

Amp-Master™ AM-HV-1000

HV CURRENT RECORDER

USER'S MANUAL



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1. OVERVIEW

1.1 INTRODUCTION

The Amp-Master™ AM-HV-1000 is a high-voltage current recorder that is installed onto overhead power lines where it measures and stores a profile of the current flowing. A special adaptor tool enables quick and easy installation of the device onto HV power lines using a standard link-stick. The device ships with PC-based software which is used to configure the unit as well as to download and view recorded data. The recorders are shipped with a rugged carry case with foam cutouts for locating and protecting the recorders and ancillary equipment. A photograph of an installed recorder is shown in Figure 1.

**FIGURE 1:
AMP-MASTER™ RECORDER**



1.2 FEATURES

- 1000A full scale current
- 1A resolution
- 2-5% typical accuracy
- Overload-proof current sensor
- Large memory
- Long battery operating life
- Battery healthy monitor
- Software for device configuration and downloading
- Immediate, scheduled or current-present recording modes
- IP65 environment protection
- Rugged and reliable electronics
- ISO9001 based quality assurance
- Electromagnetic compatibility

2. INSTALLATION

The AM-HV-1000 is installed onto an overhead power line using a standard link-stick fitted with a special adaptor tool (Figure 2). The adaptor tool has a hook which is inserted through an eye on the recorder. The adaptor is then screwed closed to fasten it to the recorder. The spring clamp mechanism on the recorder is then turned until it latches in the open position (Figure 3). The recorder is then lifted up to the power line so that the conductor passes through the center of the probe assembly. When the conductor presses against the clamp it will snap shut, locking the recorder firmly in position (Figure 1).

To retrieve the recorder the reverse is done. The adaptor tool is re-inserted into the eye on the recorder and the adaptor is then screwed closed by rotating the link-stick. The recorder can then be pulled off the line.

**FIGURE 2:
ADAPTOR TOOL**



**FIGURE 3:
ADAPTOR TOOL FASTENED**



3. OPERATION

3.1 CURRENT MEASUREMENT

The recorder has a current sensor which consists of a rogowski coil encapsulated inside a U-shaped probe. This sensor picks up the magnetic field of the current flowing in the power-line. Electronic circuitry amplifies the signal and measures the RMS magnitude of the current flowing. The full scale current of the recorder is 1000A. The recorder will not be damaged by overloads.

3.2 RECORDING INTERVAL

The recorder samples the current every 10 seconds and then records the average of the samples over a period to memory. This averaging period is known as the recording interval. Data averaged over the interval is only stored to memory at the end of the recording interval. The recorder can be programmed with recording intervals of 1, 5, 10, 15, 30 and 60 minutes. All data recording done in the recorder is clock hour orientated. This means that the recording start time may be delayed so that the data storage times always align with the top of the hour. This allows data from several recorders to be correlated easily. For example, if the programmed recording interval is 15 minutes, and the recording is programmed to start at 08:20, the averaging interval will only start at 08:30, with the first recorded data being recorded at the end of this interval at 08:45.

3.3 MEMORY

3.3.1 RECORDING TIME

The memory capacity of the recorder is just over 16 000 readings. The available recording time is determined by the recording interval, with shorter intervals using up memory quicker. The battery life is not affected by the choice of recording interval. Table 1 lists the approximate maximum recording times for each of the possible recording intervals.

TABLE 1: RECORDING TIME

Recording Interval	Recording Time
1 minute	11 days
5 minutes	56 days
10 minutes	112 days
15 minutes	168 days
30 minutes	335 days
60 minutes	670 days

3.4 MEMORY FULL CONDITION

At some point during recording, the recorder may completely fill its internal memory with data. The recorder can be programmed to either stop recording when out of memory, or to continue recording by wrapping around to the start of memory and overwriting the oldest recorded data with the most recent data.

3.5 RECORDING MODE

The recorder has three recording modes to start or stop recording - *Immediate*, *Current present*, or *Scheduled*.

3.6 IMMEDIATE RECORDING MODE

When programmed for *Immediate* recording mode, recording is started immediately while the recorder is still connected to the computer. It is then taken to site and installed. After recording at the site is completed, the recorder is brought back to the computer, where the data is downloaded. The recorder can then be programmed to stop recording. The advantage of this recording mode is that the installation crew does not need to initiate the recording. There will however be some data at the beginning and end of the test when the recorder was not installed on the power line.

3.6.1 CURRENT PRESENT RECORDING MODE

When programmed for *Current Present* recording mode, recording only occurs while the current flowing in the power line is above a trigger level which is programmed by the user. The recorder samples the current flowing over each averaging interval, and will only start recording to memory when it detects that the current flowing in the line over an averaging interval is above the trigger level. It will keep recording until the average current over the averaging interval is less than the trigger level, at which time recording will be stopped. Once recording has been initiated and then subsequently stopped it will not restart if current above the trigger level resumes. The trigger level is prevented from being set below 20A.

The advantage of this recording mode is that recording starts automatically upon installation on a live power line with sufficient current flowing, and stops automatically when the recorder is removed. The recorder will however also stop recording due to a lightly loaded line or a tripped line.

Another advantage of this recording mode is that a high trigger setting can be used to only initiate recording when high levels of current are flowing. This could be used for example to establish whether the current flowing in a line ever exceeds a certain level over a period of time. With this recording mode the recorder could be left installed for many months and would only record data if the current trigger level is reached.

3.6.2 SCHEDULE RUN

When programmed for *Scheduled Run* recording mode, the recorder automatically starts and stops recording at the date and time specified when programming. The recorder has a real-time clock onboard that is set to the computer's clock whenever the recorder is programmed.

The advantage of this recording mode is that the recorder can be set up in advance to start and stop recording automatically. It can be programmed many days or weeks in advance and then handed over to the installation crew.

3.7 BATTERY SUPPLY

The recorder is powered from an internal long-life lithium battery. The electronic circuitry has been designed to use ultra-low power, maximizing battery life. The recorder monitors its own usage of battery power and the status of the battery can be viewed from within the programming software environment. During normal operation the battery has a typical operating life of at least one year. If the recording mode of the device is switched off the battery has a typical operating life of up to five years. If the battery is removed from the device it has a typical shelf-life of at least ten years.

3.8 SERIAL COMMUNICATION

The recorder has an on-board serial port which is accessed via a water-tight screw cap on the lid of the electronics enclosure. This enables the recorder to be connected via a serial-cable to a personal computer, both for downloading data and for device setup. The serial cable is shown in Figure 4.

The serial cable has a female DB-9 connector on one end to connect with a male DB9 connector on a RS-232 port on the computer. The other end of the serial cable has a 3-way jack plug which is inserted into a jack socket on-board the recorder.

**FIGURE 4:
SERIAL CABLE**



The Amp-Master™ software communicates with the recorder via the serial cable at a baud rate of 19600. Any valid communications port (i.e. COM1, COM2, COM3, COM4) can be used if it is available and not being used by another program. If the software is started with the recorder already connected, it will automatically detect which communication port to open.

A USB-to-RS232 converter can be used on PC's which do not have a serial port. The driver for the converter enables the USB port to be used as a virtual serial port by the application software.

When data is sent from the recorder to the computer, this action is referred to as a download. When data is sent from the computer to the recorder, this action is referred to as an upload.

3.9 SETUP PROGRAMMING

The Amp-Master™ software is used to program the setup configuration of the recorder. A setup screen enables the user to customize each setting. The setup screen can be initialized with default settings, or the settings can be retrieved from a saved file, or the settings can be retrieved from the recorders existing on-board settings.

3.10 DOWNLOADING DATA

The Amp-Master™ software is used to download data from the recorder to the computer. The data is then saved in a comma-delimited file format that is suitable for importing into a spreadsheet package like Microsoft Excel. After the download and file saving is complete, the software automatically displays the data for user verification. A summary of the recording is provided, along with the data in tabular and graphical format.

4. SOFTWARE

4.1 SYSTEM REQUIREMENTS

To use the Amp-Master™ software, your computer must have one of the following Windows operating systems:

- Windows Me
- Windows NT 4.0 Workstation
- Windows 2000
- Windows XP

Your computer must also meet the following minimum requirements:

- Pentium processor at 133MHz
- 16MB RAM
- 10MB of available hard disk space
- CD ROM drive
- 9-pin RS232 serial port (or USB port with a USB-to-serial port adaptor).

4.2 SOFTWARE INSTALLATION

Insert the Amp-Master™ CD into the CD ROM drive. The CD has an autorun feature to automatically start the software installation. Alternatively the software can be installed by double-clicking on the "setup.exe" file located in the root-directory of the CD. Follow the instructions during the installation. If prompted with the question "A file already exists which is newer... Overwrite?" then select <No>.

4.3 COMMUNICATION

A serial cable with a DB9 connector is available to connect the recorder to a PC via a 9-pin RS232 male serial port. The serial cable is shown in Figure 5. On startup the Amp-Master™ software will automatically detect which port the recorder is using if it is connected. Alternatively the user can select COM1, COM2, COM3 or COM4 via the menu sequence <Options> <Comm Port>. The baud rate is fixed at 19200. This serial link is used to both download data from the recorder as well as upload setup information.

4.4 DEVICE SETUP

The menu sequence <File> <New Setup> allows the user to configure the setup of the recorder. The Setup form is shown in Figure 5. Once this form has been configured, the setup can be saved under a file name with the menu sequence <File> <Save Setup As>. The setup can then be uploaded to the recorder by clicking on the <Program> pushbutton.

The Setup form allows the user to enter a site description, the recording interval and whether the recording should stop when the memory is full or rotate around writing over old data. The user can also select the recording mode of the device. The recording interval, memory mode and recording mode are discussed in more detail in Sections 3.2, 3.3 and 3.4 respectively.

The menu sequence <File> <Download Setup> downloads and displays the existing setup in the recorder. The user can edit this setup, save setup to a file and reprogram the recorder.

The menu sequence <File> <Open Setup> allows the user to open a previously saved setup configuration.

FIGURE 5: SETUP FORM

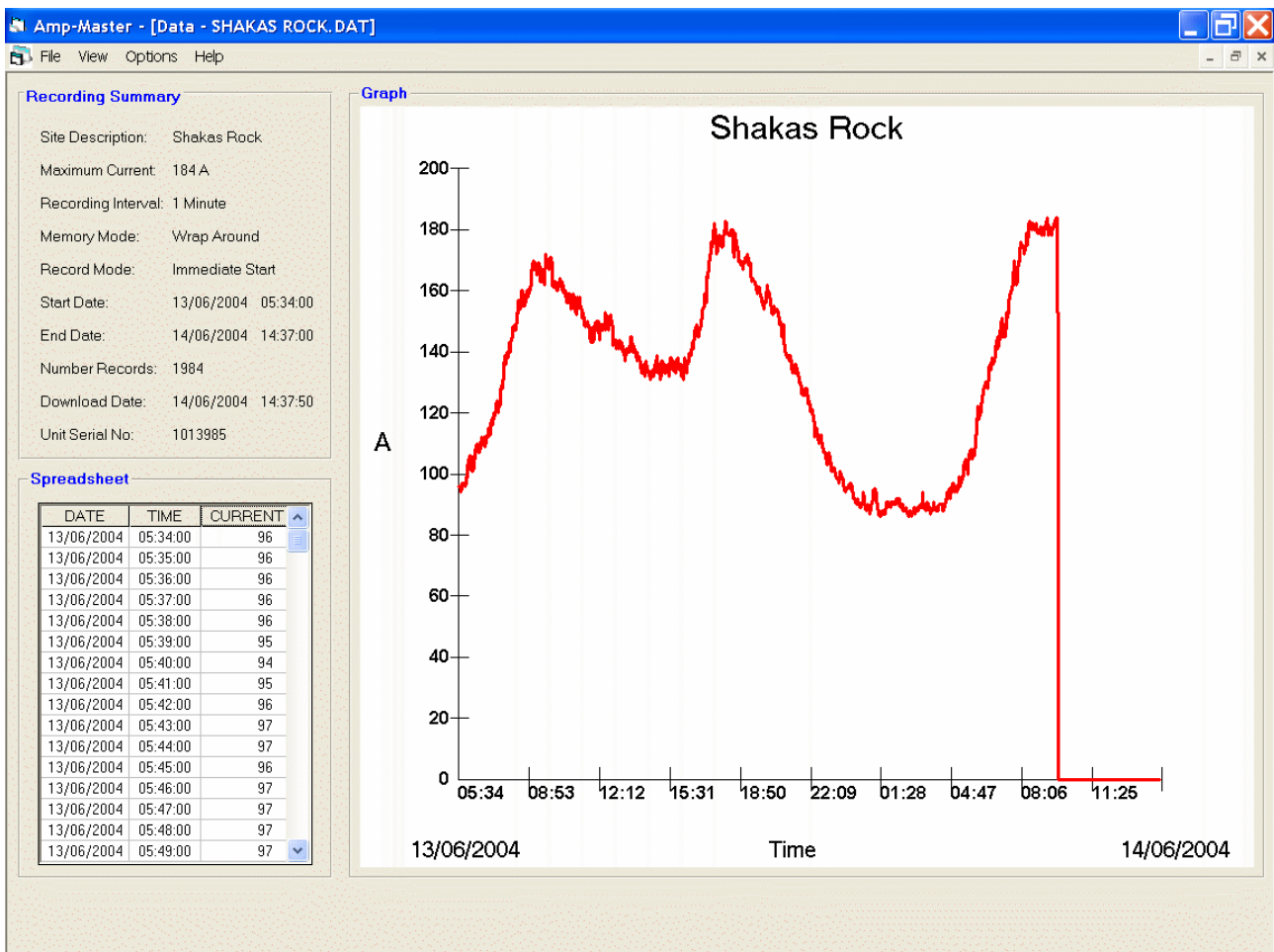
4.5 DATA DOWNLOAD

The recorded data saved on-board the AM-HV-1000 can be downloaded to the PC by using the menu sequence <File> <Download>. The user will be prompted for a file name and directory. The downloaded data file will be saved in a comma-delimited text file format. This format can be easily imported into any of the popular spreadsheet packages available. After the download and file saving is complete, the software automatically displays the data for user verification. A summary of the recording is provided, along with the data in tabular and graphical format. A typical Data form is shown in Figure 6.

4.6 VIEWING THE DATA

The data can viewed from within the Amp-Master™ software by selecting the menu sequence <File> <Open Data>. After prompting for the file name the software then displays the data in both graphical and tabular format along with a recording summary. A typical Data form is shown in Figure 6.

FIGURE 6: SAMPLE DATA FORM



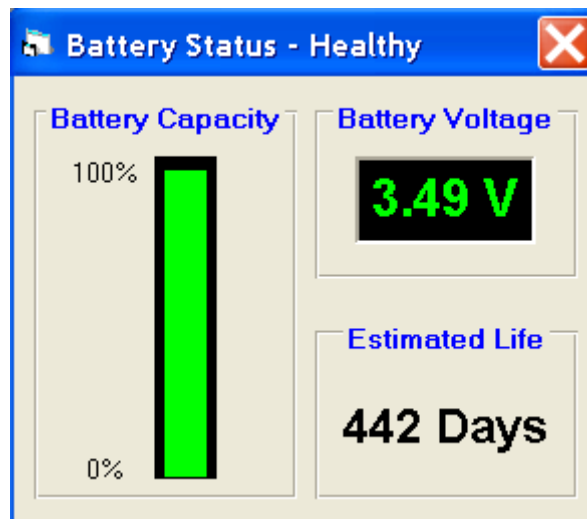
4.7 SPREADSHEET IMPORTING

The downloaded data can be easily imported into Microsoft Excel for further viewing and manipulation. To do this, run Excel and then use the menu sequence <File> <Open>. The Amp-Master™ files are stored with a “.dat” extension. When prompted for a file, make sure that you select “All files (*.*)” in the “Files of type” drop-down list-box. Then select your file. A text-import wizard will appear. Accept the default settings (Delimited) for Step 1 and select the “Next” command button. For Step 2 select the “comma” option button in the “Delimiters” frame and then select the “Finish” command button. Your data should be displayed in the spreadsheet.

4.8 BATTERY STATUS

The health of the battery can be viewed by the menu sequence <View> <Battery Status>. The Battery Status form shown in Figure 7 will be shown. The bar graph to the left of the form shows the approximate battery capacity remaining. The recorder calculates this by tracking the number of program cycles that have occurred since the recorder was last powered up. This will be when the battery was last removed and replaced. The recorder will assume that the replacement battery is new and use the battery's rated ampere-hour capacity to calculate the remaining operating capacity. Based on this capacity the form also displays the estimated life of the battery. The battery voltage is also monitored and displayed. If the battery voltage drops below 3.4V the form will indicate that the battery is unhealthy and requires replacement.

FIGURE 7: BATTERY STATUS FORM



5. TESTING

The AM-HV-1000 can be tested by injecting current through the current sensor. Large currents can easily be injected by looping the conductor several times through the sensor. This method should only be used for performing very rough tests - accuracy can only be achieved by using the method described under the section on calibration.

A typical test procedure is suggested below.

1. Set the record mode of the recorder to "Immediate".
2. Configure the unit for a recording interval of 1 minute.
3. Inject a constant test current for 5 minutes.
4. Download the data.
5. View the data.

- The average current over the recording intervals between the first and last intervals should be the same as the injected current. The readings for the first and last intervals might be lower due to the current not being measured over a full interval.

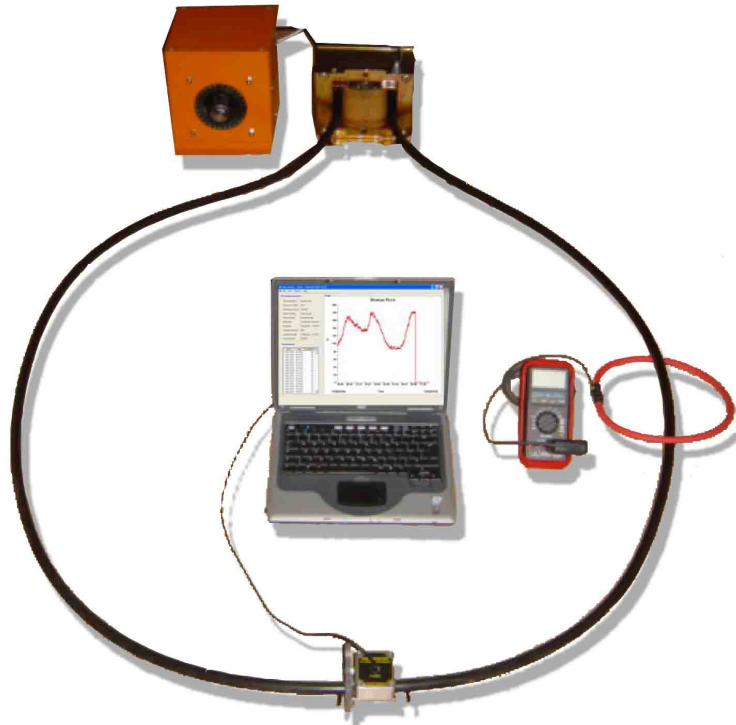
6. CALIBRATION

The AM-HV-1000 is shipped after it has been fully tested and factory-calibrated. Re-calibration should only be performed if equipment with sufficient rating and dimension is available as described below.

6.1 CALIBRATION EQUIPMENT

Calibration equipment is required which can source, control and measure an injection current of 1000A. Figure 8 shows a typical setup for performing calibration. A mains-powered variac rated 230V,10A is used to control the primary voltage on a 5KVA transformer. The transformer secondary consists of a single turn of 240mm² welding cable. The cable should be at least 5m in length and arranged to form a large circle. A current transducer of the rogowski coil type is used for measuring the injected current. Most clamp-on ammeters are not suitable because they are usually rated for at most 400A and actually start saturating before reaching their rated current. The Amp-Master™ recorder under calibration should be clamped onto the conductor at the furthest point from the transformer and be positioned so that the sensor is at 90° to the plane of the coil i.e. vertical. This is to prevent the sensor from being adversely influenced by magnetic field coming from the far end of the circle. The large cable diameter also helps reduce this effect.

**FIGURE 8:
CALIBRATION EQUIPMENT
AND SETUP**

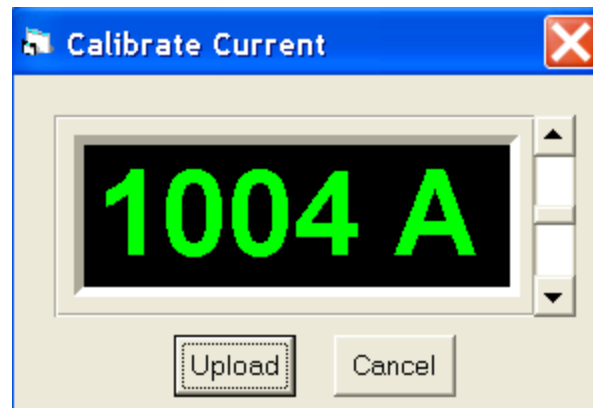


6.2 CALIBRATION PROCEDURE

The recorder calibration is performed from within the Amp-Master™ software. No adjustments are required to be made to the electronic circuitry inside the recorder enclosure.

Connect the serial cable and run the Amp-Master™ software. Select <View> <Realtime Current>. Now select <Options> <Calibrate>. The Calibration Current form will be visible as shown in Figure 9. Turn on the current injection set and adjust the current until the reading on the reference measuring instrument is close to 1000A. It does not need to be exact and in fact the reading will gradually decrease as the injection cable starts heating up. The recorder reading shown in the Amp-Master™ software can now be adjusted using the scrollbar. When the readings on both the reference instrument and the recorder are equal the calibration can be uploaded by clicking on the <Upload> button.

FIGURE 9: CALIBRATION FORM



7. SPECIFICATIONS

Network voltage range:	1-33kV
Full-load current:	1000A
Resolution:	1A
Measurement accuracy:	5%+10 ($\geq 200A$) 5%+20 ($< 200A$)
Fault current withstand:	25kA for 1s
Memory capacity:	670 days @ 60 min intervals 335 days @ 30 min intervals 168 days @ 15 min intervals 112 days @ 10 min intervals 56 days @ 5 min intervals 11 days @ 1 min intervals
Real-time clock accuracy:	± 1 min per week
Operating temperature:	-20°C to 70°C

Enclosure

-dimensions	65mm × 55mm × 40mm
-material	die-cast aluminium
-degree of protection	IP65
-mass:	250g

Clamp Assembly

-dimensions	65mm × 55mm × 70mm
-material	stainless-steel
-degree of protection	weather-proof and UV-resistant
-mass:	250g

Current sensor

-maximum conductor size:	≤ 28 mm diameter
-material:	PVC

Battery

-type:	3.6 V, ½AA, lithium battery
-international size refs.	½AA, 1/2R6, 1/2UM-3
-open-circuit voltage	3.6-3.7 V
-capacity:	0.85-1.2 AH
-operating current:	< 0.1mA (2mA during communications)
-operating life:	>1 year
-shelf life:	>10 years
-temperature effects	no adverse effects -55° C to +85° C
-suggested makes	SAFT, TADIRAN

8. ORDERING

ORDER NO:	DESCRIPTION:
AM-HV-1000KIT	Amp-Master™ Kit - 3 HV Current Recorders - 1 Carry Case - 1 Serial Cable - 1 Installation Tool - 1 Application Software CD
AM-HV-1000SET	Amp-Master™ Set - 3 HV Current Recorders - 1 Carry Case
AM-HV-1000	HV Current Recorder
AM-HV-1000-Serial cable	Serial Cable
AM-HV-1000-Installation tool	Installation Tool

FIGURE 10:
AMP-MASTER™ AM-HV-1000 KIT



9. SAFETY

To avoid electric shock read the following carefully:

- Ensure that the AM-HV-1000 is only used by qualified personnel practicing applicable safety precautions.
- Ensure that the AM-HV-1000 is installed only using an approved high-voltage link-stick
- Use caution during the installation and use of this product; high voltages and currents may be present in the circuit.
- Wear protective clothing and gloves as required.
- Always inspect the recorder for damage before using the product.
- Do not use the product if damaged.

10. WARRANTY

The Amp-Master™ AM-HV-1000 electronic hardware and software is copyrighted to Cybertronix cc 1996.

This product is warranted to be free from defects in material and workmanship for a period of twelve months (12) from the date of shipment. Correction shall be in the form of repair or replacement of the defective items or components, freight paid by the customer both ways. Such correction shall constitute a fulfillment of all Cybertronix cc liabilities in respect to said items and components. In no event shall Cybertronix be liable for consequential damage.

No other warranties:

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