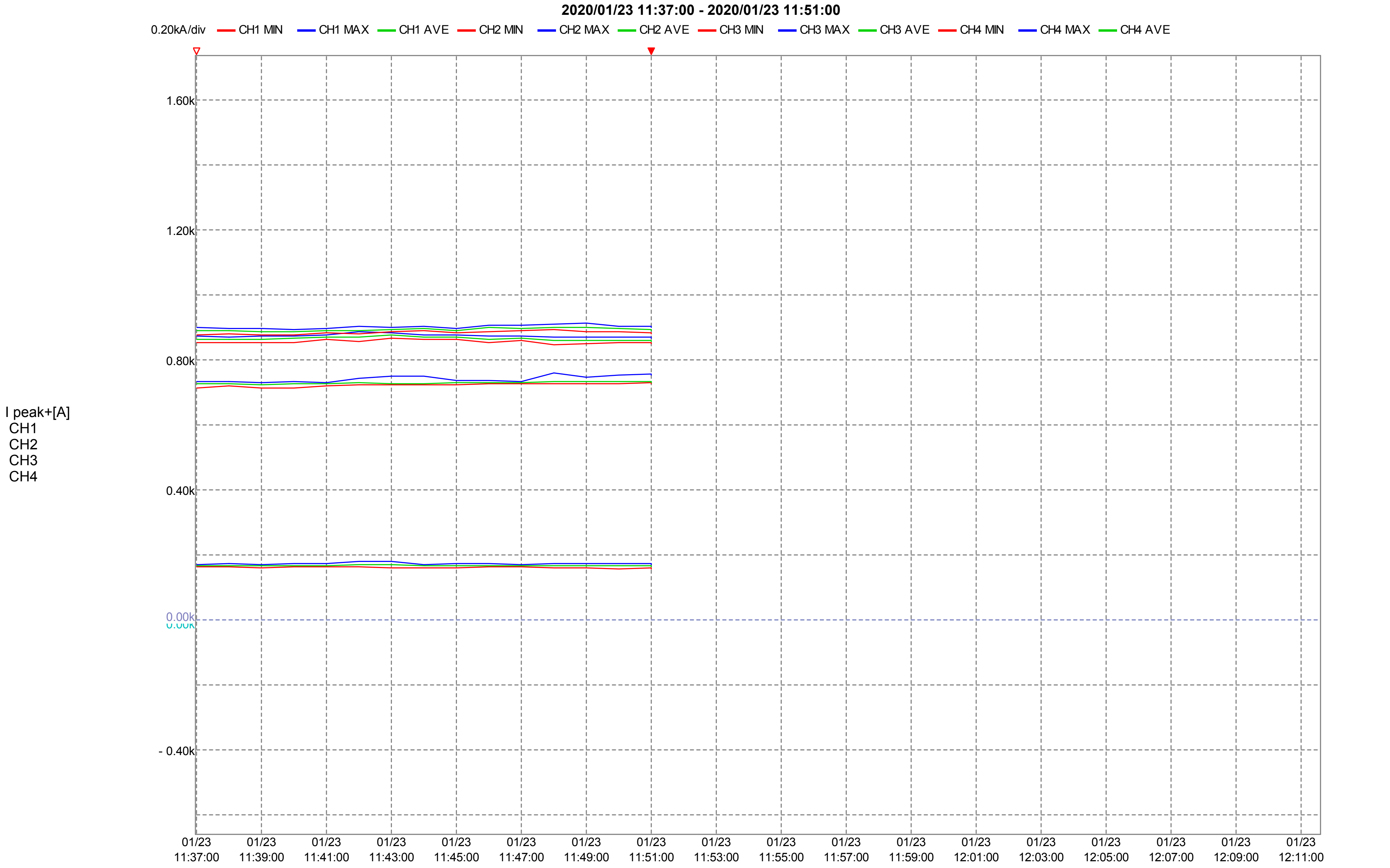

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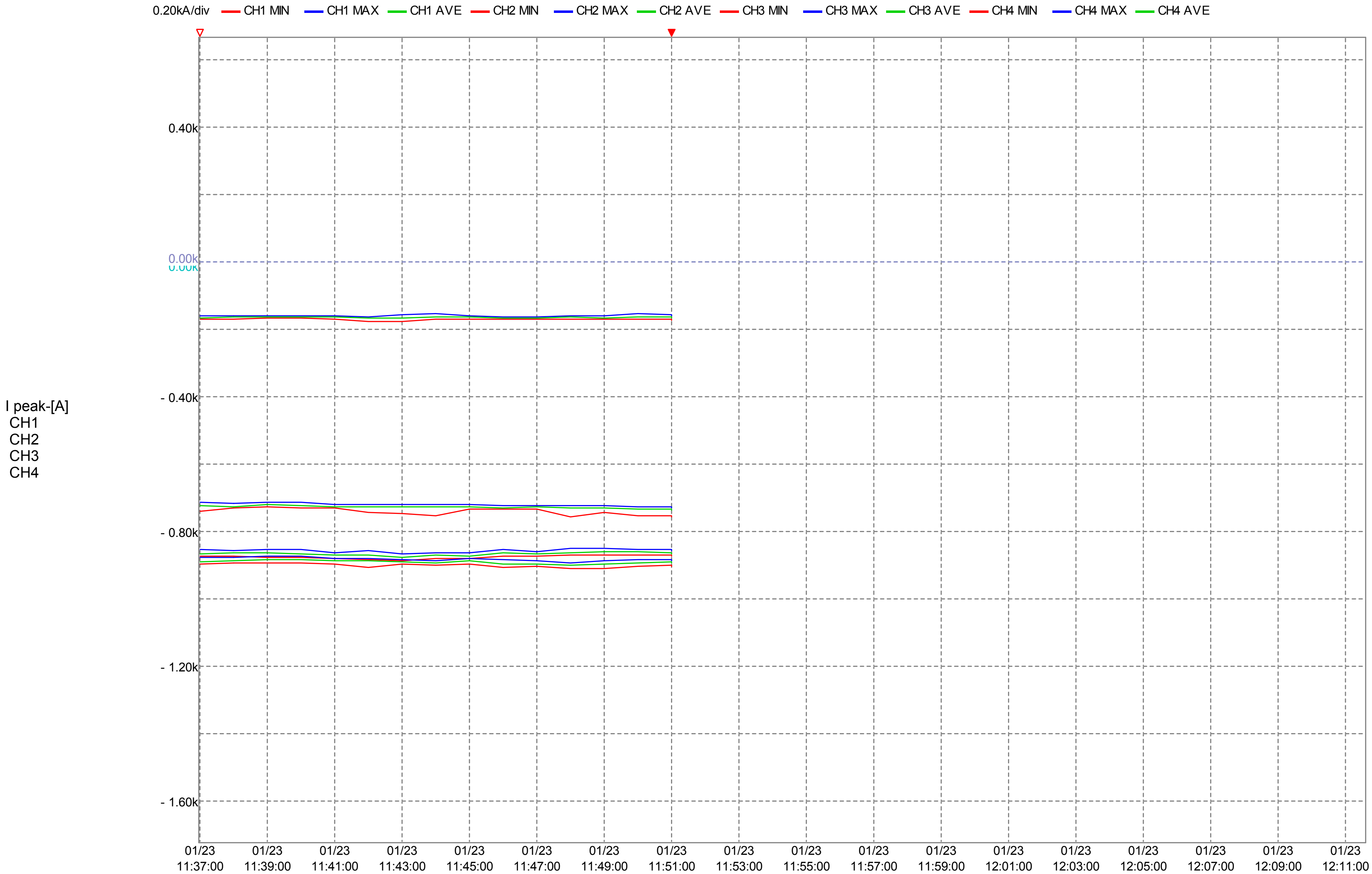

9624-50 PQA-HiVIEW PRO

Time Plot Graph

Measurement from a HIOKI 3197 PQA

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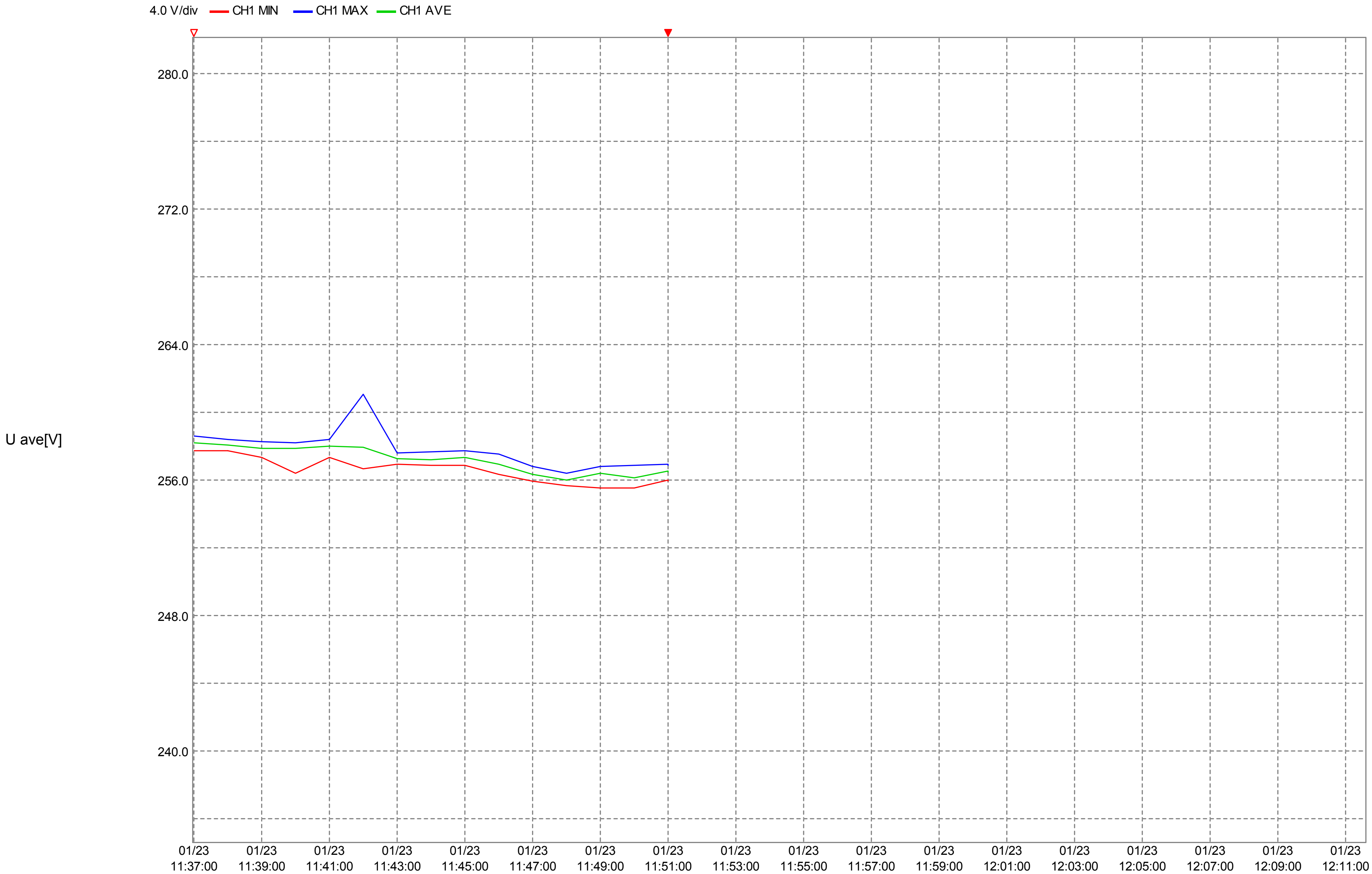

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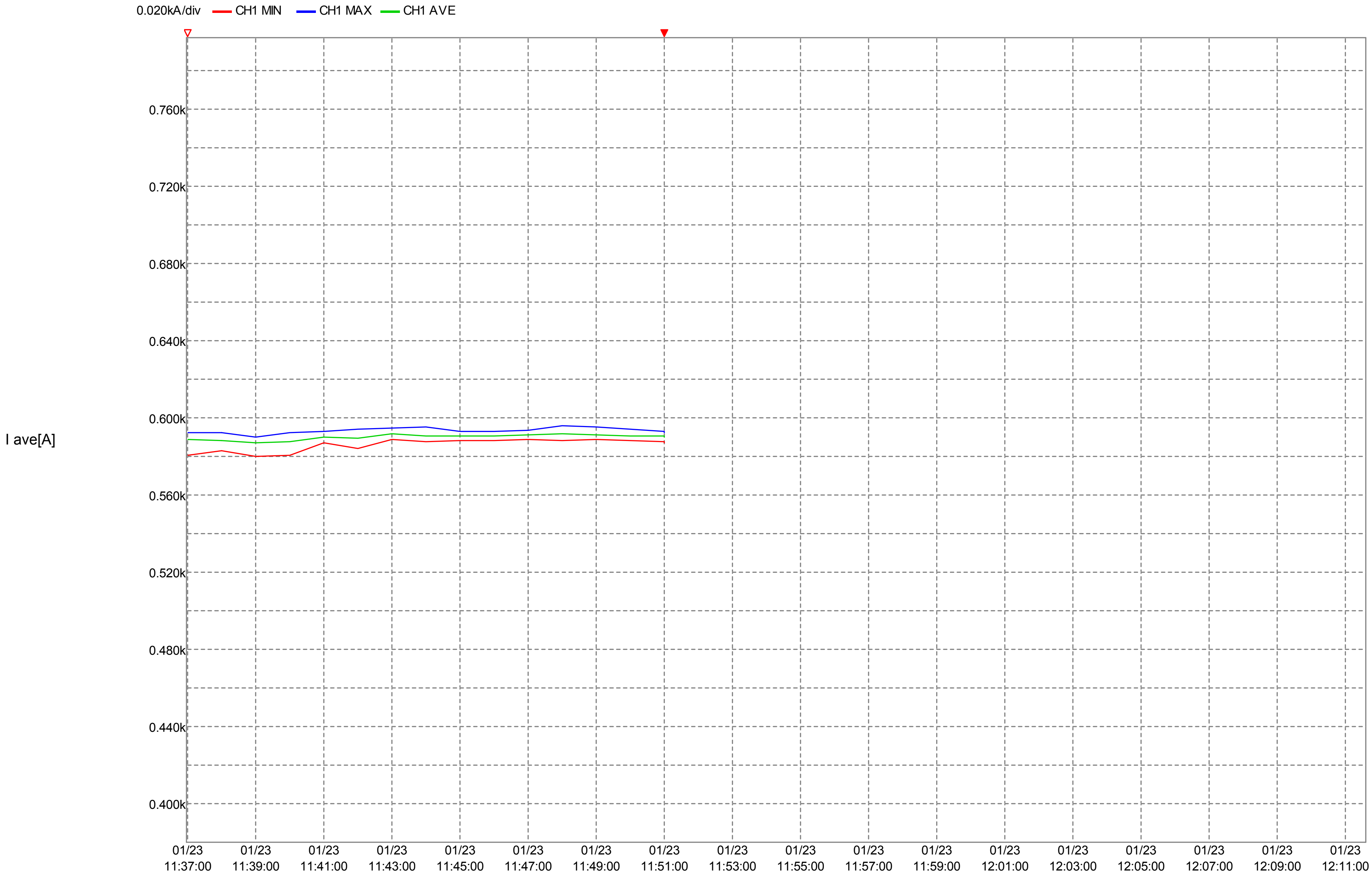

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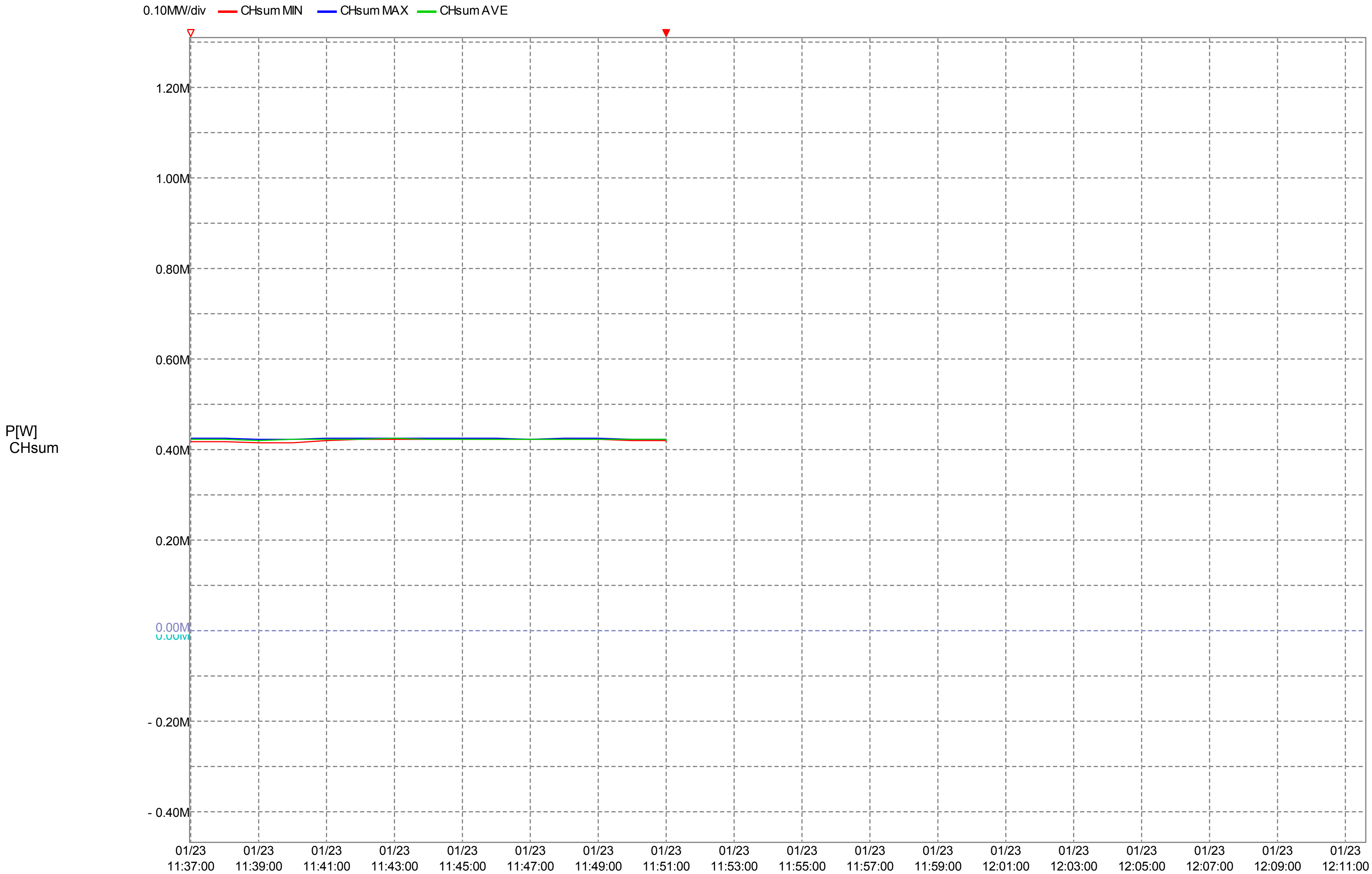

9624-50 PQA-HiVIEW PRO

Time Plot Graph

Measurement from a HIOKI 3197 PQA

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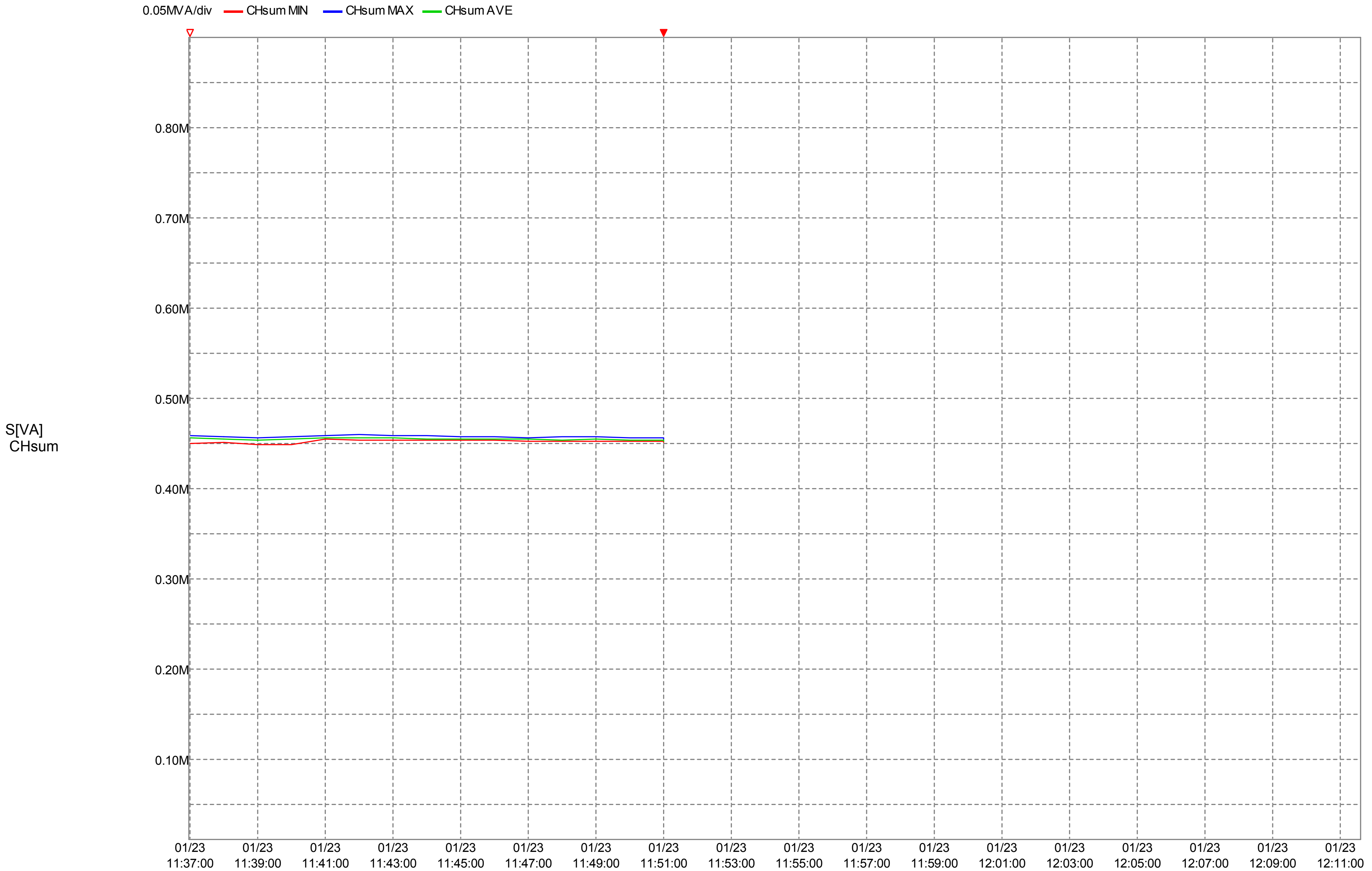

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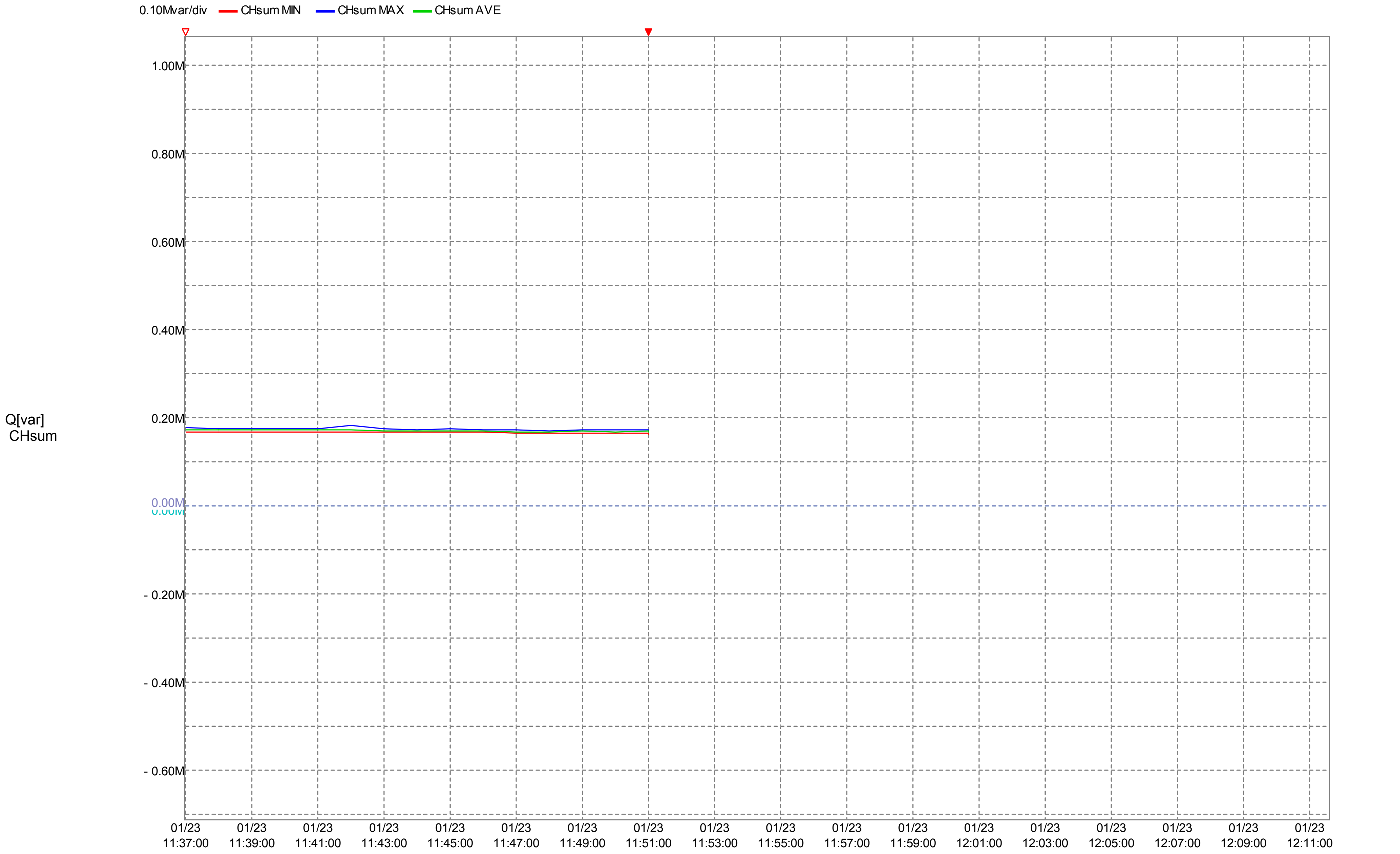

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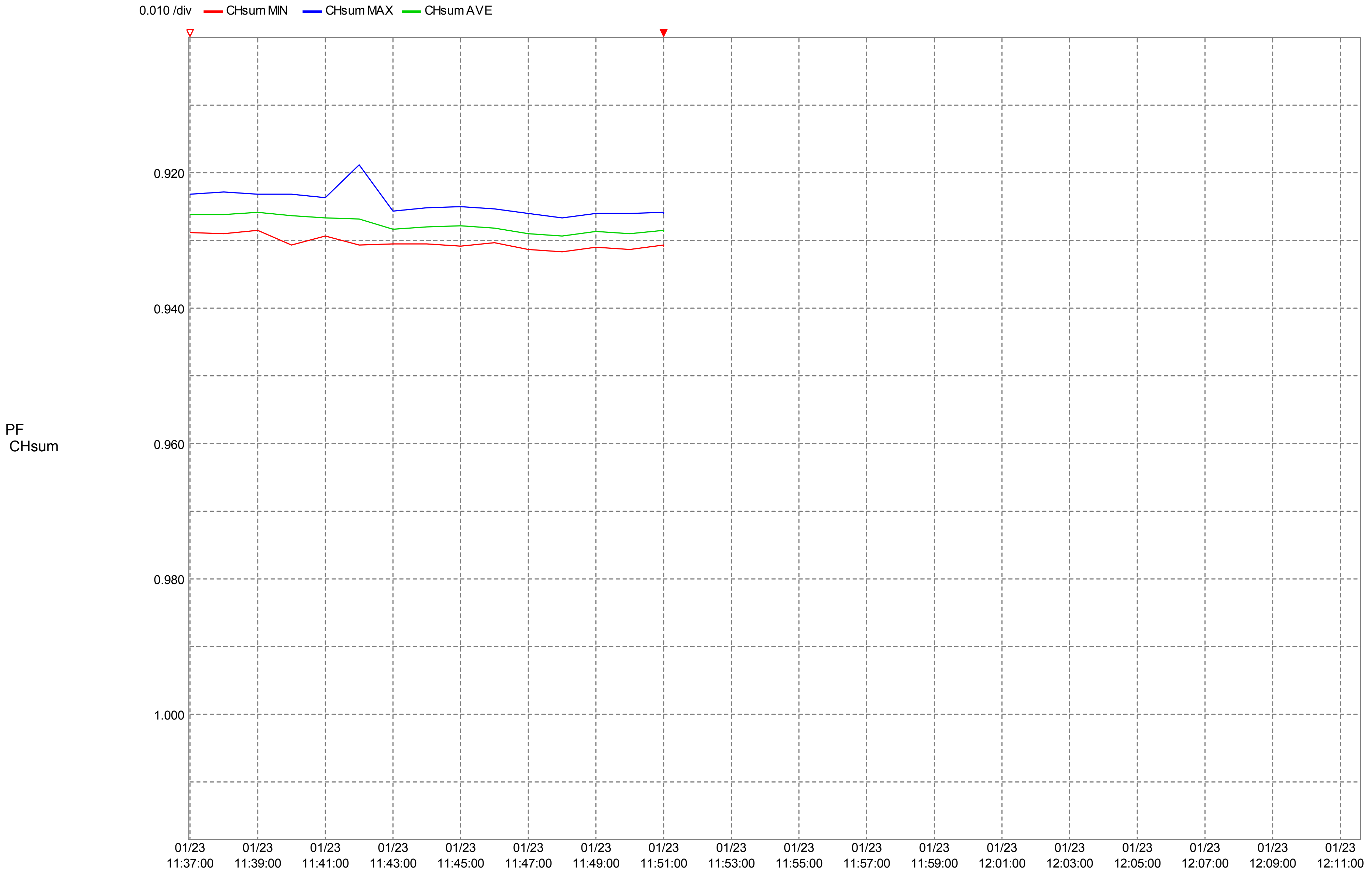

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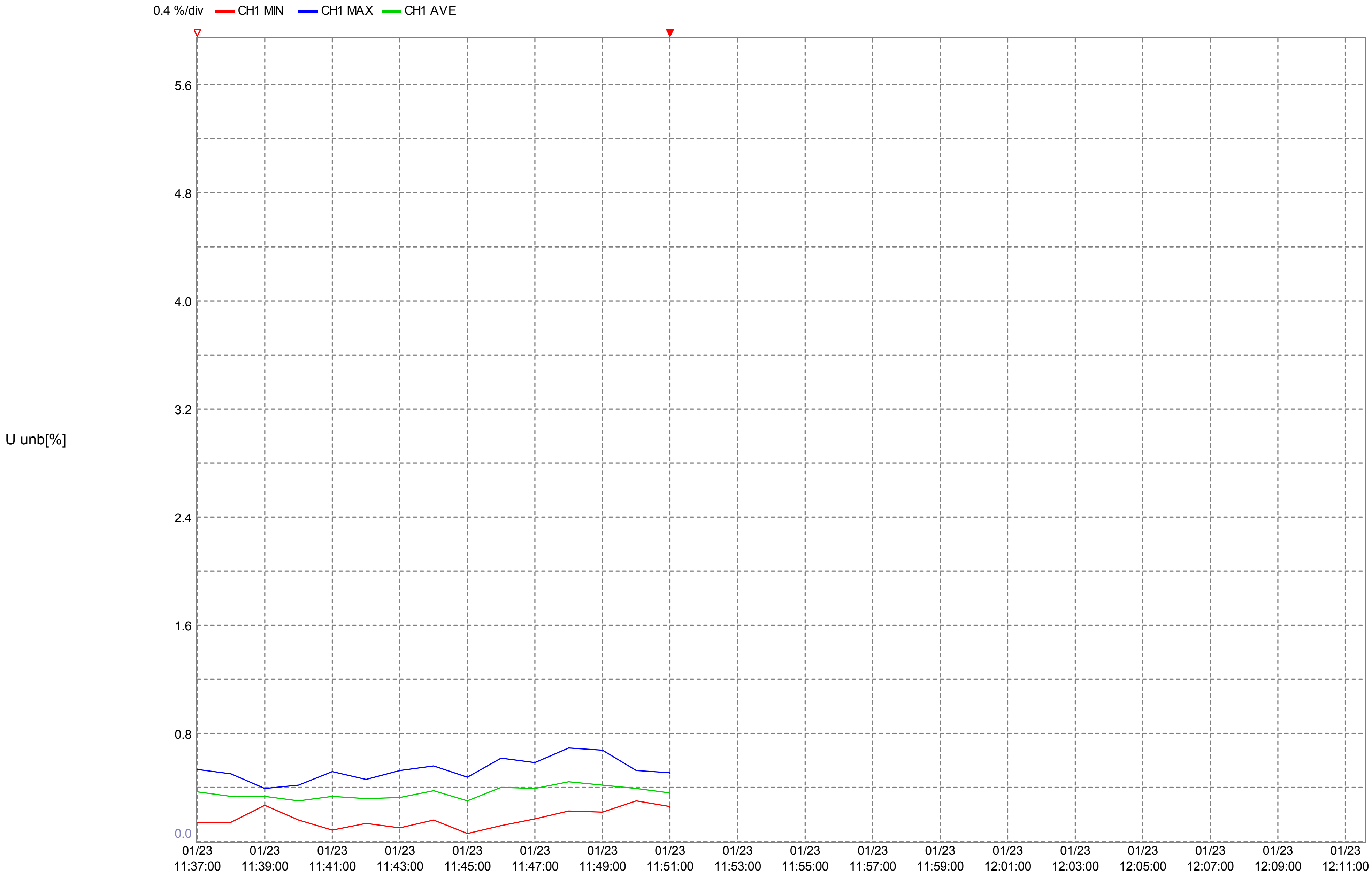

9624-50 PQA-HiVIEW PRO

Time Plot Graph

Measurement from a HIOKI 3197 PQA

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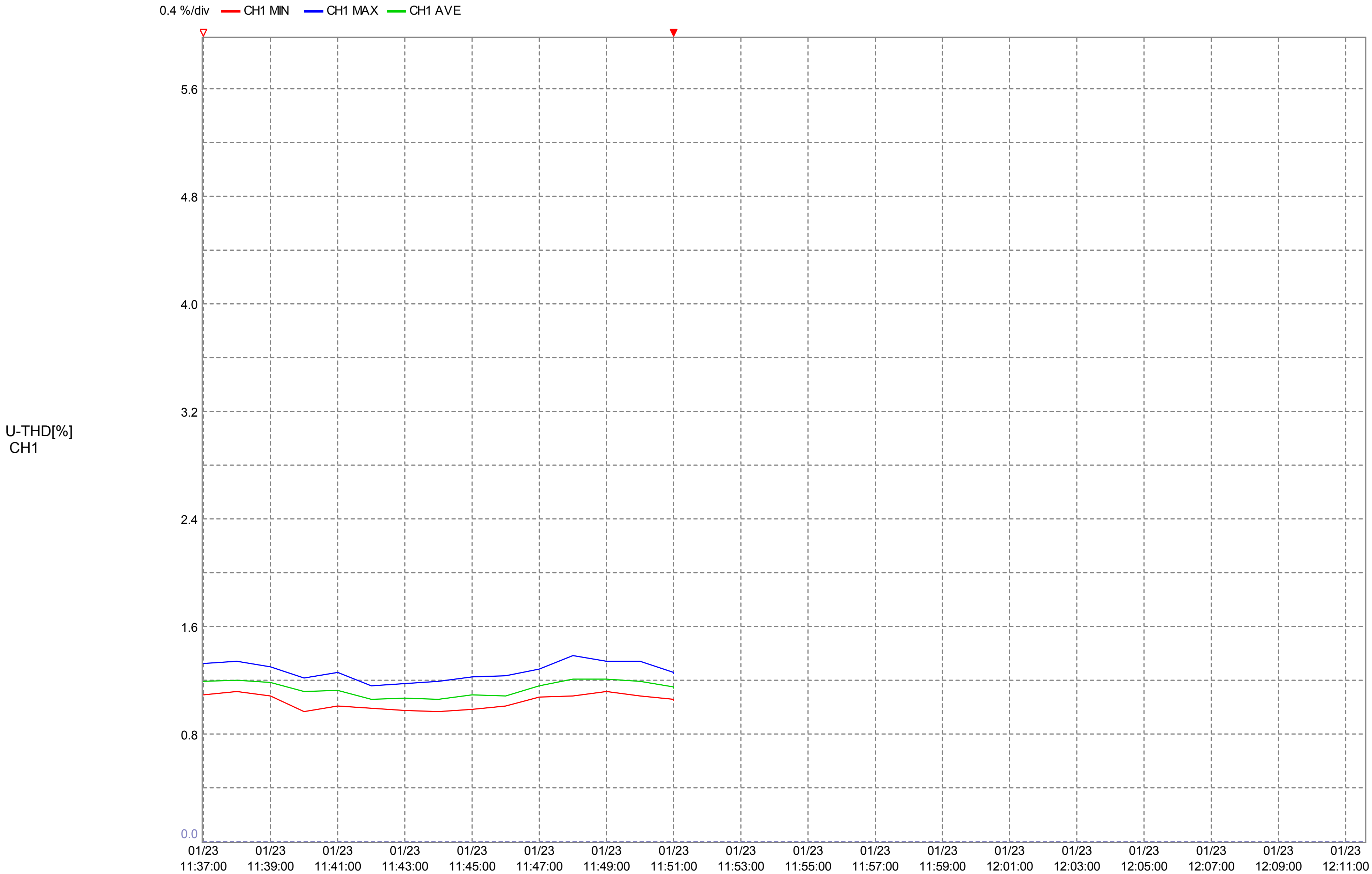

HIOKI 9624-50 PQA-HiVIEW PRO

Time Plot Graph

Measurement from a HIOKI 3197 PQA

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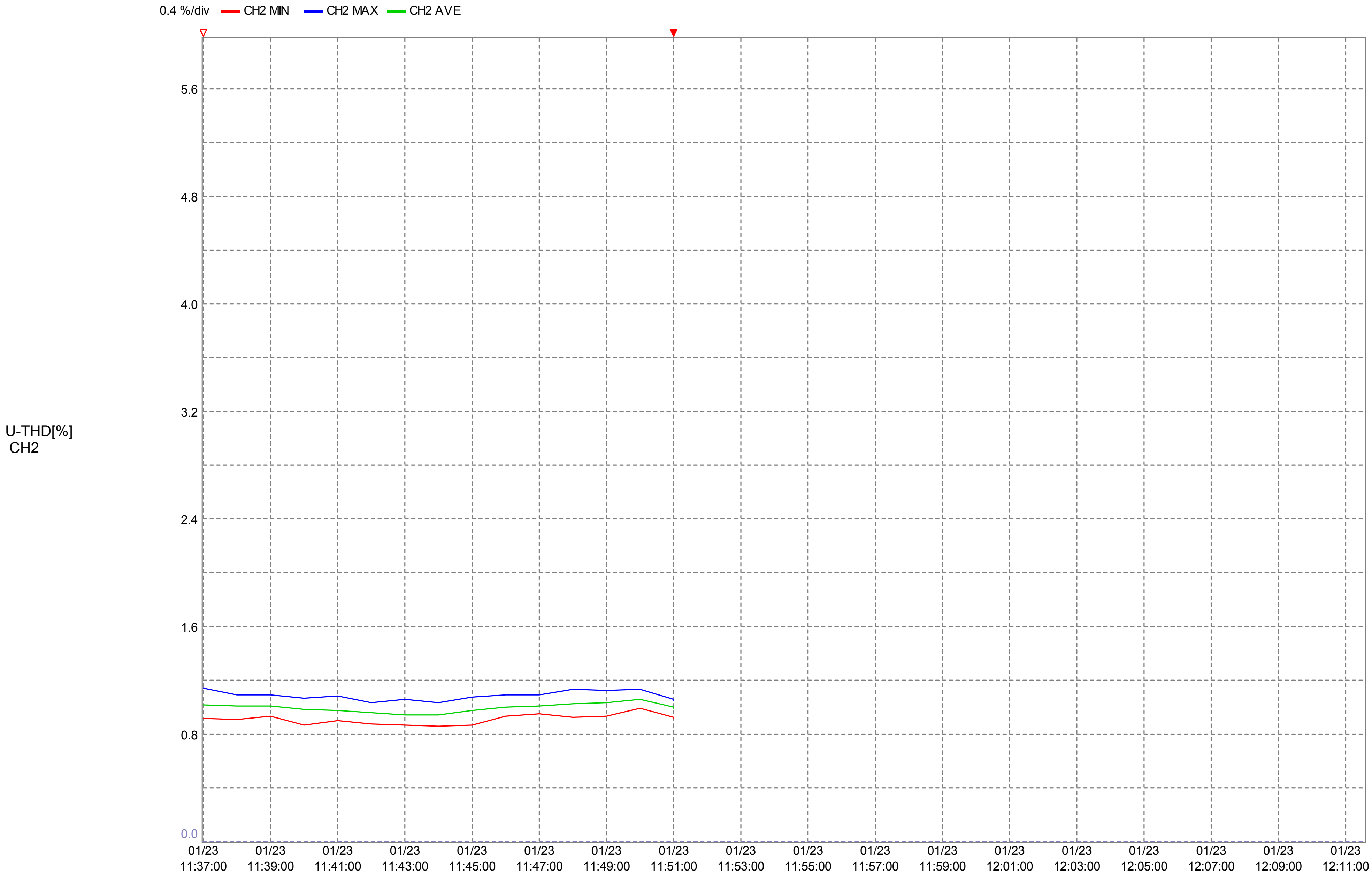
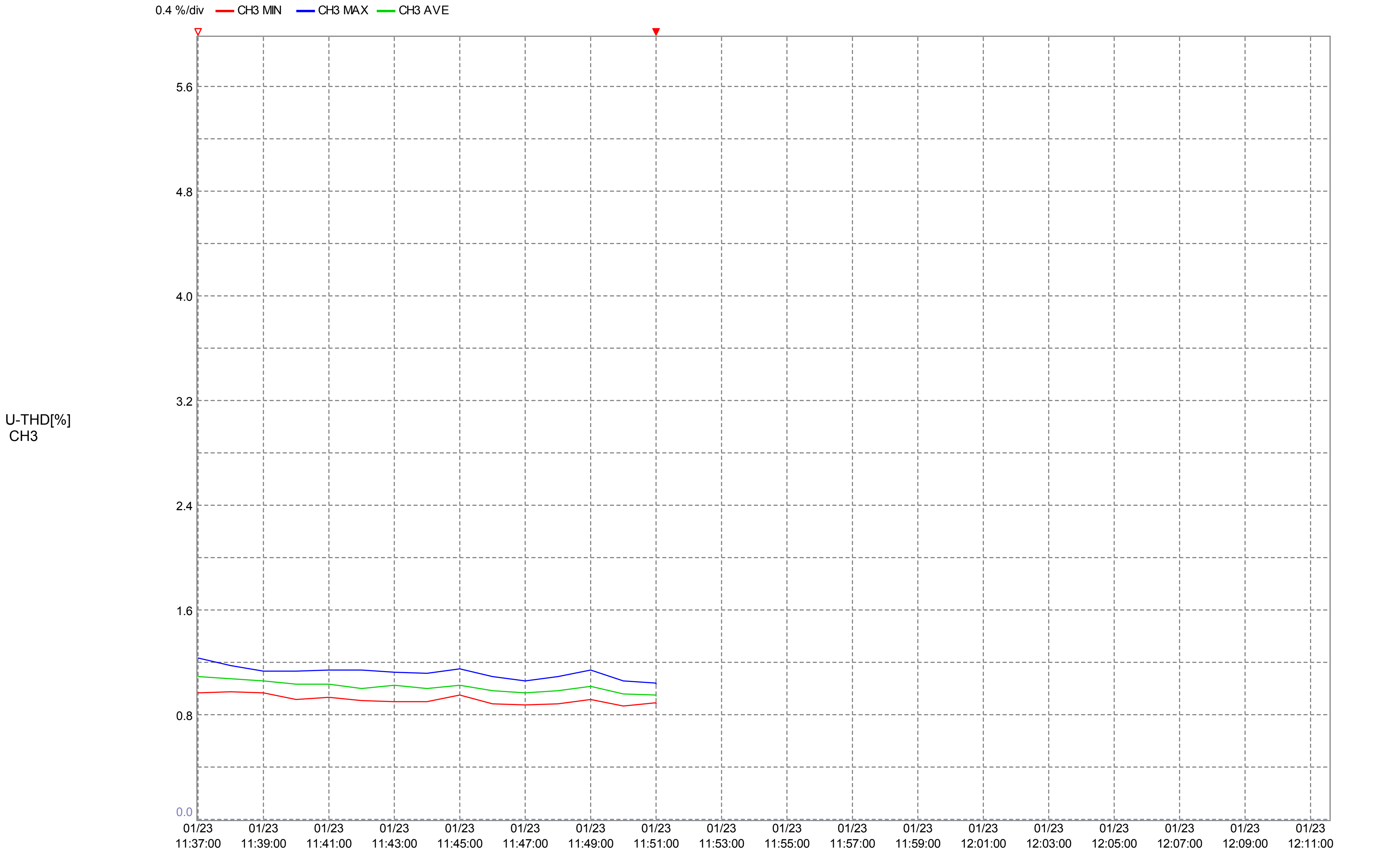


HIOKI 9624-50 PQA-HiVIEW PRO	Time Plot Graph Measurement from a HIOKI 3197 PQA	13-09-2020 D:\OT ABIN AUG 2019\Ongoing\EA\KWA HT\EA 586 PS Kadthuruthy\Load study\Tr-1 Mains\B0012301

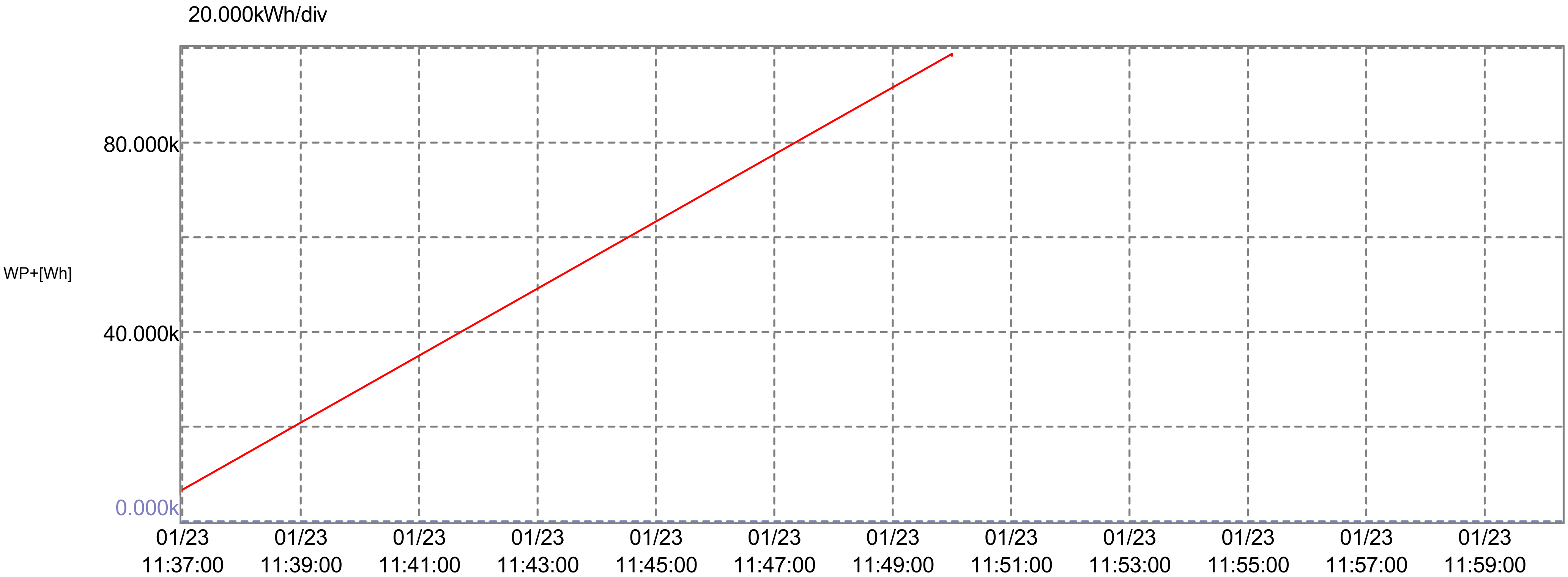
2020/01/23 11:37:00 - 2020/01/23 11:51:00



HIOKI 9624-50 PQA-HiVIEW PRO	Integrated Power Analysis Measurement from a HIOKI 3197 PQA	13-09-2020 D:\OT ABIN AUG 2019\Ongoing\EA\KWA HT\EA 586 PS Kadthuruthy\Load study\Tr-1 Mains\B0012301

2020/01/23 11:37:00 - 2020/01/23 11:51:00

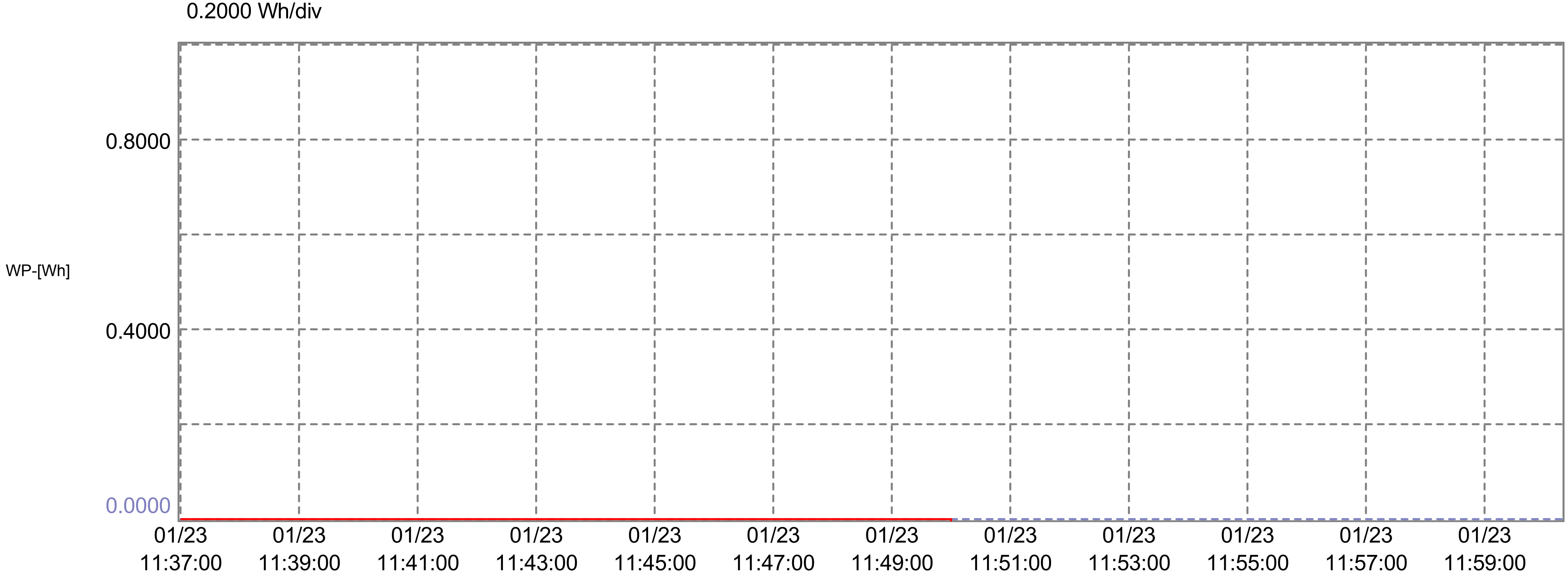
Maximum integrated pow er value: 98.589kWh



9624-50 PQA-HiVIEW PRO	Integrated Power Analysis Measurement from a HIOKI 3197 PQA	13-09-2020 D:\OT ABIN AUG 2019\Ongoing\EA\KWA HT\EA 586 PS Kadthuruthy\Load study\Tr-1 Mains\B0012301

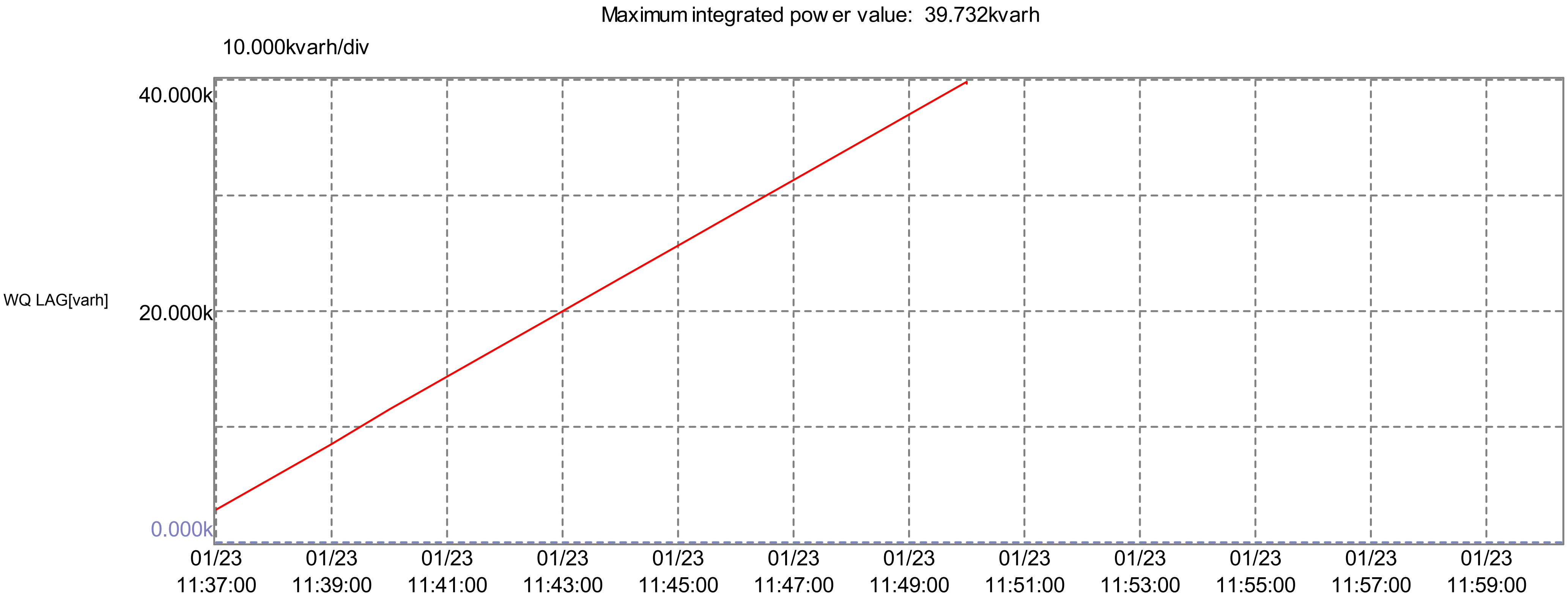
2020/01/23 11:37:00 - 2020/01/23 11:51:00

Maximum integrated pow er value: 0.0000 Wh



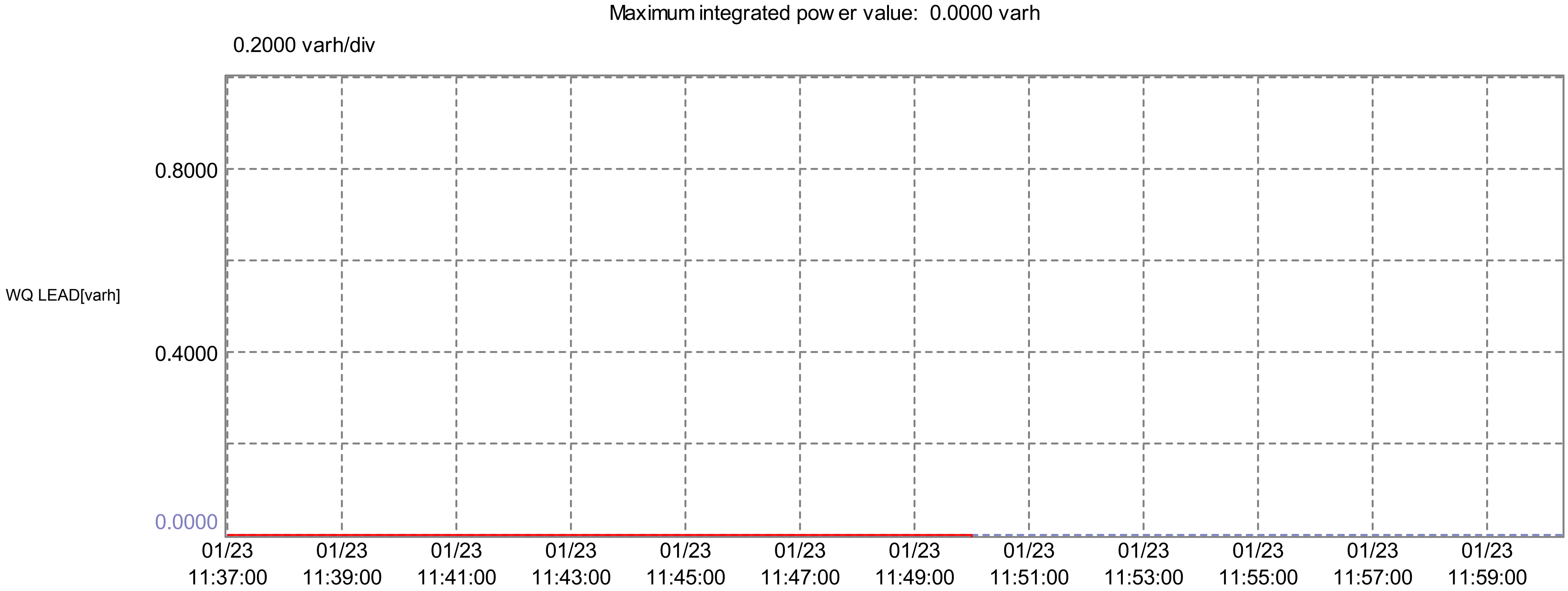
HIOKI 9624-50 PQA-HiVIEW PRO	Integrated Power Analysis Measurement from a HIOKI 3197 PQA	13-09-2020 D:\OT ABIN AUG 2019\Ongoing\EA\KWA HT\EA 586 PS Kadthuruthy\Load study\Tr-1 Mains\B0012301

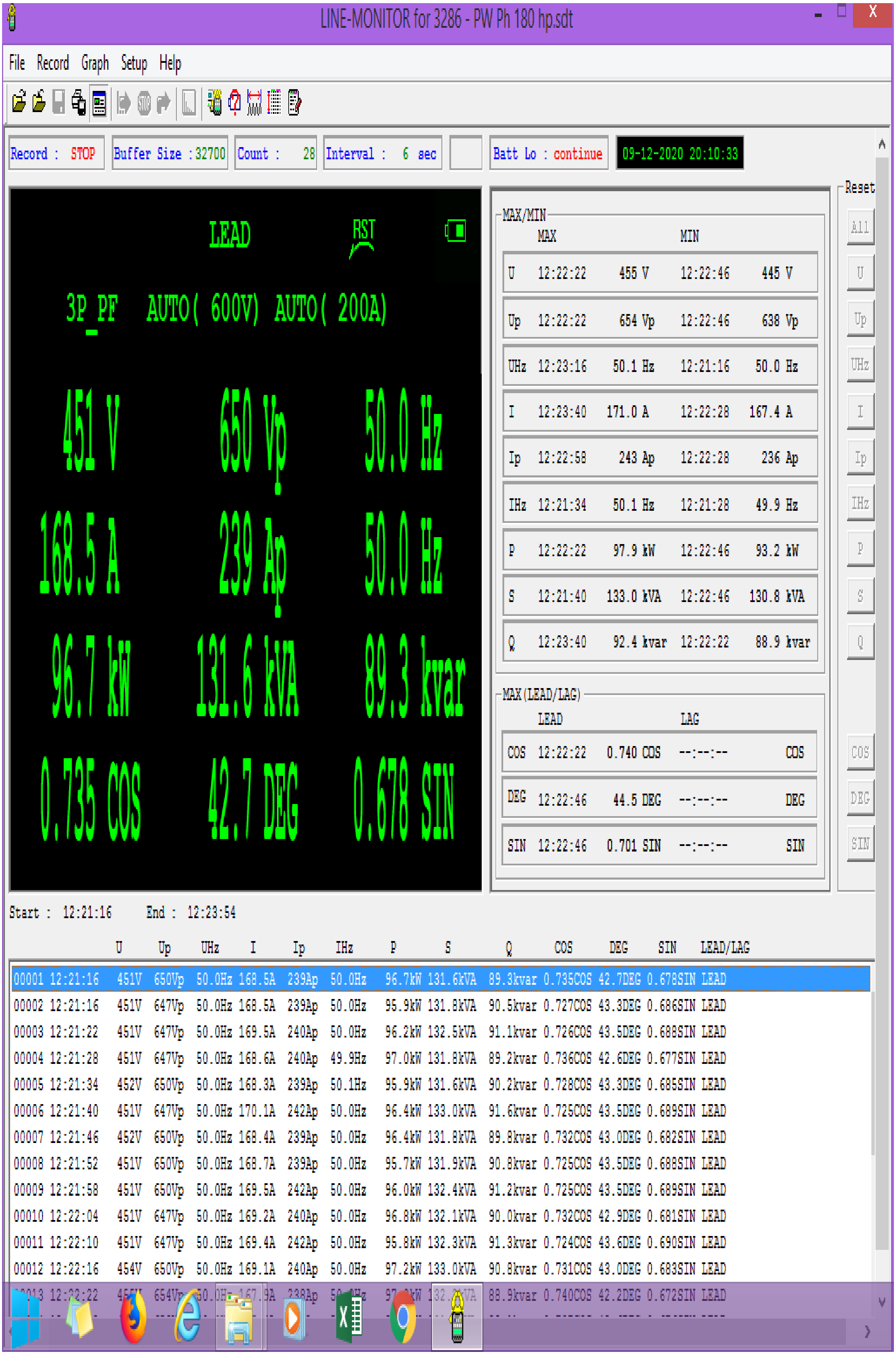
2020/01/23 11:37:00 - 2020/01/23 11:51:00

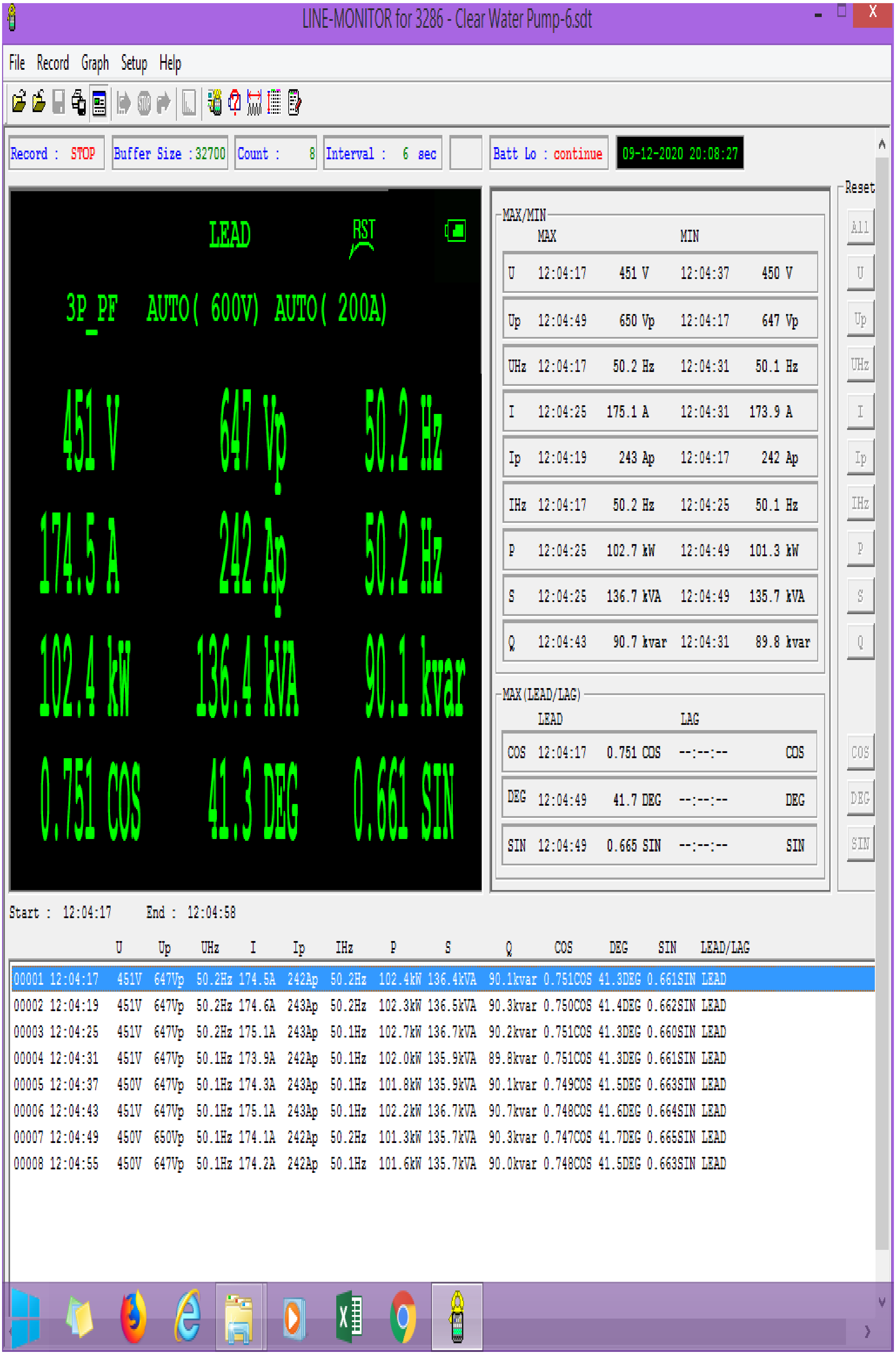


HIOKI 9624-50 PQA-HiVIEW PRO	Integrated Power Analysis Measurement from a HIOKI 3197 PQA	13-09-2020 D:\OT ABIN AUG 2019\Ongoing\EA\KWA HT\EA 586 PS Kadthuruthy\Load study\Tr-1 Mains\B0012301

2020/01/23 11:37:00 - 2020/01/23 11:51:00



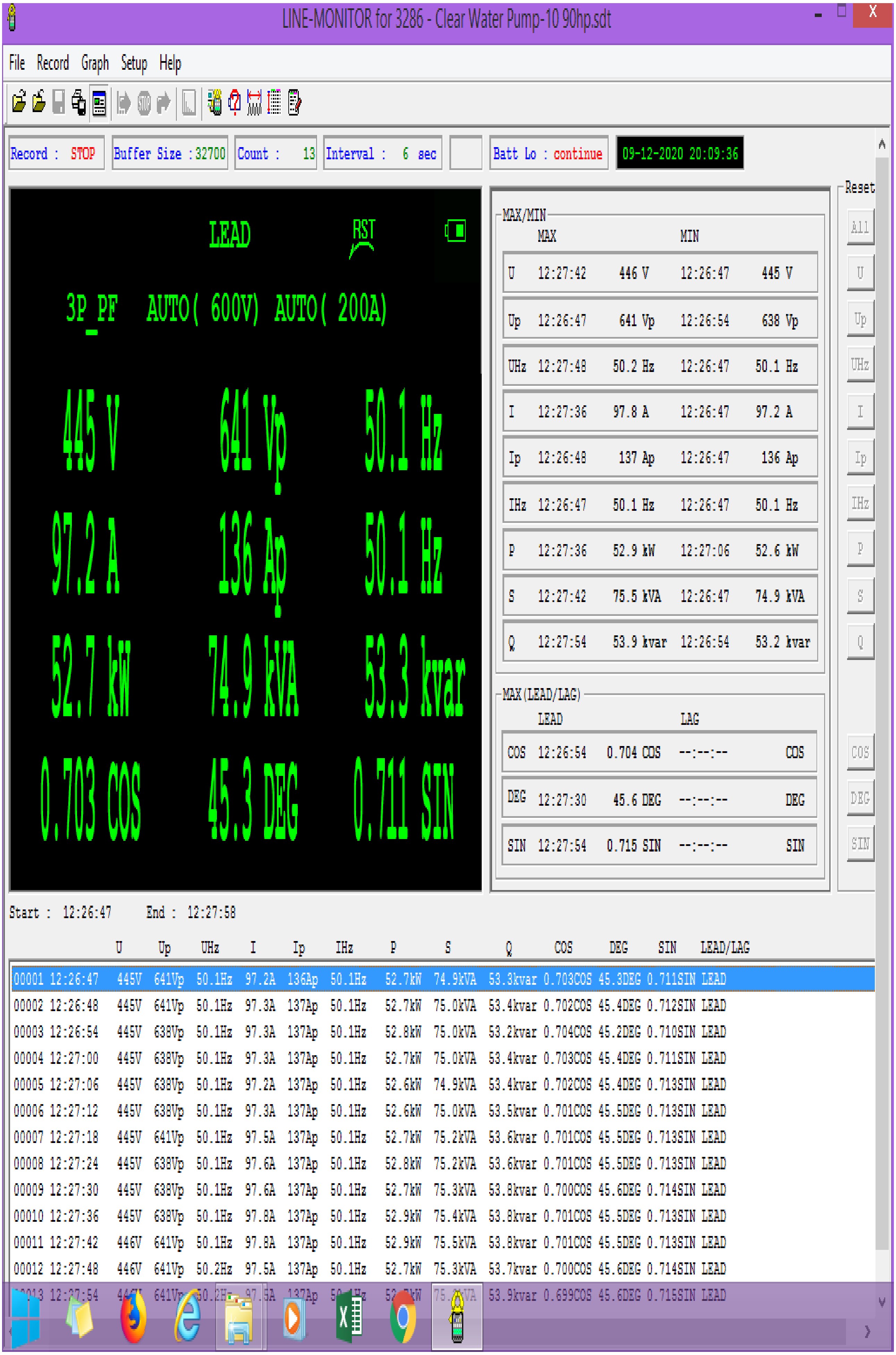

LINE-MONITOR for 3286 - PW Ph 180 hp.sdt
File Record Graph Setup Help
Record : STOP
Buffer Size : 32700
Count : 28
Interval : 6 sec
Batt Lo : continue
09-12-2020 20:10:33
LEAD
RST
3P_PF AUTO(600V) AUTO(200A)
451 V 650 Vp 50.0 Hz
168.5 A 239 Ap 50.0 Hz
96.7 kW 131.6 kVA 89.3 kvar
0.735 COS 42.7 DEG 0.678 SIN
MAX/MIN
MAX MIN
U 12:22:22 455 V 12:22:46 445 V
Up 12:22:22 654 Vp 12:22:46 638 Vp
UHz 12:23:16 50.1 Hz 12:21:16 50.0 Hz
I 12:23:40 171.0 A 12:22:28 167.4 A
Ip 12:22:58 243 Ap 12:22:28 236 Ap
IHz 12:21:34 50.1 Hz 12:21:28 49.9 Hz
P 12:22:22 97.9 kW 12:22:46 93.2 kW
S 12:21:40 133.0 kVA 12:22:46 130.8 kVA
Q 12:23:40 92.4 kvar 12:22:22 88.9 kvar
MAX(LEAD/LAG)
LEAD LAG
COS 12:22:22 0.740 COS --:--:-- COS
DEG 12:22:46 44.5 DEG --:--:-- DEG
SIN 12:22:46 0.701 SIN --:--:-- SIN
Reset
All
U
Up
UHz
I
Ip
IHz
P
S
Q
COS
DEG
SIN
Start : 12:21:16 End : 12:23:54
U Up UHz I Ip IHz P S Q COS DEG SIN LEAD/LAG
00001 12:21:16 451V 650Vp 50.0Hz 168.5A 239Ap 50.0Hz 96.7kW 131.6kVA 89.3kvar 0.735COS 42.7DEG 0.678SIN LEAD
00002 12:21:16 451V 647Vp 50.0Hz 168.5A 239Ap 50.0Hz 95.9kW 131.8kVA 90.5kvar 0.727COS 43.3DEG 0.686SIN LEAD
00003 12:21:22 451V 647Vp 50.0Hz 169.5A 240Ap 50.0Hz 96.2kW 132.5kVA 91.1kvar 0.726COS 43.5DEG 0.688SIN LEAD
00004 12:21:28 451V 647Vp 50.0Hz 168.6A 240Ap 49.9Hz 97.0kW 131.8kVA 89.2kvar 0.736COS 42.6DEG 0.677SIN LEAD
00005 12:21:34 452V 650Vp 50.0Hz 168.3A 239Ap 50.1Hz 95.9kW 131.6kVA 90.2kvar 0.728COS 43.3DEG 0.685SIN LEAD
00006 12:21:40 451V 647Vp 50.0Hz 170.1A 242Ap 50.0Hz 96.4kW 133.0kVA 91.6kvar 0.725COS 43.5DEG 0.689SIN LEAD
00007 12:21:46 452V 650Vp 50.0Hz 168.4A 239Ap 50.0Hz 96.4kW 131.8kVA 89.8kvar 0.732COS 43.0DEG 0.682SIN LEAD
00008 12:21:52 451V 650Vp 50.0Hz 168.7A 239Ap 50.0Hz 95.7kW 131.9kVA 90.8kvar 0.725COS 43.5DEG 0.688SIN LEAD
00009 12:21:58 451V 650Vp 50.0Hz 169.5A 242Ap 50.0Hz 96.0kW 132.4kVA 91.2kvar 0.725COS 43.5DEG 0.689SIN LEAD
00010 12:22:04 451V 647Vp 50.0Hz 169.2A 240Ap 50.0Hz 96.8kW 132.1kVA 90.0kvar 0.732COS 42.9DEG 0.681SIN LEAD
00011 12:22:10 451V 647Vp 50.0Hz 169.4A 242Ap 50.0Hz 95.8kW 132.3kVA 91.3kvar 0.724COS 43.6DEG 0.690SIN LEAD
00012 12:22:16 454V 650Vp 50.0Hz 169.1A 240Ap 50.0Hz 97.2kW 133.0kVA 90.8kvar 0.731COS 43.0DEG 0.683SIN LEAD
88.9kvar 0.740COS 42.2DEG 0.672SIN LEAD



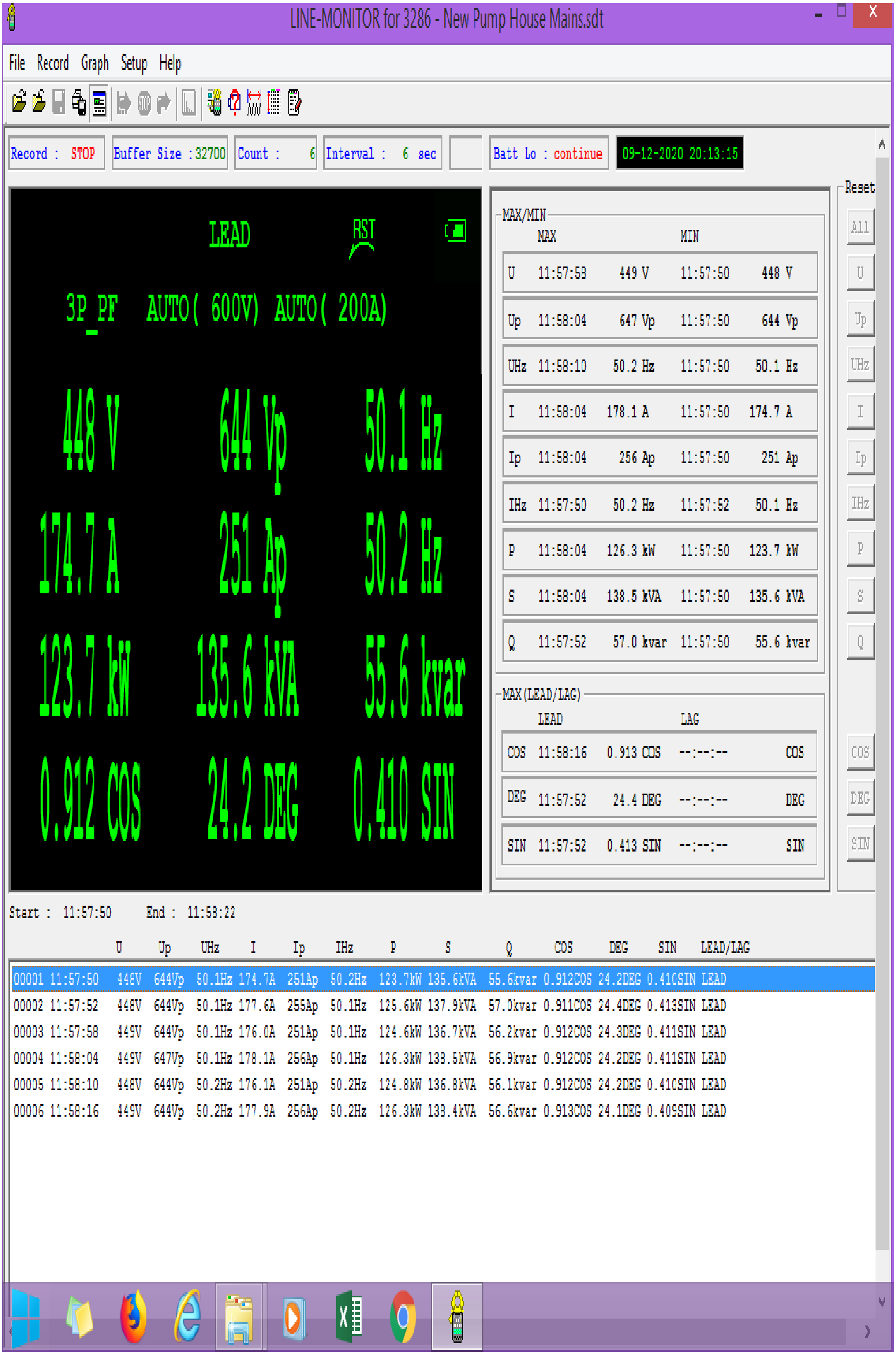
	MAX		MIN	
U	12:04:17	451 V	12:04:37	450 V
Up	12:04:49	650 Vp	12:04:17	647 Vp
UHz	12:04:17	50.2 Hz	12:04:31	50.1 Hz
I	12:04:25	175.1 A	12:04:31	173.9 A
Ip	12:04:19	243 Ap	12:04:17	242 Ap
IHz	12:04:17	50.2 Hz	12:04:25	50.1 Hz
P	12:04:25	102.7 kW	12:04:49	101.3 kW
S	12:04:25	136.7 kVA	12:04:49	135.7 kVA
Q	12:04:43	90.7 kvar	12:04:31	89.8 kvar

	LEAD		LAG	
COS	12:04:17	0.751 COS	--:--:--	COS
DEG	12:04:49	41.7 DEG	--:--:--	DEG
SIN	12:04:49	0.665 SIN	--:--:--	SIN

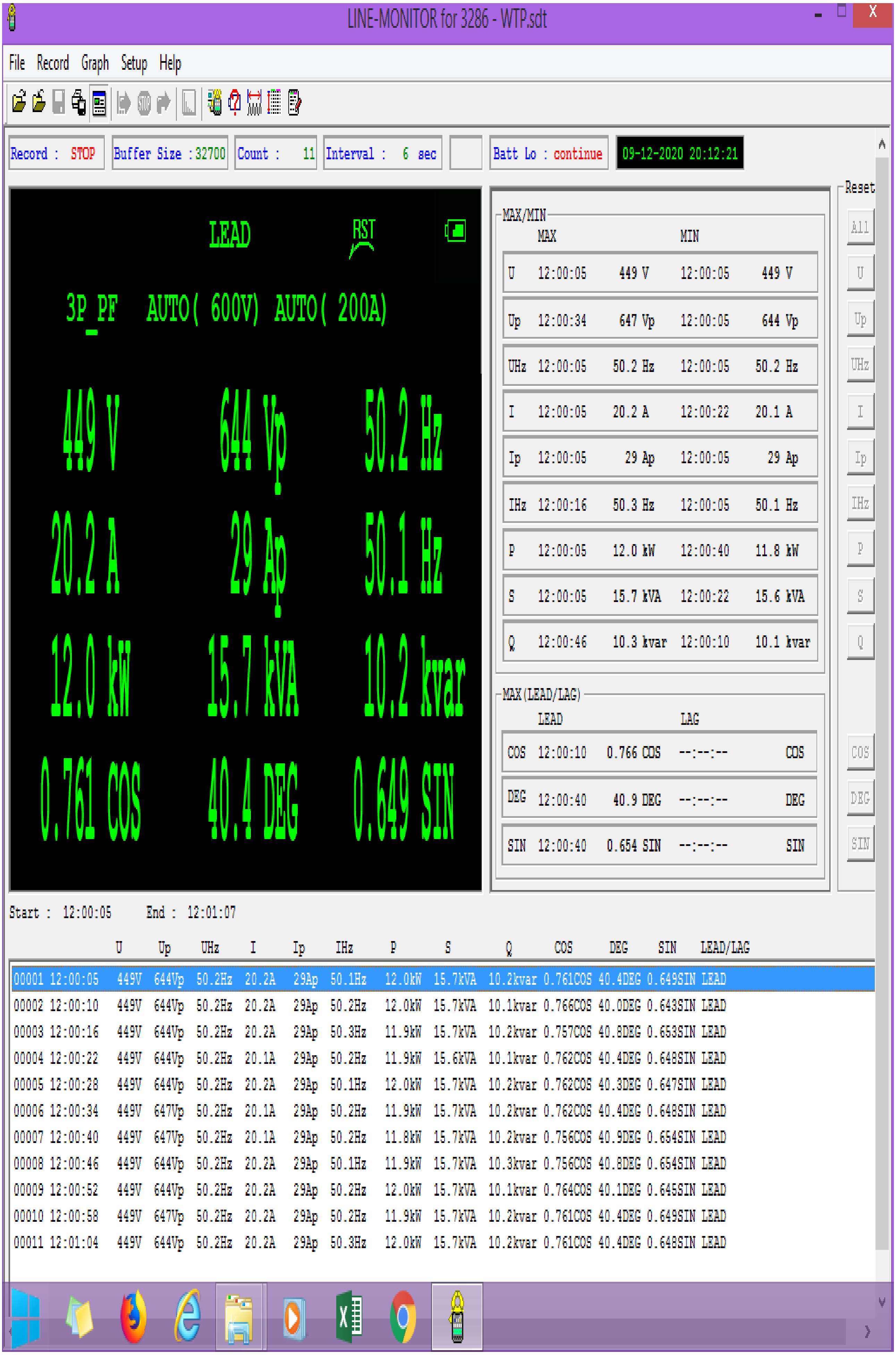
		U	Up	UHz	I	Ip	IHz	P	S	Q	COS	DEG	SIN	LEAD/LAG
00001	12:04:17	451V	647Vp	50.2Hz	174.5A	242Ap	50.2Hz	102.4kW	136.4kVA	90.1kvar	0.751COS	41.3DEG	0.661SIN	LEAD
00002	12:04:19	451V	647Vp	50.2Hz	174.6A	243Ap	50.2Hz	102.3kW	136.5kVA	90.3kvar	0.750COS	41.4DEG	0.662SIN	LEAD
00003	12:04:25	451V	647Vp	50.2Hz	175.1A	243Ap	50.1Hz	102.7kW	136.7kVA	90.2kvar	0.751COS	41.3DEG	0.660SIN	LEAD
00004	12:04:31	451V	647Vp	50.1Hz	173.9A	242Ap	50.1Hz	102.0kW	135.9kVA	89.8kvar	0.751COS	41.3DEG	0.661SIN	LEAD
00005	12:04:37	450V	647Vp	50.1Hz	174.3A	243Ap	50.1Hz	101.8kW	135.9kVA	90.1kvar	0.749COS	41.5DEG	0.663SIN	LEAD
00006	12:04:43	451V	647Vp	50.1Hz	175.1A	243Ap	50.1Hz	102.2kW	136.7kVA	90.7kvar	0.748COS	41.6DEG	0.664SIN	LEAD
00007	12:04:49	450V	650Vp	50.1Hz	174.1A	242Ap	50.2Hz	101.3kW	135.7kVA	90.3kvar	0.747COS	41.7DEG	0.665SIN	LEAD
00008	12:04:55	450V	647Vp	50.1Hz	174.2A	242Ap	50.1Hz	101.6kW	135.7kVA	90.0kvar	0.748COS	41.5DEG	0.663SIN	LEAD



No.	Time	U	Up	UHz	I	Ip	IHz	P	S	Q	COS	DEG	SIN	LEAD/LAG
00001	12:26:47	445V	641Vp	50.1Hz	97.2A	136Ap	50.1Hz	52.7kW	74.9kVA	53.3kvar	0.703COS	45.3DEG	0.711SIN	LEAD
00002	12:26:48	445V	641Vp	50.1Hz	97.3A	137Ap	50.1Hz	52.7kW	75.0kVA	53.4kvar	0.702COS	45.4DEG	0.712SIN	LEAD
00003	12:26:54	445V	638Vp	50.1Hz	97.3A	137Ap	50.1Hz	52.8kW	75.0kVA	53.2kvar	0.704COS	45.2DEG	0.710SIN	LEAD
00004	12:27:00	445V	638Vp	50.1Hz	97.3A	137Ap	50.1Hz	52.7kW	75.0kVA	53.4kvar	0.703COS	45.4DEG	0.711SIN	LEAD
00005	12:27:06	445V	638Vp	50.1Hz	97.2A	137Ap	50.1Hz	52.6kW	74.9kVA	53.4kvar	0.702COS	45.4DEG	0.713SIN	LEAD
00006	12:27:12	445V	638Vp	50.1Hz	97.3A	137Ap	50.1Hz	52.6kW	75.0kVA	53.5kvar	0.701COS	45.5DEG	0.713SIN	LEAD
00007	12:27:18	445V	641Vp	50.1Hz	97.5A	137Ap	50.1Hz	52.7kW	75.2kVA	53.6kvar	0.701COS	45.5DEG	0.713SIN	LEAD
00008	12:27:24	445V	638Vp	50.1Hz	97.6A	137Ap	50.1Hz	52.8kW	75.2kVA	53.6kvar	0.701COS	45.5DEG	0.713SIN	LEAD
00009	12:27:30	445V	638Vp	50.1Hz	97.6A	137Ap	50.1Hz	52.7kW	75.3kVA	53.8kvar	0.700COS	45.6DEG	0.714SIN	LEAD
00010	12:27:36	445V	638Vp	50.1Hz	97.8A	137Ap	50.1Hz	52.9kW	75.4kVA	53.8kvar	0.701COS	45.5DEG	0.713SIN	LEAD
00011	12:27:42	446V	641Vp	50.1Hz	97.8A	137Ap	50.1Hz	52.9kW	75.5kVA	53.8kvar	0.701COS	45.5DEG	0.713SIN	LEAD
00012	12:27:48	446V	641Vp	50.2Hz	97.5A	137Ap	50.1Hz	52.7kW	75.3kVA	53.7kvar	0.700COS	45.6DEG	0.714SIN	LEAD
00013	12:27:54	[illegible]	641Vp	50.2Hz	97.5A	137Ap	50.1Hz	52.7kW	[illegible]	53.9kvar	0.699COS	45.6DEG	0.715SIN	LEAD



		U	Up	UHz	I	Ip	IHz	P	S	Q	COS	DEG	SIN	LEAD/LAG
00001	11:57:50	448V	644Vp	50.1Hz	174.7A	251Ap	50.2Hz	123.7kW	135.6kVA	55.6kvar	0.912COS	24.2DEG	0.410SIN	LEAD
00002	11:57:52	448V	644Vp	50.1Hz	177.6A	255Ap	50.1Hz	125.6kW	137.9kVA	57.0kvar	0.911COS	24.4DEG	0.413SIN	LEAD
00003	11:57:58	449V	644Vp	50.1Hz	176.0A	251Ap	50.1Hz	124.6kW	136.7kVA	56.2kvar	0.912COS	24.3DEG	0.411SIN	LEAD
00004	11:58:04	449V	647Vp	50.1Hz	178.1A	256Ap	50.1Hz	126.3kW	138.5kVA	56.9kvar	0.912COS	24.2DEG	0.411SIN	LEAD
00005	11:58:10	448V	644Vp	50.2Hz	176.1A	251Ap	50.2Hz	124.8kW	136.8kVA	56.1kvar	0.912COS	24.2DEG	0.410SIN	LEAD
00006	11:58:16	449V	644Vp	50.2Hz	177.9A	256Ap	50.2Hz	126.3kW	138.4kVA	56.6kvar	0.913COS	24.1DEG	0.409SIN	LEAD

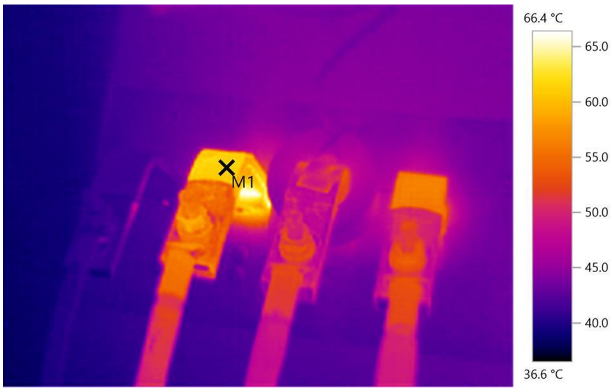


		U	Up	UHz	I	Ip	IHz	P	S	Q	COS	DEG	SIN	LEAD/LAG
00001	12:00:05	449V	644Vp	50.2Hz	20.2A	29Ap	50.1Hz	12.0kW	15.7kVA	10.2kvar	0.761COS	40.4DEG	0.649SIN	LEAD
00002	12:00:10	449V	644Vp	50.2Hz	20.2A	29Ap	50.2Hz	12.0kW	15.7kVA	10.1kvar	0.766COS	40.0DEG	0.643SIN	LEAD
00003	12:00:16	449V	644Vp	50.2Hz	20.2A	29Ap	50.3Hz	11.9kW	15.7kVA	10.2kvar	0.757COS	40.8DEG	0.653SIN	LEAD
00004	12:00:22	449V	644Vp	50.2Hz	20.1A	29Ap	50.2Hz	11.9kW	15.6kVA	10.1kvar	0.762COS	40.4DEG	0.648SIN	LEAD
00005	12:00:28	449V	644Vp	50.2Hz	20.2A	29Ap	50.1Hz	12.0kW	15.7kVA	10.2kvar	0.762COS	40.3DEG	0.647SIN	LEAD
00006	12:00:34	449V	647Vp	50.2Hz	20.1A	29Ap	50.2Hz	11.9kW	15.7kVA	10.2kvar	0.762COS	40.4DEG	0.648SIN	LEAD
00007	12:00:40	449V	647Vp	50.2Hz	20.1A	29Ap	50.2Hz	11.8kW	15.7kVA	10.2kvar	0.756COS	40.9DEG	0.654SIN	LEAD
00008	12:00:46	449V	644Vp	50.2Hz	20.2A	29Ap	50.1Hz	11.9kW	15.7kVA	10.3kvar	0.756COS	40.8DEG	0.654SIN	LEAD
00009	12:00:52	449V	644Vp	50.2Hz	20.2A	29Ap	50.2Hz	12.0kW	15.7kVA	10.1kvar	0.764COS	40.1DEG	0.645SIN	LEAD
00010	12:00:58	449V	647Vp	50.2Hz	20.2A	29Ap	50.2Hz	11.9kW	15.7kVA	10.2kvar	0.761COS	40.4DEG	0.649SIN	LEAD
00011	12:01:04	449V	644Vp	50.2Hz	20.2A	29Ap	50.3Hz	12.0kW	15.7kVA	10.2kvar	0.761COS	40.4DEG	0.648SIN	LEAD

Thermography report

Company	OTTOTRACTIONS ACCREDITED ENERGY AUDITOR BUREAU OF ENERGY EFFICIENCY	**Customer**	KERALA WATER AUTHIRITY Kaduthuruthty
Tester	Abin		

Device	testo 875-1i	Serial No.:	2621731	Lens:	Standard 32°
Task	Energy audit				



Picture data:	**Date:**	23-01-2020	**Emissivity:**	0.95
	Measuring Time:	12:25:20	**Refl. temp. [°C]:**	20.0
	File:	Clear water pump 90HP.BMT		

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 1	61.4	0.95	20.0	-

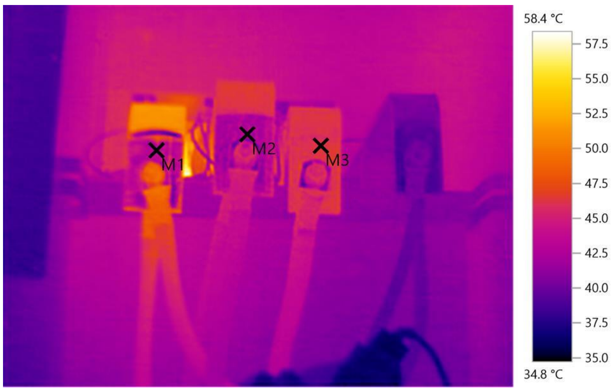
Remarks: Terminal loose at B-Phase

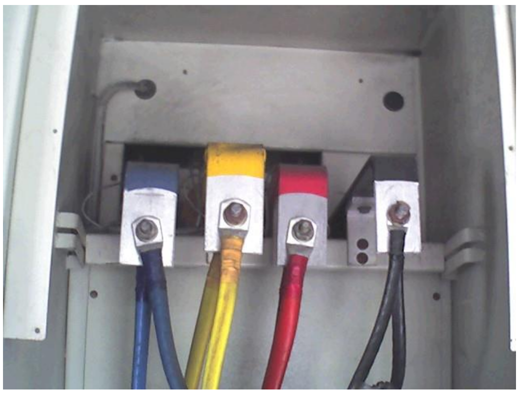
Picture data:	**Date:**	23-01-2020	**Emissivity:**	0.95
	Measuring Time:	11:58:55	**Refl. temp. [°C]:**	20.0
	File:	New pump house mains.BMT		

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 1	57.2	0.95	20.0	-

Remarks: Loose connection at R-Phase





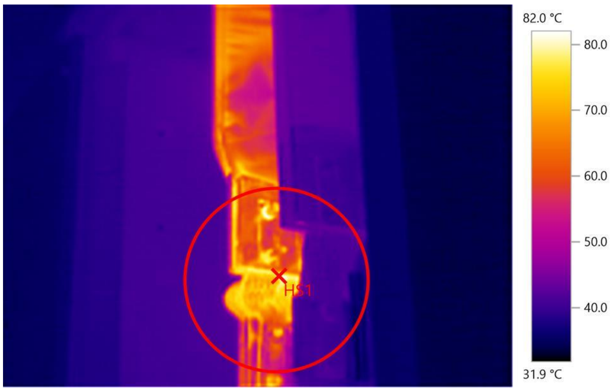
Picture data:	**Date:**	23-01-2020	**Emissivity:**	0.95
	Measuring Time:	12:23:25	**Refl. temp. [°C]:**	20.0
	File:	PWP 180HP-2.BMT		

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 1	43.5	0.95	20.0	-
Measure point 2	42.5	0.95	20.0	-

Thermography report

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 3	46.4	0.95	20.0	-

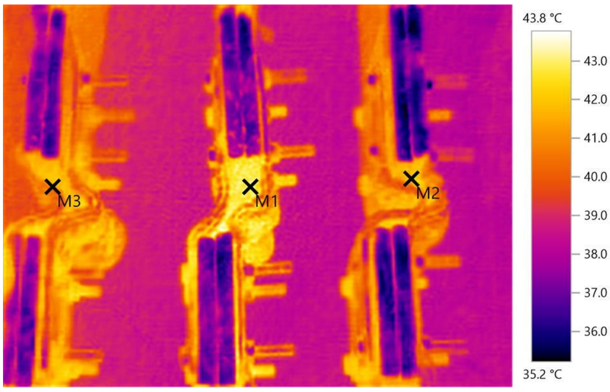


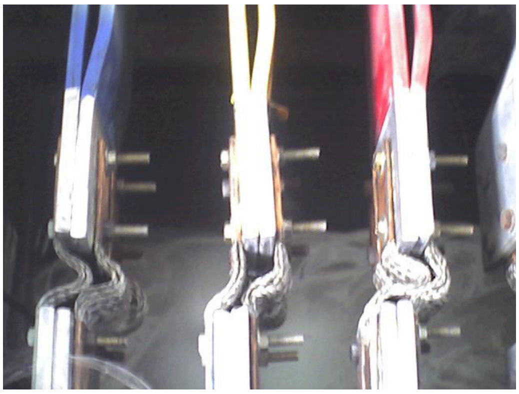
Picture data: **Date:** 23-01-2020 **Emissivity:** 0.95
Measuring Time: 10:51:36 **Refl. temp. [°C]:** 20.0
File: TR-1 mains (2).BMT

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Hot spot 1	82.0	0.95	20.0	-

OTTOTRACTIONS
Energy Engineering Environment

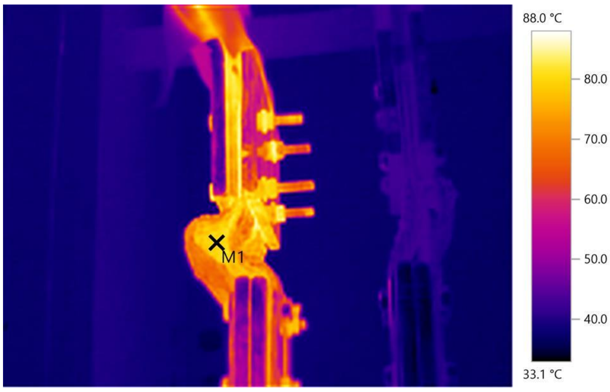


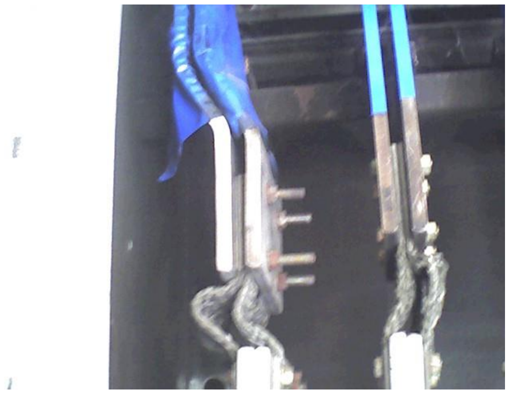


Picture data:	**Date:**	23-01-2020	**Emissivity:**	0.95
	Measuring Time:	11:14:24	**Refl. temp. [°C]:**	20.0
	File:	TR-1 mains (3).BMT		

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 1	42.9	0.95	20.0	-
Measure point 2	42.1	0.95	20.0	-
Measure point 3	40.9	0.95	20.0	-

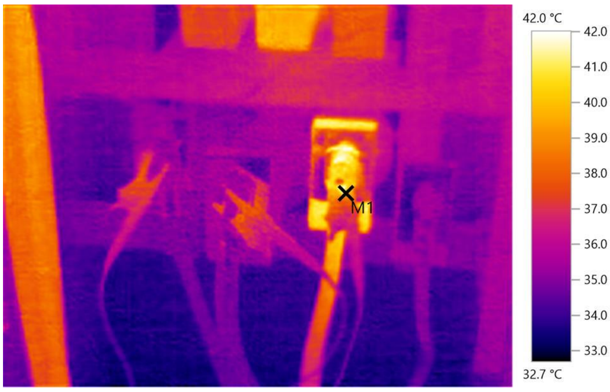


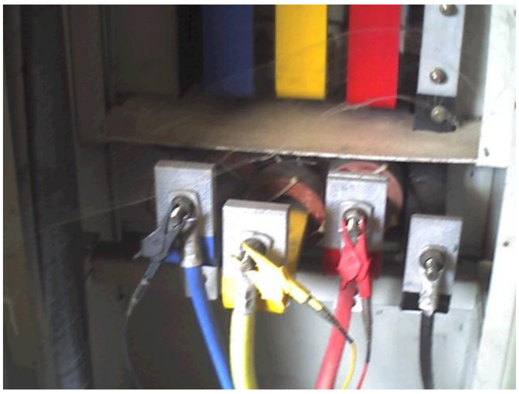


Picture data:	**Date:**	23-01-2020	**Emissivity:**	0.95
	Measuring Time:	10:49:40	**Refl. temp. [°C]:**	20.0
	File:	TR-1 mains.BMT		

Picture markings:

Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 1	80.5	0.95	20.0	-





Picture data:	**Date:**	23-01-2020	**Emissivity:**	0.95
	Measuring Time:	12:00:32	**Refl. temp. [°C]:**	20.0
	File:	WTP.BMT		

Picture markings:

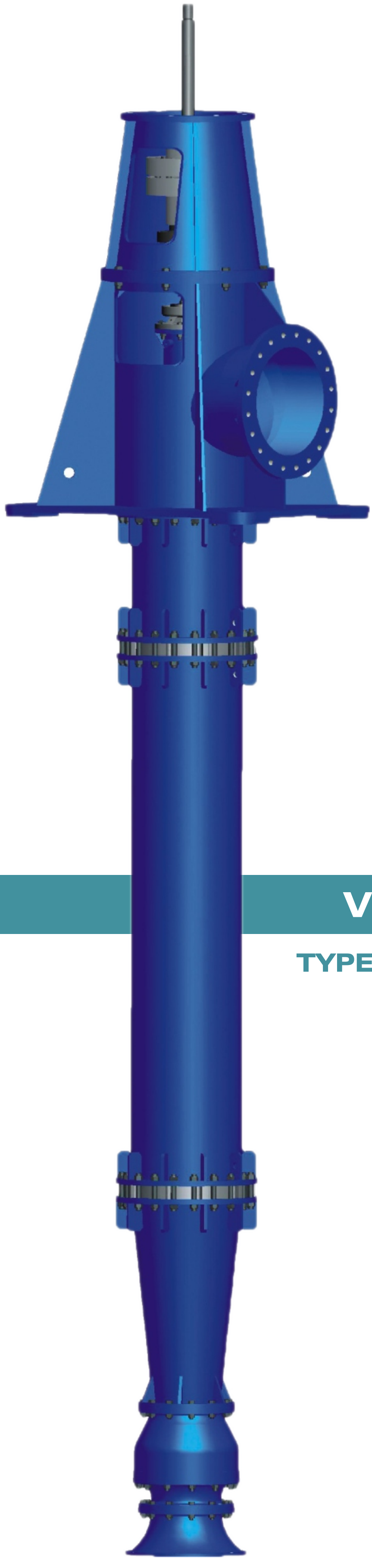
Measurement Objects	Temp. [°C]	Emiss.	Refl. temp. [°C]	Remarks
Measure point 1	39.8	0.95	20.0	-

Remarks: Terminal loose at R-phase

12-09-2020 , ____________ ____________

Abin

Enriching Lives



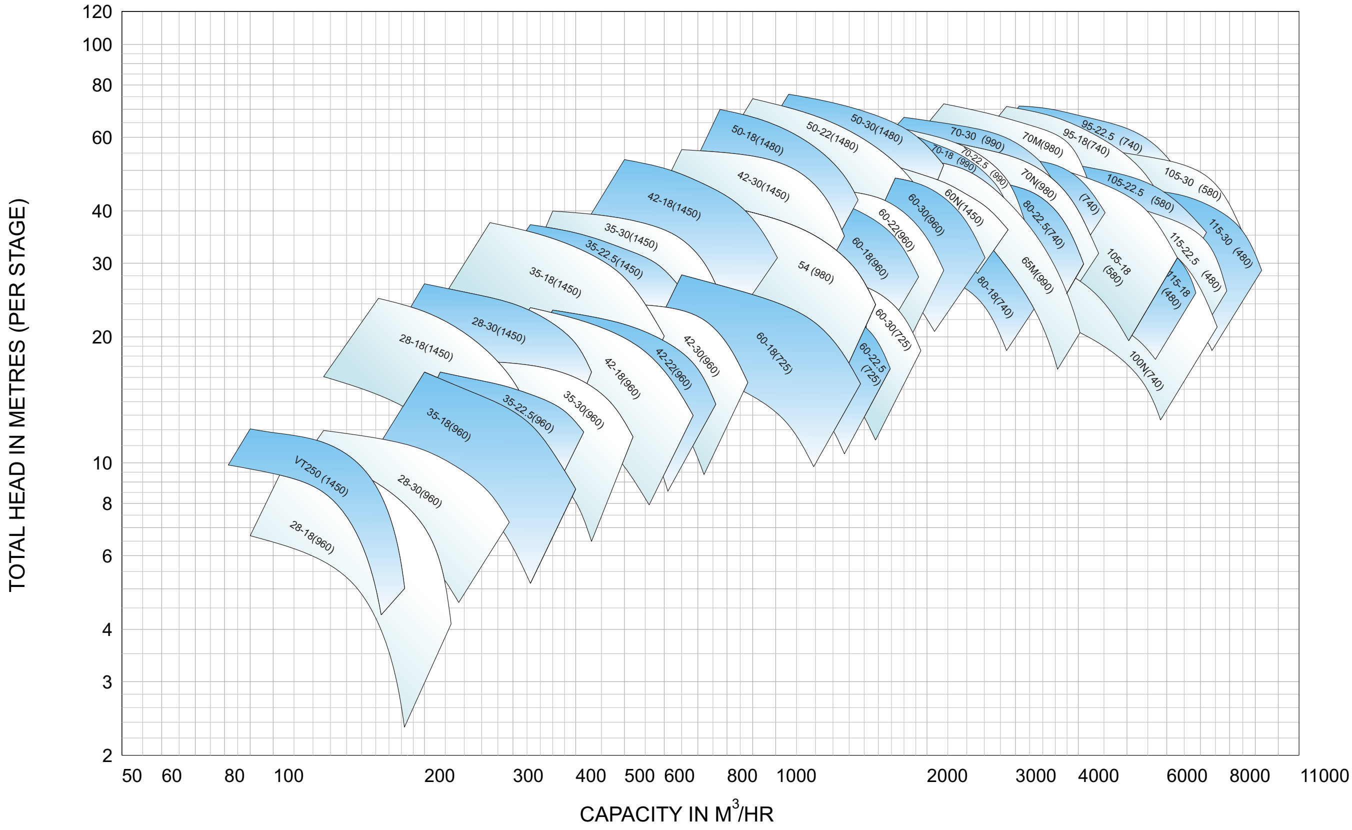
VERTICAL PUMPS

TYPE - BHR / BHQ / BHM / BHK / BHMa / BHA

KIRLOSKAR BROTHERS LIMITED

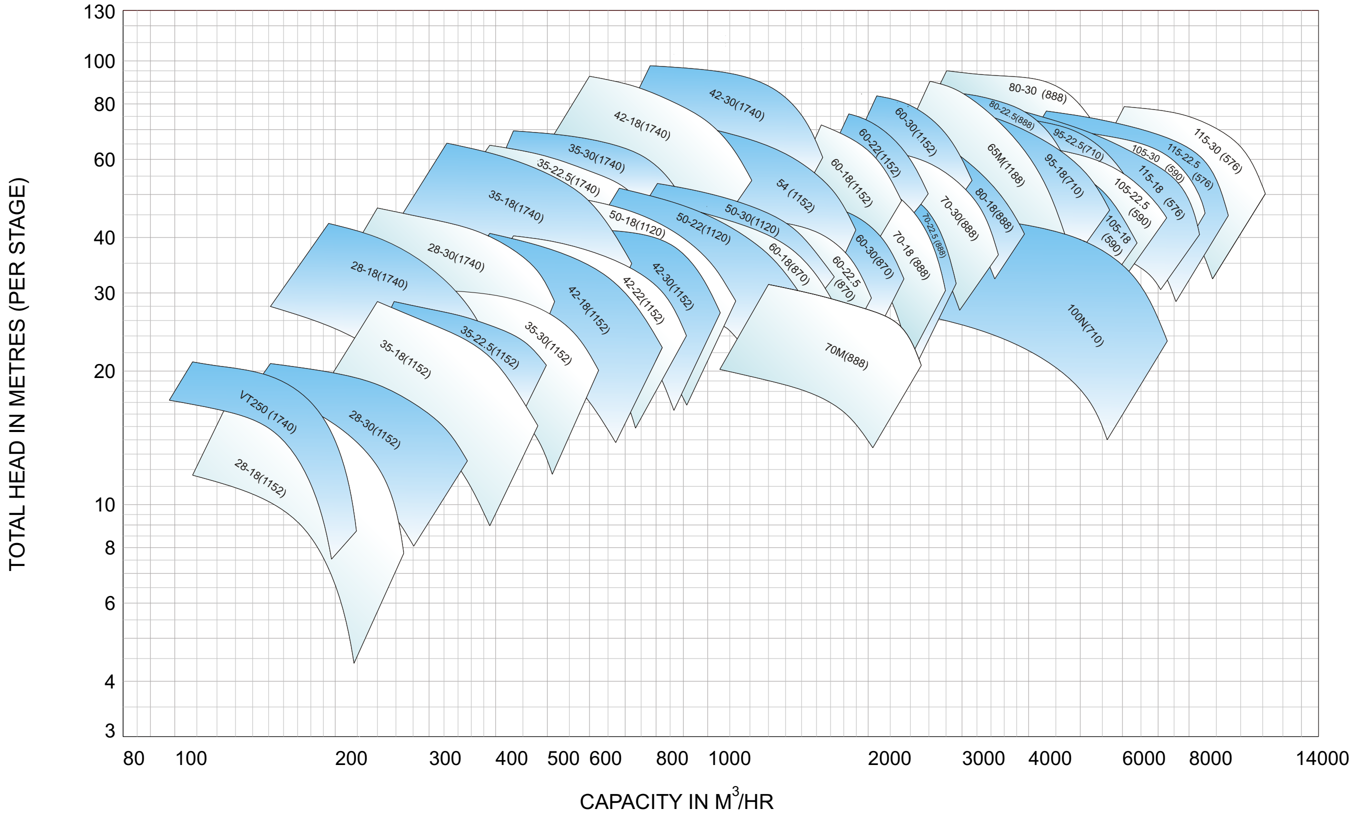
A Kirloskar Group Company

FAMILY CURVES FOR BHR PUMPS (50HZ)



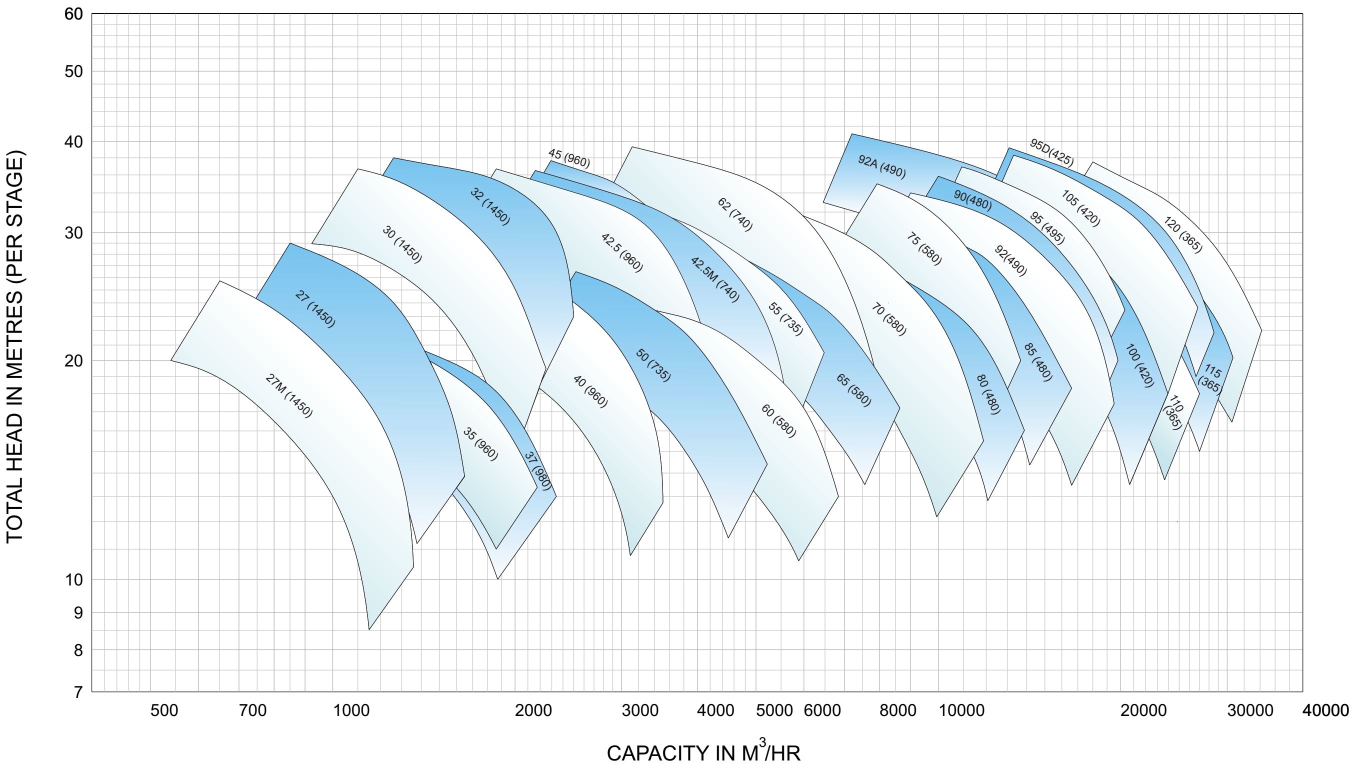
NOTE: FIGURES IN BRACKET INDICATE SPEED IN RPM

FAMILY CURVES FOR BHR PUMPS (60HZ)



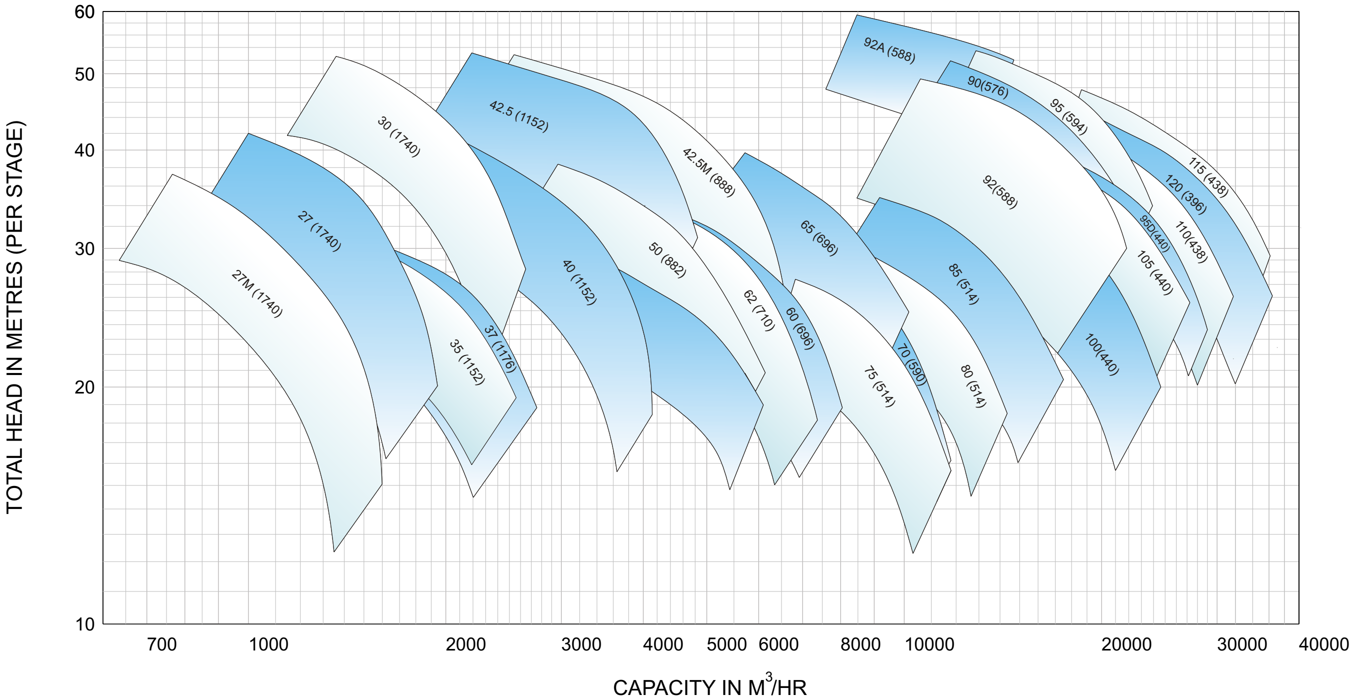
NOTE: FIGURES IN BRACKET INDICATE SPEED IN RPM

FAMILY CURVES FOR BHQ PUMPS (50HZ)



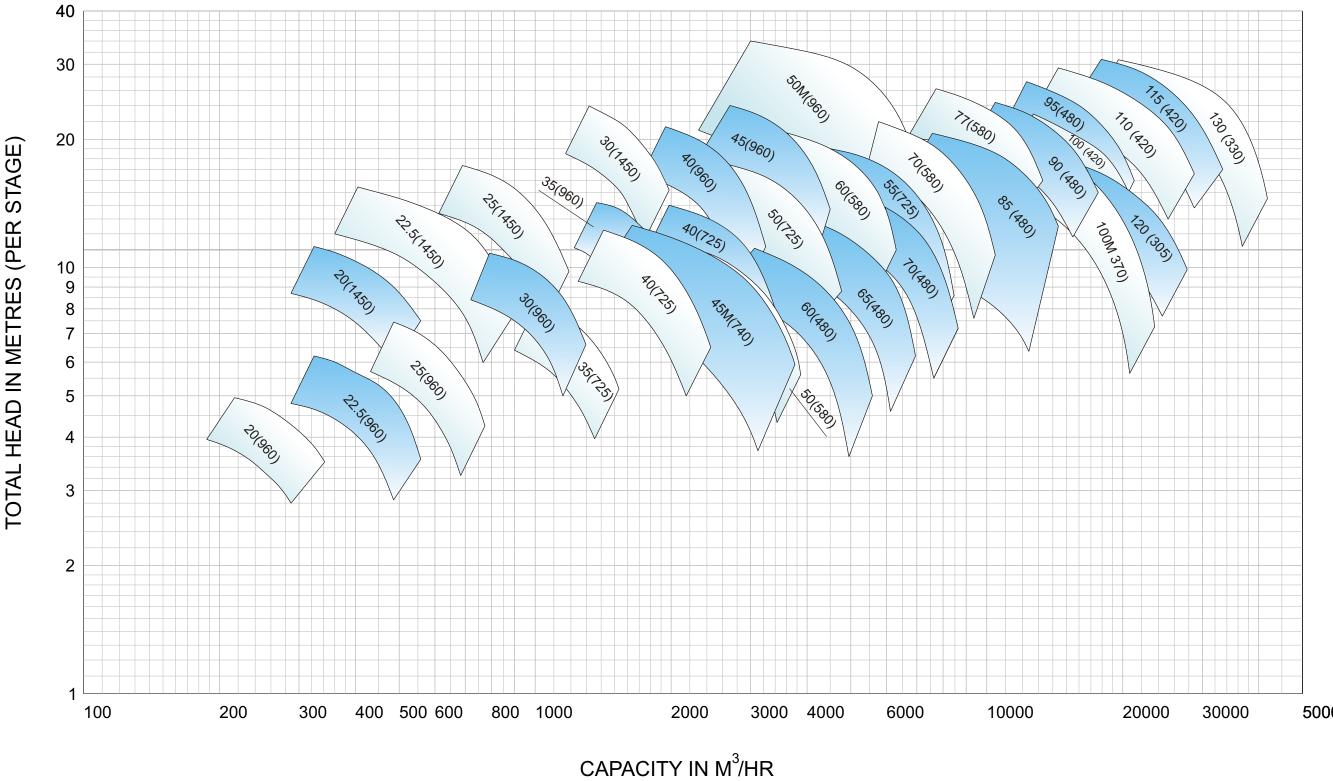
NOTE: FIGURES IN BRACKET INDICATE SPEED IN RPM

FAMILY CURVES FOR BHQ PUMPS (60HZ)



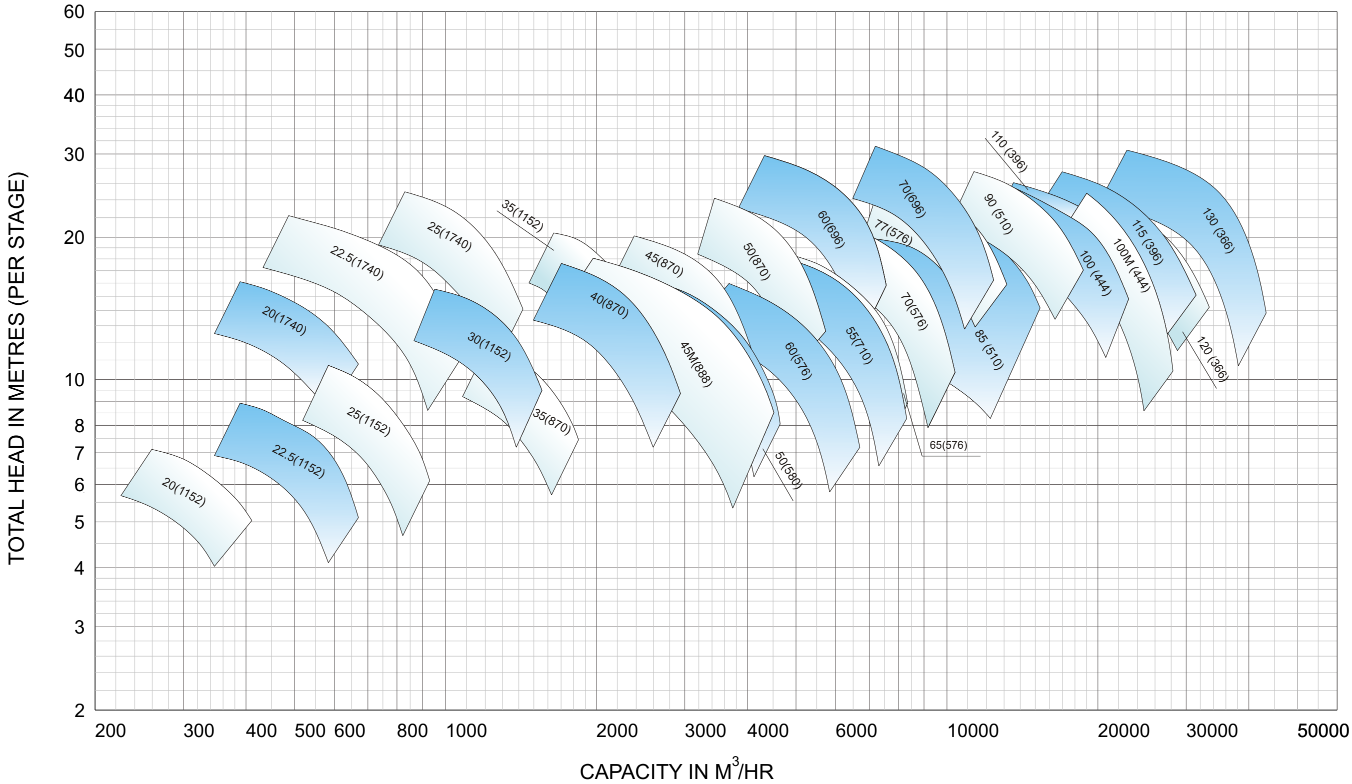
NOTE: FIGURES IN BRACKET INDICATE SPEED IN RPM

FAMILY CURVES FOR BHM PUMPS (50HZ)



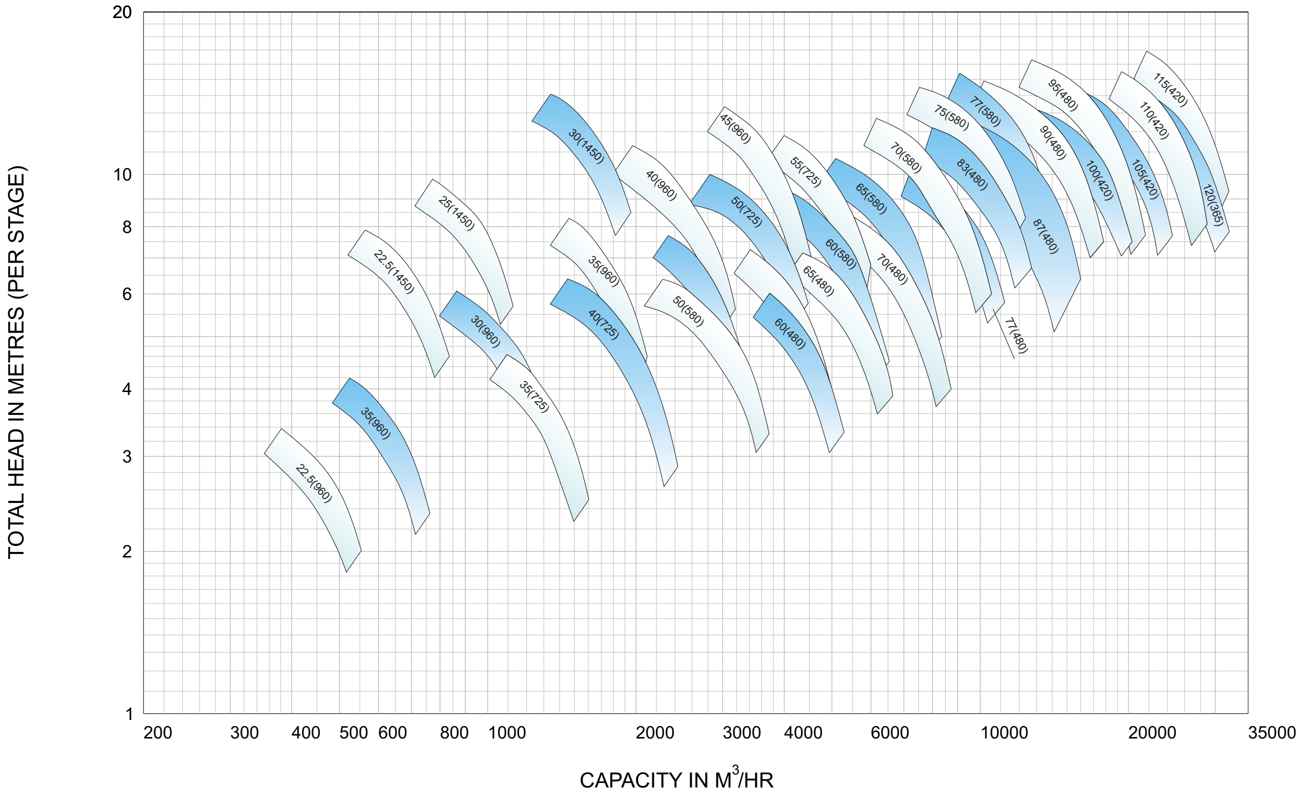
NOTE: FIGURES IN BRACKET INDICATE SPEED IN RPM

FAMILY CURVES FOR BHM PUMPS (60HZ)



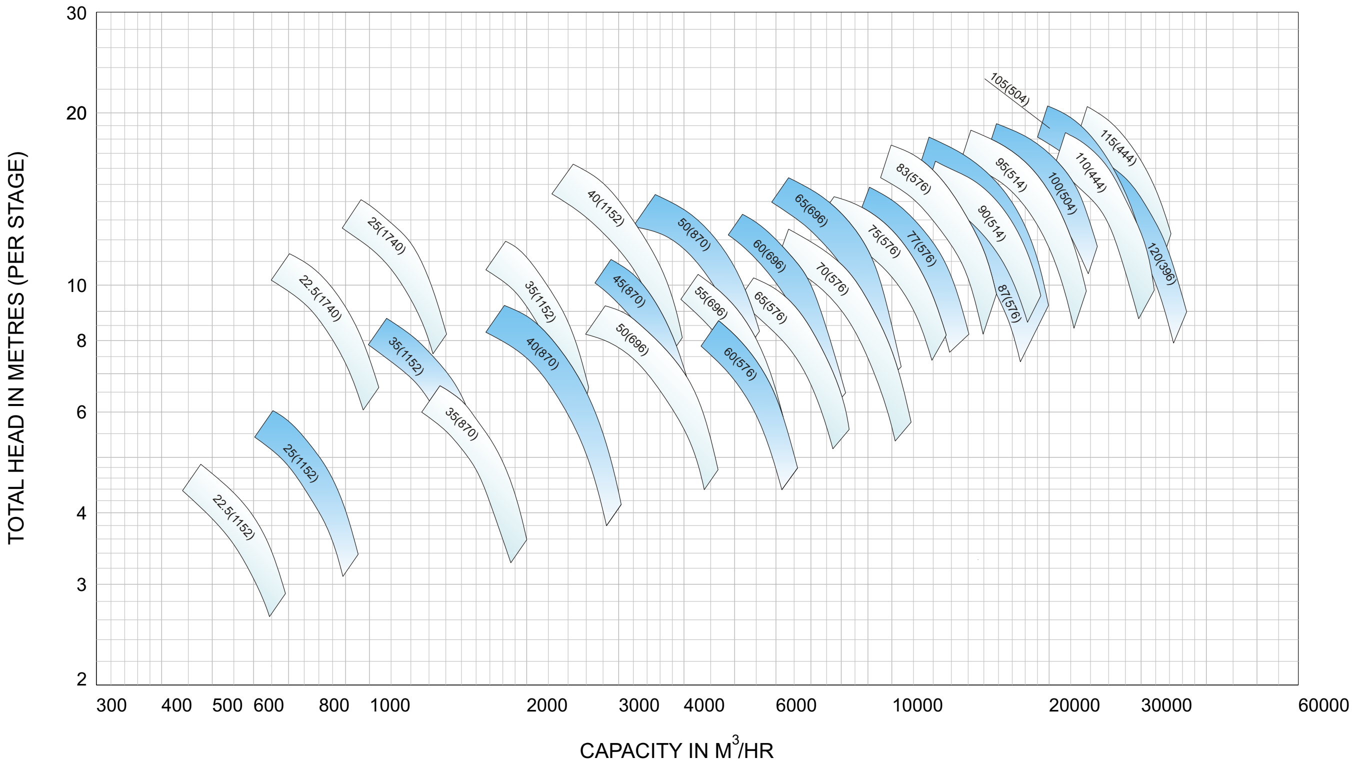
NOTE: FIGURES IN BRACKET INDICATE SPEED IN RPM

FAMILY CURVES FOR BHMa PUMPS (50HZ)



NOTE: FIGURES IN BRACKET INDICATE SPEED IN RPM

FAMILY CURVES FOR BHMa PUMPS (60HZ)



NOTE: FIGURES IN BRACKET INDICATE SPEED IN RPM

ABOUT KBL

Kirloskar Brothers Limited (KBL) is a world class pump manufacturing company with expertise in engineering and manufacture of systems for fluid management. Established in 1888 and incorporated in 1920, KBL is the flagship company of the $ 2.1 billion Kirloskar Group. KBL, a market leader, provides complete fluid management solutions for large infrastructure projects in the areas of water supply, power plants, irrigation, oil & gas and marine & defence. We engineer and manufacture industrial, agriculture and domestic pumps, valves and hydro turbines.

In 2003, KBL acquired SPP Pumps, United Kingdom and established SPP INC, Atlanta, USA, as a wholly owned subsidiary of SPP, UK to expand its international presence. In 2007, Kirloskar Brothers International B.V., The Netherlands and Kirloskar Brothers (Thailand) Ltd., a wholly owned subsidiary in Thailand, were incorporated. In 2008, KBL incorporated Kirloskar Brothers Europe B.V. (Kirloskar Pompen B.V. since June 2014), a joint venture between Kirloskar International B.V. and Industrial Pump Group, The Netherlands. In 2010, KBL further consolidated its global position by acquiring Braybar Pumps, South Africa. SPP MENA was established in Egypt in 2012. In 2014, KBL acquired SyncroFlo Inc., the largest independent fabricator of commercial and municipal domestic water booster pumps.

To further strengthen its global position, in 2015, Kirloskar Pompen B.V. acquired Rodelta Pumps International, The Netherlands.

KBL has joint venture cooperation with Ebara, Japan since 1988 for the manufacture of API 610 standard pumps. Kirloskar Corrocoat Private Limited is a joint venture cooperation with Corrocoat, UK since 2006. KBL acquired The Kolhapur Steel Limited in 2007 and Hematic Motors in 2010.

KBL has eight manufacturing facilities in India at Kirloskarvadi, Dewas, Kondhapuri, Shirwal, Sanand, Kaniyur, Kolhapur and Karad. In addition, KBL has global manufacturing and packaging facilities in Egypt, South Africa, Thailand, The Netherlands, United Arab Emirates, United Kingdom and United States of America. KBL has 12,700 channel partners in India and 80 overseas and is supported by best-in-class network of Authorised Centres and Authorised Refurbishment Centres across the country.

All the manufacturing facilities at KBL are certified for ISO 9001, ISO 14001, ISO 50001, BS OHSAS 18001 and SA8000. In addition, the Kirloskarvadi plant is also certified for N & NPT Stamp. KBL's corporate office in Pune is certified for ISO 9001 & Sa8000.

The factories deploy Total Quality Management tools using European Foundation for Quality Management (EFQM) model.
The Kirloskarvadi plant of KBL is a state-of-the-art integrated manufacturing facility having Asia's largest hydraulic research centre with testing facility upto 5000 kW and 50,000 m^3/hr.

KBL is the ninth pump manufacturing company in the world to be accredited with the N and NPT certification by American Society of Mechanical Engineers (ASME).

Pumps | Valves | Hydro Turbines | Turnkey Projects

Water Resource Management | Irrigation | Power | Industry | Oil & Gas | Marine & Defence | Building & Construction| |
Distribution (Small Pumps) | Valves | Customer Service & Spares

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KIRLOSKAR BROTHERS LIMITED

A Kirloskar Group Company

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Global Headquarters: “Yamuna”, Survey No. 98/(3.7), Baner, Pune 411045. Tel: +91(20)27214444
Email: marketing@kbl.co.in, Website: www.kirloskarpumps.com, CIN No.: L29113PN1920PLC000670

OUR COMPANIES

SPP Pumps	SyncroFlo	BP	KOPL	RODELTA
United Kingdom	U.S.A.	South Africa	India	The Netherlands

VT-BHR-BHQ - 06-2016

Jyoti Ltd.

Water • Power • Progress

JYOTI
Vertical Turbine Pumps
(oil & water-lubricated)

Manufactured, designed
and made the First Vertical Turbine
(VT) Pump in India, way back in 1942

ISO 9001:2015 || TUV INDIA

TÜV INDIA
TÜV NORD GROUP

70 YEARS OF ENGINEERING EXCELLENCE

APPLICATION

Pumps for

- irrigation
- urban & rural water supply
- Cooling tower
- Fire fighting
- Flood control
- Mine dewatering
- Thermal power stations
- Condensate extraction
- General & process water in industries
- Oil field water services and a hoast of other needs.

RANGE

Bowl sizes	150 mm to 600 mm
Capacity	200 lpm to 33200 lpm
Head	upto 225 mts

For higher capacities refer to us.

SPECIAL DESIGN FEATURES

- Heavy wall cast iron bowls & cast iron / Stainless Steel impellers provided for maximum operating life, under ardous Indian conditions.
- Impeller shafts of stainless steel
- Column pipes and line shafts are machined and threaded on double ended special purpose machines in single setting ensuring concentricity.
- All shaft couplings in water lubricated pumps are made of stainless steel for extra-long life.

CONSTRUCTIONAL FEATURES

'JYOTI' VT pumps are offered in non-pull out construction as a standard design. The pump can be supplied for coupling with vertical hollow shaft motors or vertical solid shaft motors. Also for surface discharge or underground discharge.

BOWLS

Standard bowls are made of close grained cast iron. The diffuser vanes are cast integrally.

IMPELLERS

Impellers are closed or semi-open type, statically and dynamically balanced for vibration-free operation. They are secured to the impeller shaft with tapered lock collects or keys & split rings. The impeller position can be adjusted vertically by means of impeller-adjusting nut provided in the drive.

IMPELLER SHAFT

Impeller shaft is of stainless steel, accurately ground to close tolerances. The shaft is supported by bearings above and below each impeller.

COLUMN PIPES

Column pipes are normally supplied in nominal lengths of 3.0m, 1.5m and 0.75m pipes of non-standard lengths also can be supplied on request.

LINE SHAFTS

Line shafts are of high grade carbon steel, ground to close tolerances and threaded concentrically at the ends. Available in nominal lengths of 3.0m, 1.5m and 0.75m and in non-standard lengths to suit specific site conditions. Line shaft in stainless steel and suitable for muff couplings also can be supplied, if required.

LINE SHAFT BEARINGS

Made of bronze for oil lubricated pumps and Nitrile Rubber for water lubricated pumps.

SHAFT ENCLOSING TUBES

(for oil-lubricated pump)

These heavy duty steel tubes protect the line shafts from corrosion and foreign materials and support the line shaft bearings. The tubes are threaded concentrically in one setting at both ends. Available in different lengths, as line shafts.

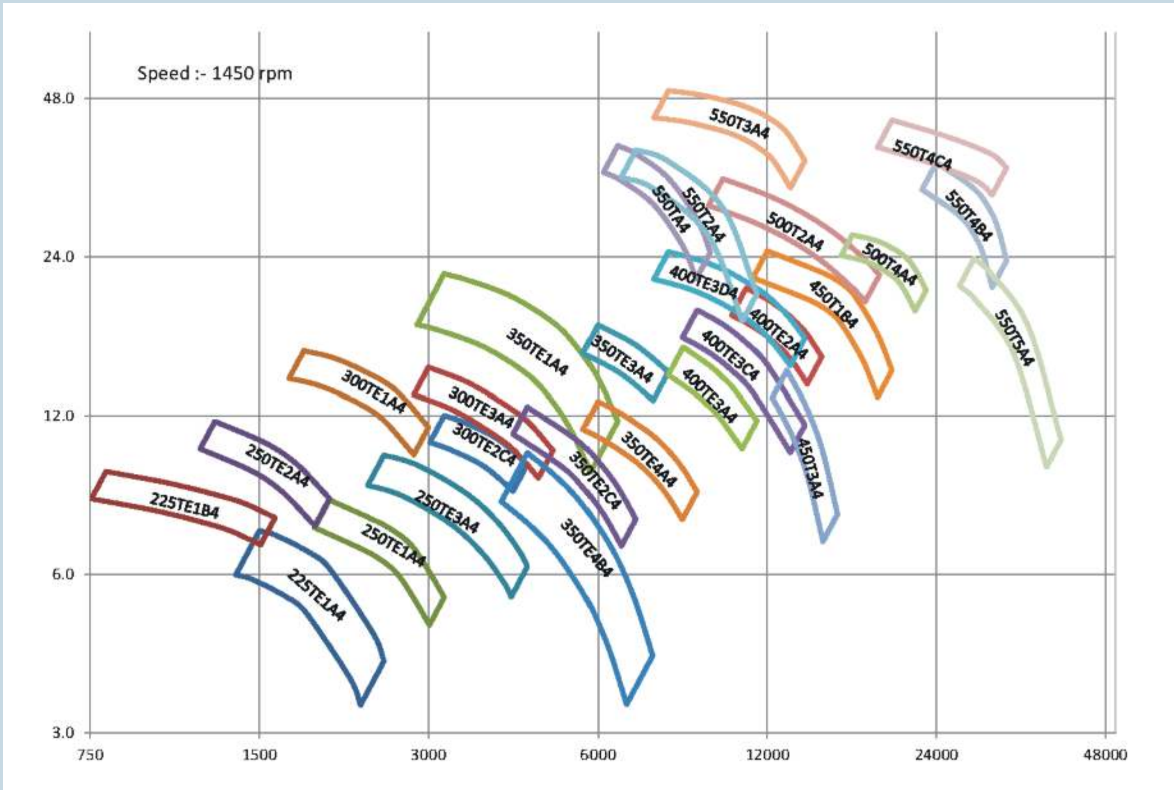
DISCHARGE HEAD

Standard construction in cast iron. Fabricated ones also can be supplied on request. Pump can be supplied with surface or underground discharge to suit specific site conditions.

DRIVES

Electrical motors with vertical hollow shaft or vertical solid shaft are normally used. Alternatively right angle gear head with diesel engine also can be used.

FAMILY CURVE FOR STANDARD VT PUMPS (225 to 550 mm)



STANDARD MATERIAL OF CONSTRUCTION

OIL LUBRICATED / WATER LUBRICATED / FORCE LUBRICATED PUMP

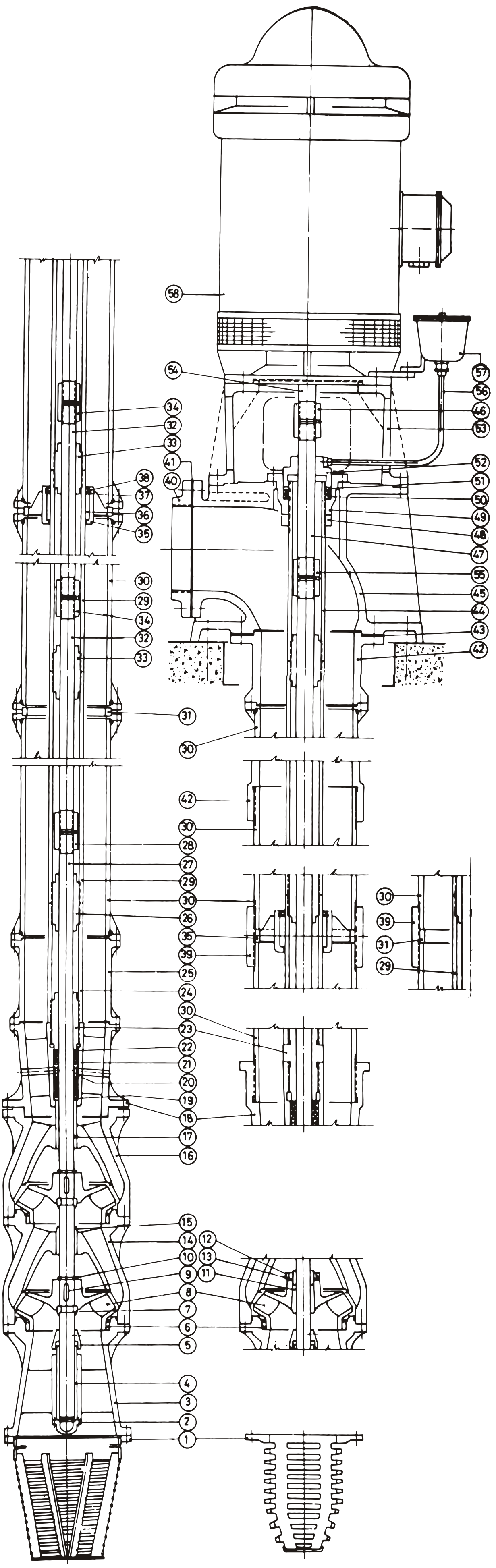
S.NO.	PART DESCRIPTION	MATERIAL	SPECIFICATION
1	STAINER	M.S.	IS : 2062 St.42-S
2	SUCTION CASE	CAST IRON	IS : 210 Gr FG-200
3	SUCTION CASE BEARING	BRONZE	IS : 318 Gr LTB2
4	IMPELLER SEAL RING	CAST IRON	IS : 210 Gr FG-200
		BRONZE	IS : 318 Gr LTB2
5	IMPELLER	CAST IRON	IS : 210 Gr FG-200/260
		BRONZE	IS : 318 Gr LTB2
6	BOWL	CAST	IRON IS : 210 Gr FG-260
7	IMPELLER SHAFT	ST. STEEL	ASTM A276 SS 410
8	DISCHARGE CASE	CAST IRON	IS : 210 Gr FG-200/260
9	COLUMN PIPE ADOPTOR	CAST IRON	IS : 210 Gr FG-200/260
10	GUIDE SPIDER/BEARING HOLDER	CAST IRON	IS : 210 Gr FG-200/260
11	COLUMN PIPE	ERW STEEL	IS : 1239 Class C / IS : 1978
		M.S. FABRICATED	IS : 2062 St.42-S
12	SHAFT ENCLOSING TUBE (OL)	STEEL	IS : 1239 Class C / IS : 1978
13	LINE SHAFT CARBON	STEEL	IS: 1570 C40 / ASTM A276 SS 410
14	LINE SHAFT COUPLING (OL) CARBON	STEEL	IS: 1570 C40 / ASTM A276 SS 410
15	LINE SHAFT COUPLING (WL) ST.	STEEL	ASTM A276 SS 410
16	LINE SHAFT BEARING (OL)	BRONZE	IS : 318 Gr LTB2
17	LINE SHAFT BEARING (WL)	NITRILE RUBBER	SHORE HARDNESS 60-65
18	TOP COLUMN FLANGE	CAST IRON	IS : 210 Gr FG-200/260
19	DISCHARGE HEAD BODY	CAST IRON	IS : 210 Gr FG-200/260
		M.S. FABRICATED	IS : 2062 St.42-S
20	HEAD SHAFT CARBON	STEEL	IS: 1570 C40 / ASTM A276 SS 410
21	STUFFING BOX	CAST IRON	IS : 210 Gr FG-200/260
22	GLAND	CAST IRON	IS : 210 Gr FG-200/260
23	MOTOR SKIRT	CAST IRON	IS : 210 Gr FG-200/260
		M.S. FABRICATED	IS : 2062 St.42-S
24	MOTOR	VERTICAL HOLLOW OR	IS: 325
		SOLID SHAFT	

NOTE : Material of Construction mentioned above are our standard ones, other materials to suit specific site conditions can be supplied on request.

OPTIONAL ACCESSORIES

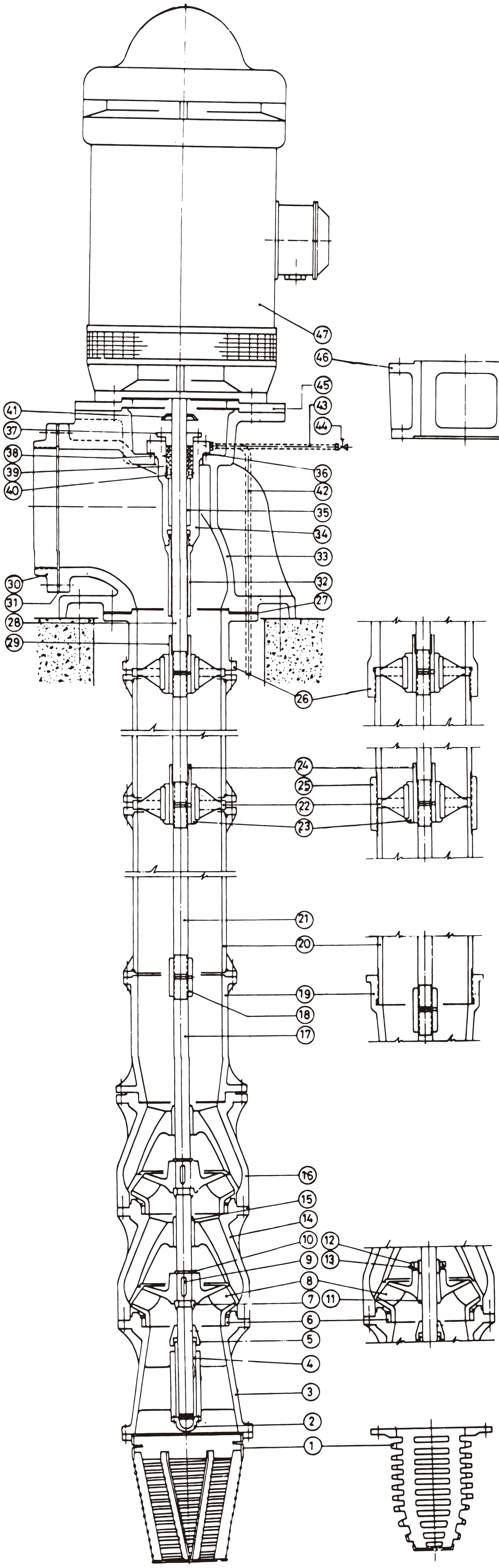
- Foundation bolts
- Sole plate
- Companion flanges.

'JYOTI' VERTICAL TURBINE PUMP
(OIL-LUBRICATED)



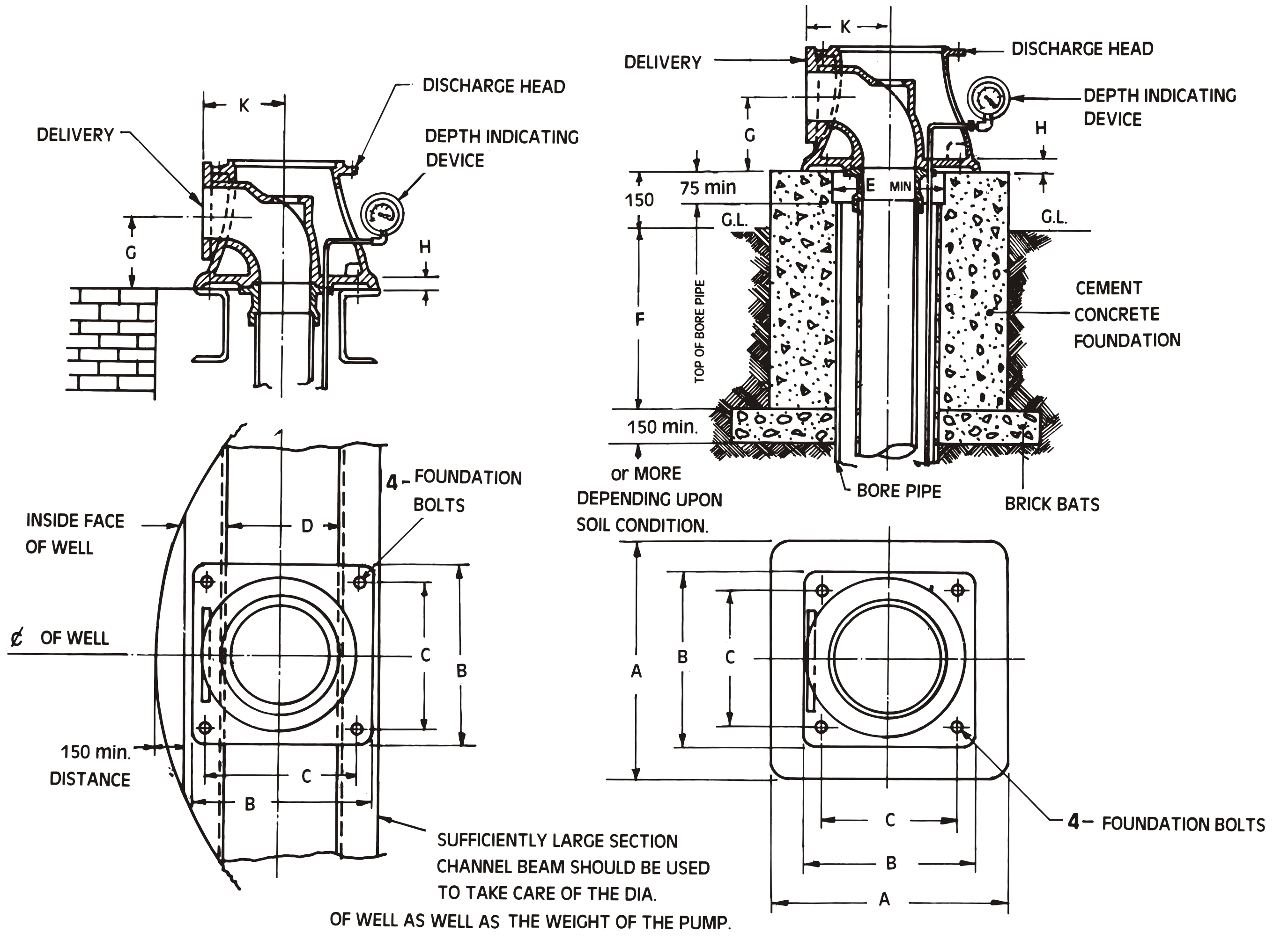
Sr. No.	PART NAME
58	Vertical Hollow Shaft Motor
57	Automatic Lubricator Assly
56	Oiling Pipe
55	Head Shaft Coupling
54	Head Shaft
53	Motor Skirt or Adapting Plate
52	Gland
51	Gland Packing Ring
50	Gland Packing
49	Tube Tension Plate
48	Check Nut
47	Head Shaft Extension
46	Head Shaft Extension Coupling
45	Discharge Head Body
44	Tube Tension Nipple
43	Top Column Flange Gasket
40	Delivery Flange (Up to D-150 Dis-Head)
39	Column Pipe Coupling
38	Circlip
37	Rubber Guide Ring Washer
36	Rubber Guide Ring
35	Guide Spider
34	Line Shaft Coupling
33	Line Shaft Bearing
32	Line Shaft
31	Column pipe spacer
30	Column Pipe Flanged or Threaded
29	Shaft Enclosing Tube
28	Impeller Shaft Coupling
27	Impeller Shaft
26	Impeller Shaft Bearing
25	Column Pipe Adoptor
24	Tubing Adaptor
23	Discharge Case Bearing
22	Impeller Shaft Packing Ring
21	Impeller Shaft Packing
20	Lantern Ring
19	Distance Piece
18	Discharge Case Flange or Threaded
17	Top Bowl Bearing
16	Top Bowl
15	Bowl Bearing
14	Bowl
13	Impeller Collect Nut Washer
12	Impeller Collet Nut
11	Impeller Collet
10	Circlip
9	Impeller Key
8	Impeller
7	Impeller Holding Split Ring
6	Impeller Seal Ring
5	Suction Case Sand Collar
4	Suction Case Bearing
3	Suction Case
2	Suction Case Plug
1	Suction Pipe Strainer

'JYOTI' VERTICAL TURBINE PUMP
(WATER-LUBRICATED)



Sr. No.	PART NAME
46	Vertical Hollow Shaft Motor
45	Adapting Plate or Distance Piece
44	Valve
43	Water Lubricating Tube
42	Water Leakage Tube
41	Water Deflector
40	Lantern Ring
39	Gland Packing
38	Gland Packing Ring
37	Gland
36	Stuffing Box Gasket
35	Stuffing Box Bush
34	Stuffing Box
33	Discharge Head Body
32	Stilling Pipe
31	Delivery Flange Gasket
30	Delivery Flange (Up to D-150 Dis-Head)
29	Head Shaft Coupling
28	Head Shaft
27	Top Column Flange Gasket
26	Top Column Flange - Flanged or Threaded
25	Column Pipe Coupling Threaded
24	Line Shaft Coupling
23	Rubber Bearing
22	Brg. Holder Flanged or Threaded
21	Line Shaft
20	Column Pipe flanged or Threaded
19	Col. Pipe flanged or Threaded or Threaded
18	Impeller Shaft Coupling
17	Impeller Shaft
16	Top Bowl
15	Bowl Bearing
14	Bowl
13	Impeller Collet Nut washer
12	Impeller Collet Nut
11	Impeller Collet
10	Circlip
9	Impeller Key
8	Impeller
7	Impeller Holding Split Ring
6	Impeller Seal Ring
5	Suction Case Sand Collar
4	Suction Case Bearing
3	Suction Case
2	Suction Case Plug
1	Suction pipe Strainer

FOUNDATION DRAWING for 'JYOTI' VERTICAL TURBINE PUMP



PUMP ON OPEN WELL | **PUMP ON TUBE WELL**

Discharge Head	A	B	C	D	E	F	G	H	K	L	M	N	Foundation		
													Dia	No.	Length
D/DS 100	600	400	335	260	295	460	156	30	190	4	18	178	M 16	4	250
D/DS 150	640	440	375	295	330	460	203	35	215	8	18	235	M 20	4	300
D/DS 200	775	565	485	410	410	610	235	45	285	8	18	292	M 24	4	500
D/DS 250	900	690	600	500	520	610	270	60	350	8	22	356	M 24	4	500
D/DS 300	900	700	600	500	520	610	320	60	355	12	22	406	M 24	4	500
D/DS 350	1050	850	740	625	590	700	365	60	430	12	24	470	M 24	4	500
D/DS 400	1050	850	740	625	590	700	380	60	430	12	24	521	M 24	4	500

All dimensions are in mm except otherwise stated.

Note : Delivery flanges are acording to BS : 10, Table "E"

Jyoti Ltd. VADODARA (INDIA)

Water • Power • Progress

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In keeping with the technological strides the world is making in the engineering field, we introduce changes in the design of our products. Hence, the products as actually supplied might have features varying here from.

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