# Expedited System Impact Study for Generation Interconnection Request

# GEN-2004-013

*SPP Tariff Studies*

*(#GEN-2004-013)*

**December 2004**

# Executive Summary

<OMITTED TEXT>Customer has requested an Expedited System Impact Study to evaluate a proposal to add up to 900MW of generation in eastern Atchison County, KS. The requested in-service date is June 1, 2009.

The Customer has proposed the addition of 900MW of coal-fired generation at the site. The unit will be interconnected to the existing Kansas City Power and Light (KCPL) Iatan 345kV substation.

This interconnection request was studied including a previously queued 900MW generation addition at the same interconnection point (GEN-2004-008). Including the existing 670MW of generation at Iatan and the 900MW for GEN-2004-008, the total generation capability at the Iatan 345kV substation would be a net of 2470MW.

The network upgrade requirements include expansion of the Iatan 345kV bus and installation of new 345kV circuit breakers to provide terminals for the unit and start/standby transformers. There are also numerous network upgrades required to alleviate the contingency overloading on the 345kV and 161kV transmission systems that results from the additional generation.

The total estimated cost of the required network upgrades for interconnection is $41,500,000 including work at the Iatan substation.

Short circuit analysis will be performed as part of the Facility Study performed by the Transmission Owner if the customer wishes to proceed.

Transient stability analysis indicates that for more probable disturbances with normal fault clearing times, system stability is maintained. With the occurrence of a less probable, extreme fault condition at the Iatan bus, in which fault clearing is delayed due to stuck breaker conditions, the Iatan and Customer units exhibit poor damping until the fault is cleared. Instability appears to be limited to relatively low magnitude, high frequency voltage oscillations.

Equipment at the Iatan substation is equipped with independent pole tripping to reduce the likelihood of delayed clearing of the three-phase fault condition. New equipment for the interconnection facilities should include similar operational capability, and out-of-step relaying is recommended for equipment protection.

Transmission Service is not analyzed during the interconnection impact study.

# 1. Introduction

## 1.1 Project Description

<OMITTED TEXT>Customer has requested a System Impact Study to evaluate a proposal to add up to 900MW of generation in eastern Atchison County, KS. The requested generation addition is for a 900MW coal-fired unit at the customer's site near the existing KCPL Iatan 345kV substation. The requested in-service date is June 1, 2009.

This interconnection request was studied including a previously queued 900MW generation addition at the same interconnection point (GEN-2004-008). Including the existing 670MW of generation at Iatan and the 900MW for GEN-2004-008, the total generation capability at the Iatan 345kV substation would be a net of 2470MW.

## 1.2 Study Methodology

The Interconnection System Impact Study investigates the effect of new generation on system performance during normal and contingency conditions. Deliverability of power to final customers is not analyzed. Those facilities that are affected only by the interconnection of the generation are analyzed in the Interconnection System Impact Study. Separate studies evaluate the impact of deliverability of the plants output.

Comparison of the base case, which excludes the proposed facilities, to the study case, which includes the proposed Customer unit, reveals any system constraints that result from the proposed generation addition. The analysis cases are based on the 2005 April Minimum, 2007 summer peak, 2007 winter peak, 2010 summer peak and 2010 winter peak to address the different seasonal loading conditions of the system. The proposed plant is modeled at maximum output of 900MW for all study cases.

The proposed plant is to be located in the Kansas City Power & Light (KCPL) control area. In order to determine the impact on facilities based only on the interconnection of the facility, a single sink for the plant's output is not studied. The plant's output is allocated to KCPL and the rest of the SPP area footprint on a pro rata basis.

Full AC contingency analysis (ACCC) is used to investigate the limiting constraints of the transmission system during contingency events. The analysis is performed using Shaw PTI's PSS/E v. 29.5. Comparisons are made between the cases with and without the Customer generation in service in order to identify the severity and cause of the overloading conditions. All branches in the KCPL and surrounding control areas above 69kV and all ties with KCPL are monitored for overloads exceeding 100% of emergency rating (Rate B). A TDF of 3% is required before a facility is flagged as impacted. Buses are monitored for voltage deviations exceeding +/- 5% of nominal.

# 2. Powerflow Analysis

## 2.1 2005 April Minimum

The 2005 April Minimum study case is used to evaluate light loading conditions and the effect of the added generation. It is likely that load levels and facilities will be different from the 2005 season when the generating unit enters service. However, the 2005 April Minimum case will provide insight into what will occur during light load conditions.

Added generation at the Customer facility results in no base case overloads on the transmission system. Prior to the addition of the proposed network upgrades, several transmission facilities were overloaded due to contingencies. After addition of the proposed network upgrades, no overloads occur as a result of outages of transmission facilities in the 2005 April Minimum case.

## 2.2 2007 Summer Peak

The 2007 Summer Peak study case is used to evaluate summer peak loading conditions and the effect of the added generation. It is likely that load levels and facilities will be different from the 2007 season when the generating unit enters service. However, the 2007 Summer Peak case will provide insight into what will occur during summer peak loading conditions and the reasons for overloads in later seasons.

Added generation at the Customer facility results in no base case overloads on the transmission system. Prior to the addition of the proposed network upgrades, several transmission facilities were overloaded due to contingencies. After addition of the proposed network upgrades, some overloading still occurs as a result of outages of transmission facilities in the 2007 Summer Peak case. The table below documents the facilities impacted by the addition of the generation after the proposed network upgrades are added.

| Facility Name | Case | Rate B | Base Case Loading | Transfer Case Loading | % TDF | Outage Contingency Causing Overload Or Undervoltage |
|---|---|---|---|---|---|---|
| PLATTE CITY - IATAN 161kV | 07SP | 335 | 93.0 | 115.0 | 8.2 | NASHUA - HAWTHORN 345KV CKT 1 |

## 2.3 2007 Winter Peak

Added generation at the Customer facility results in no base case overloads on the transmission system. Prior to the addition of the proposed network upgrades, several transmission facilities were overloaded due to contingencies. After addition of the proposed network upgrades, some overloading still occurs as a result of outages of transmission facilities in the 2007 Winter Peak case. The table below documents the facilities impacted by the addition of the generation after the proposed network upgrades are added.

| Facility Name | Case | Rate B | Base Case Loading | Transfer Case Loading | % TDF | Outage Contingency Causing Overload Or Undervoltage |
|---|---|---|---|---|---|---|
| PLATTE CITY - IATAN 161kV | 07WP | 335 | 86.9 | 108.4 | 8.0 | NASHUA - HAWTHORN 345KV CKT 1 |
| ST JOE - IATAN 345kV | 07WP | 956 | 74.7 | 101.4 | 28.4 | NASHUA - HAWTHORN 345KV CKT 1 |

## 2.4 2010 Summer Peak

Added generation at the Customer facility results in no base case overloads on the transmission system. Prior to the addition of the proposed network upgrades, several transmission facilities were overloaded due to contingencies. After addition of the proposed network upgrades, some overloading still occurs as a result of outages of transmission facilities in the 2010 Summer Peak case. The table below documents the facilities impacted by the addition of the generation after the proposed network upgrades are added.

| Facility Name | Case | Rate B | Base Case Loading | Transfer Case Loading | % TDF | Outage Contingency Causing Overload Or Undervoltage |
|---|---|---|---|---|---|---|
| NASHUA - HAWTHORN 345kV | 10SP | 1138 | 75.8 | 100.9 | 31.7 | STRANGER - CRAIG 345KV CKT 1 |
| PLATTE CITY - IATAN 161kV | 10SP | 335 | 93.4 | 114.5 | 7.9 | STRANGER - CRAIG 345KV CKT 1 |

## 2.5 2010 Winter Peak

Added generation at the Customer facility results in no base case overloads on the transmission system. Prior to the addition of the proposed network upgrades, several transmission facilities were overloaded due to contingencies. After addition of the proposed network upgrades, some overloading still occurs as a result of outages of transmission facilities in the 2010 Winter Peak case. The table below documents the facilities impacted by the addition of the generation after the proposed network upgrades are added.

| Facility Name | Case | Rate B | Base Case Loading | Transfer Case Loading | % TDF | Outage Contingency Causing Overload Or Undervoltage |
|---|---|---|---|---|---|---|
| PLATTE CITY - IATAN 161kV | 10WP | 335 | 87.1 | 107.6 | 7.6 | STRANGER - CRAIG 345KV CKT 1 |
| NASHUA – SMITHVILLE 161KV | 10WP | 262 | 56.0 | 135.4 | 23.1 | STRANGER - CRAIG 345KV CKT 1 |
| SMITHVILLE – PLATTE CITY 161KV | 10WP | 262 | 60.6 | 140.1 | 23.1 | STRANGER - CRAIG 345KV CKT 1 |
| ST JOE - IATAN 345kV | 10WP | 956 | 74.8 | 101.3 | 28.1 | NASHUA - IATAN 345KV CKT 1 |

# 3. Interconnection Network Upgrades

## 3.1 Interconnection Substation

The Customer plant will be interconnected with the 345kV transmission system at the Iatan substation in northern Platte County, MO. The existing 345kV bus will be expanded to accommodate the new generating unit and two (2) unit auxiliary transformers. New circuit breakers will be added to accommodate the new unit.

## 3.2 Other Network Upgrades

Several facilities are required to be built or upgraded in the local area in order to allow for the interconnection of the proposed generator. These facilities are listed below in Table 1:

| Table 1 – Summary of Network Upgrade Costs for Interconnection | |
|---|---|
| **Network Upgrades** | |
| Description | Cost |
| ***Iatan*** | |
| Add 1 345kv line terminal on the 345kV bus | |
| Add 161kv ring bus consisting of 4 breakers, 1 transformer position, and 3 line terminals | |
| Add a 400MVA 345/161kv transformer | $ 6,187,000.00 |
| ***Tap Platte City - Stranger Creek 161kV at Iatan*** | |
| Run existng Platte City - Stranger Creek 161kV line into and out of new 161kV ring bus at Iatan. | $ 1,420,000.00 |
| ***Iatan - Lake Road 161kV*** | |
| 23 miles of new 161 kV line including associated right-of-way | $ 8,158,000.00 |
| ***2nd Circuit Iatan - Stranger Creek 345kV*** | |
| 13 miles of new 345kV line including associated right-of-way and extra terminal at Stranger Creek | $ 6,100,000.00 |
| ***Nashua 345/161kV Transformer*** | |
| New 345/161kV transformer at Nashua substation | $ 5,000,000.00 |
| ***Platte City - Iatan 161kV*** | |
| Required terminal changes at Platte City to increase rating to 584/630MVA | $ 850,000.00 |
| ***St. Joe - Iatan 345kV*** | |
| Structure change-outs to increase rating to 1195MVA | $ 3,000,000.00 |
| ***Platte City - Smithville 161kV*** | |
| Rebuild with 795 ACSR | $ 6,067,500.00 |
| ***Nashua - Smithville 161kV*** | |
| Rebuild with 795 ACSR | $ 1,717,500.00 |
| ***Nashua - Hawthorn 345kV*** | |
| Structure change-outs to increase rating to 1195MVA | $ 3,000,000.00 |
| ***Total Required Network Upgrades*** | ***$ 41,500,000.00*** |

The facilities mentioned above are required only for interconnection of the generation facility. The costs do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies when the Customer requests transmission service through Southwest Power Pool's OASIS.

## 4. Short Circuit Analysis

A short circuit study will be conducted by KCPL as part of the Facility Study to determine if fault current levels exceed equipment ratings at KCPL facilities.

## 5. Transient Stability Analysis

Transient Stability analysis was performed to verify dynamic system response to disturbances on the system using the 2010 summer peak model. The customer provided machine data for the proposed Customer plant. Typical values were provided for a 1000MVA generator with an ESST4B exciter. This data was used to create a PTI dynamics model for the Customer plant.

The machine data for the remaining system was obtained from the current SPP dynamics data files modified to include all previously queued plants proposed for the study period. Selected fault scenarios were applied with clearing times specified in accordance with KCPL Planning Criteria. Single phase and three phase fault conditions were tested at the interconnection point and machines in the KCPL, WERE, MIPU, NPPD, OPPD, and KACY control areas were monitored for stability. Analysis of stuck breaker events was included to examine the effects of extreme disturbances. A list of the faults applied is in Table 4 below.

**Table 4 Selected Faults**

| Fault # | Fault Description |
|---|---|
| FLT_1_1PH | Single Phase fault at Stranger Creek on the Stranger Creek -- Iatan 345kV line |
| FLT_1_3PH | Three Phase fault at Stranger Creek on the Stranger Creek -- Iatan 345kV line |
| FLT_2_1PH | Single Phase fault at St. Joe on the St. Joe -- Iatan 345kV line |
| FLT_2_3PH | Three Phase fault at St. Joe on the St. Joe -- Iatan 345kV line |
| FLT_3_1PH | Single Phase fault at Stranger Creek on the Stranger Creek -- Craig 345kV line |
| FLT_3_3PH | Three Phase fault at Stranger Creek on the Stranger Creek -- Craig 345kV line |
| FLT_4_1PH | Single Phase fault at Stranger Creek on the Stranger Creek -- Hoyt 345kV line |
| FLT_4_3PH | Three Phase fault at Stranger Creek on the Stranger Creek -- Hoyt 345kV line |
| FLT_5_1PH | Single Phase fault at St. Joe on the St. Joe -- Cooper 345kV line |
| FLT_5_3PH | Three Phase fault at St. Joe on the St. Joe -- Cooper 345kV line |
| FLT_6_1PH | Single Phase fault at St. Joe on the St. Joe -- Fairport 345kV line |
| FLT_6_3PH | Three Phase fault at St. Joe on the St. Joe -- Fairport 345kV line |
| FLT_7_1PH | Single Phase fault at the Midpoint on the Cooper -- Fairport 345kV line |
| FLT_7_3PH | Three Phase fault at the Midpoint on the Cooper -- Fairport 345kV line |
| FLT_8_1PH | Single Phase fault at St. Joe on the St. Joe -- Hawthorn 345kV line |
| FLT_8_3PH | Three Phase fault at St. Joe on the St. Joe -- Hawthorn 345kV line |
| FLT_9 | Trip Iatan Unit #1 (670MW) |
| FLT_10 | Trip Customer Unit at Iatan (900MW) |
| FLT_11 | Trip Jeffrey Energy Center Unit #2 (681MW) |
| FLT_12_1PH | Single Phase fault at Iatan on the St. Joe -- Iatan 345kV line |
| FLT_12_3PH | Three Phase fault at Iatan on the St. Joe -- Iatan 345kV line |
| FLT_12_1PH_stuck | Stuck breaker/delayed clearing -- Single Phase fault at Iatan on the St. Joe -- Iatan 345kV line |
| FLT_12_3PH_stuck | Stuck breaker/delayed clearing -- Three Phase fault at Iatan on the St. Joe -- Iatan 345kV line |

The faults above were applied in two scenarios: A basecase without the Customer plant or the proposed network upgrades in service, and a case with the Customer plant online at 900MW and the proposed network upgrades in service.

The study analysis indicates that normally cleared single-phase and three-phase fault events do not cause system instability. However, a less probable, extreme disturbance involving a stuck breaker with delayed clearing of a three-phase fault causes the units connected to the Iatan substation to become unstable. The terminal voltage of the plants begins to oscillate wildly. Out-of-synchronism relaying would trip the Iatan and Customer units offline and the remainder of the system should remain stable. Oscillations are generally damped following all fault clearing. The use of Independent pole tripping at the Iatan substation reduces the likelihood of the three-phase delayed clearing condition and is recommended, in addition to out-of-step relaying for generator protection during the extreme disturbance events.

Plots of machine angles and selected 345kV system voltages for all scenarios analyzed are attached in the Appendices to this report.

# 6. Conclusion

This System Impact Study was requested by Customer to assess the interconnection requirements for the addition of 900MW of new generation sited in eastern Atchison County, KS. The analysis evaluates the impact of introducing the new generation on the power system during normal operation and contingency conditions.

The addition of 900MW generating capacity at the proposed site results in the overloading of transmission facilities during outages on the 345kV and 161kV system. The existing circuits from the Iatan substation are inadequate for the additional generation. Several new outlets from the Iatan substation are required for the plant interconnection to allow the transfer of power from the Iatan site under contingency conditions.

Network upgrades are also required at the Iatan substation to accommodate the proposed plant. Expansion of the 345kV ring-bus and installation of new 345kV circuit breakers is necessary for the new unit terminal. Land acquisition and environmental impact issues are not included in the cost of constructing interconnection facilities. The total estimated cost for the network upgrades is $41,500,000. An estimated project schedule will be determined during the Facility Study.

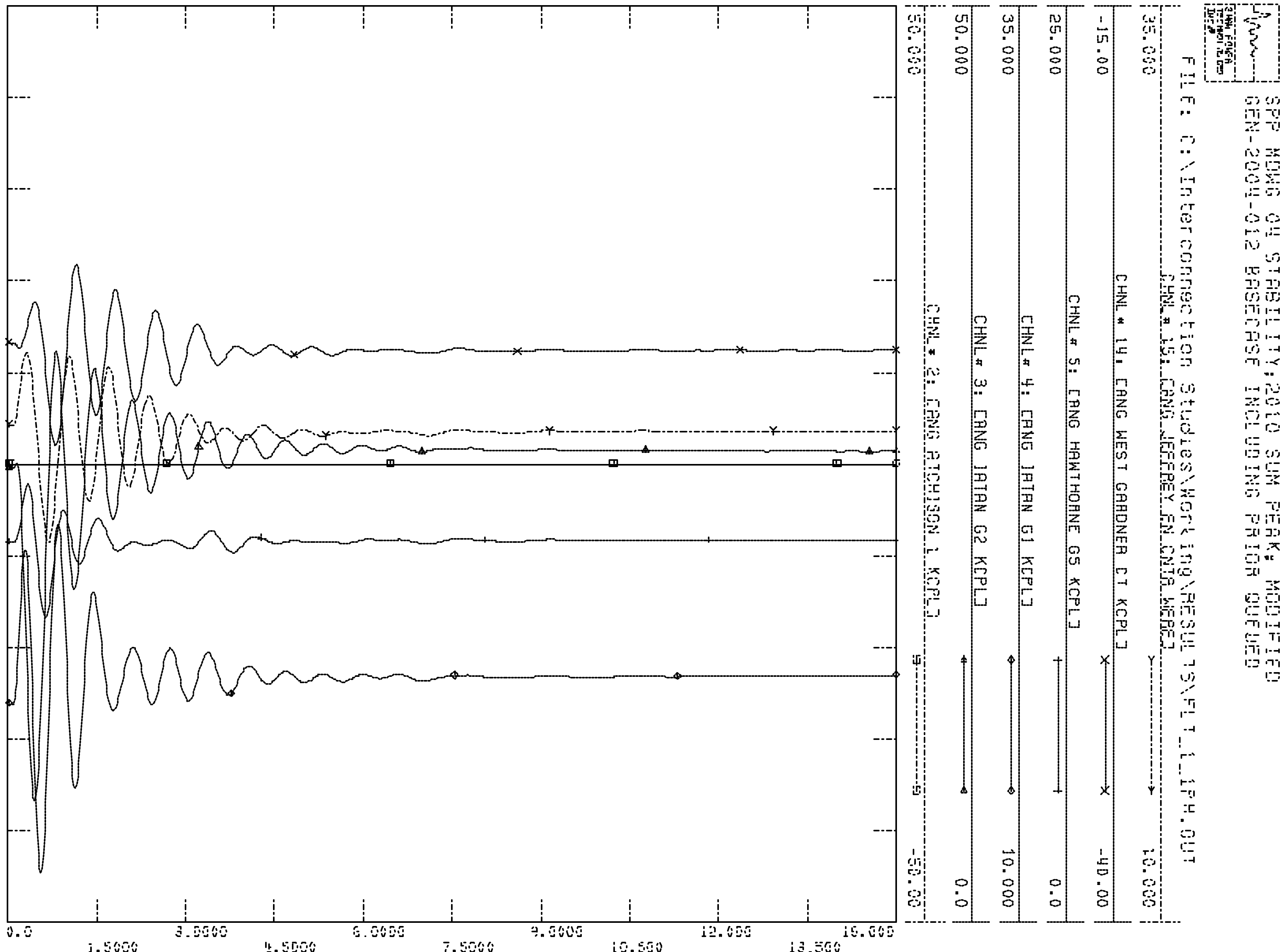
The costs do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies when the Customer requests transmission service through Southwest Power Pool’s OASIS.

# Appendix A-1

# Plots of Fault Simulations

**Plots of selected machine angle response during faults**

**Scenario:**
**2010 Summer Peak**
**Basecase**

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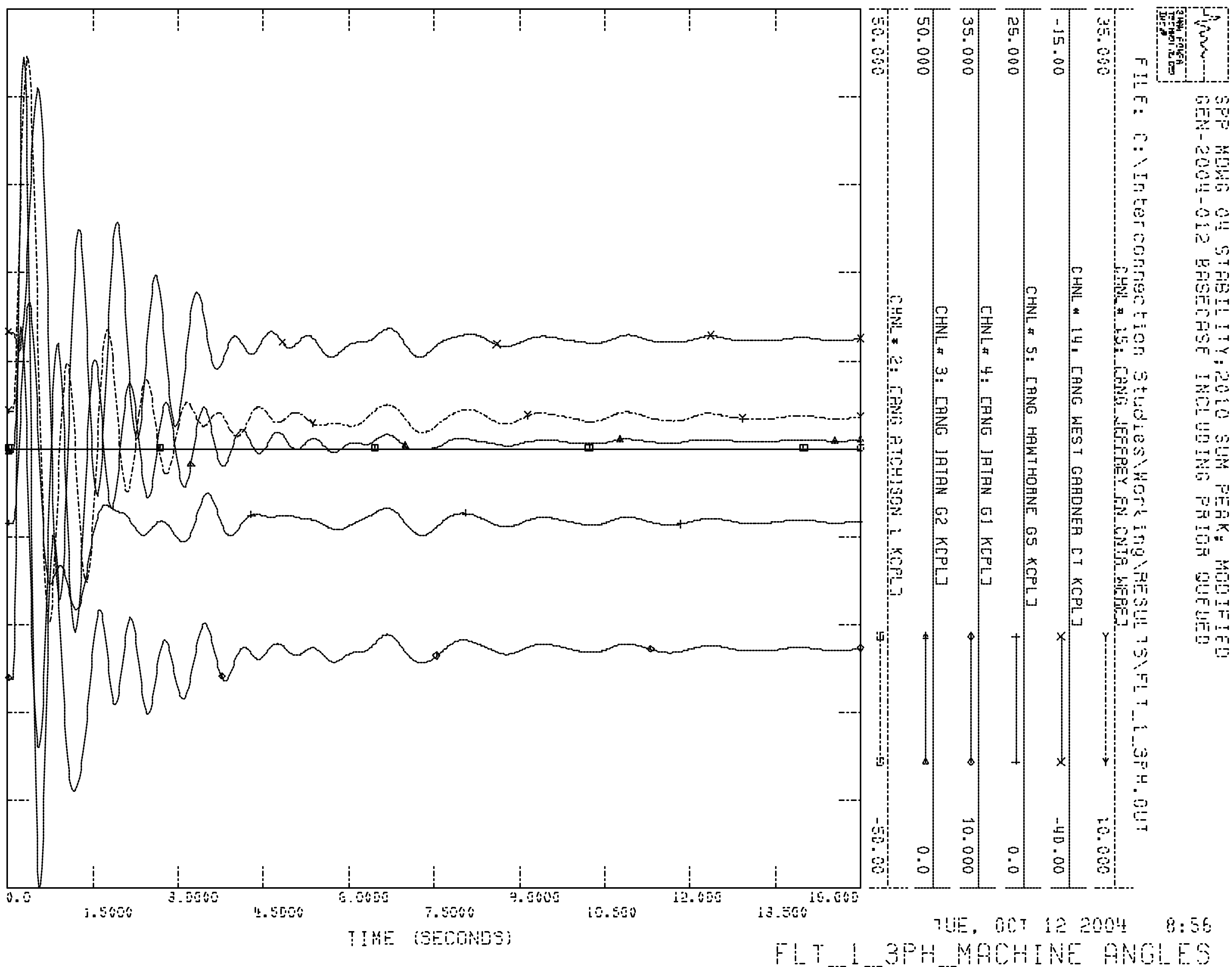
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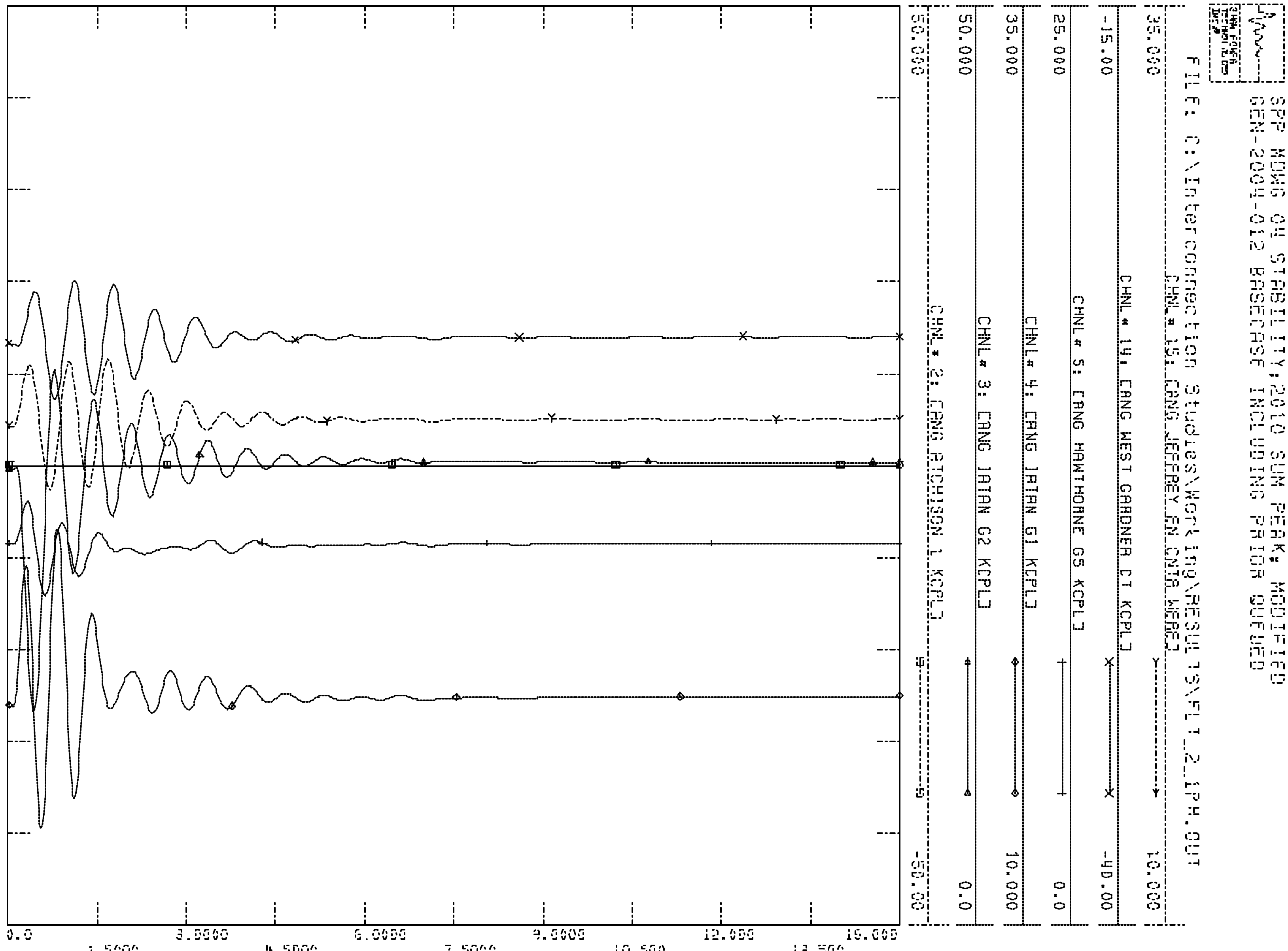


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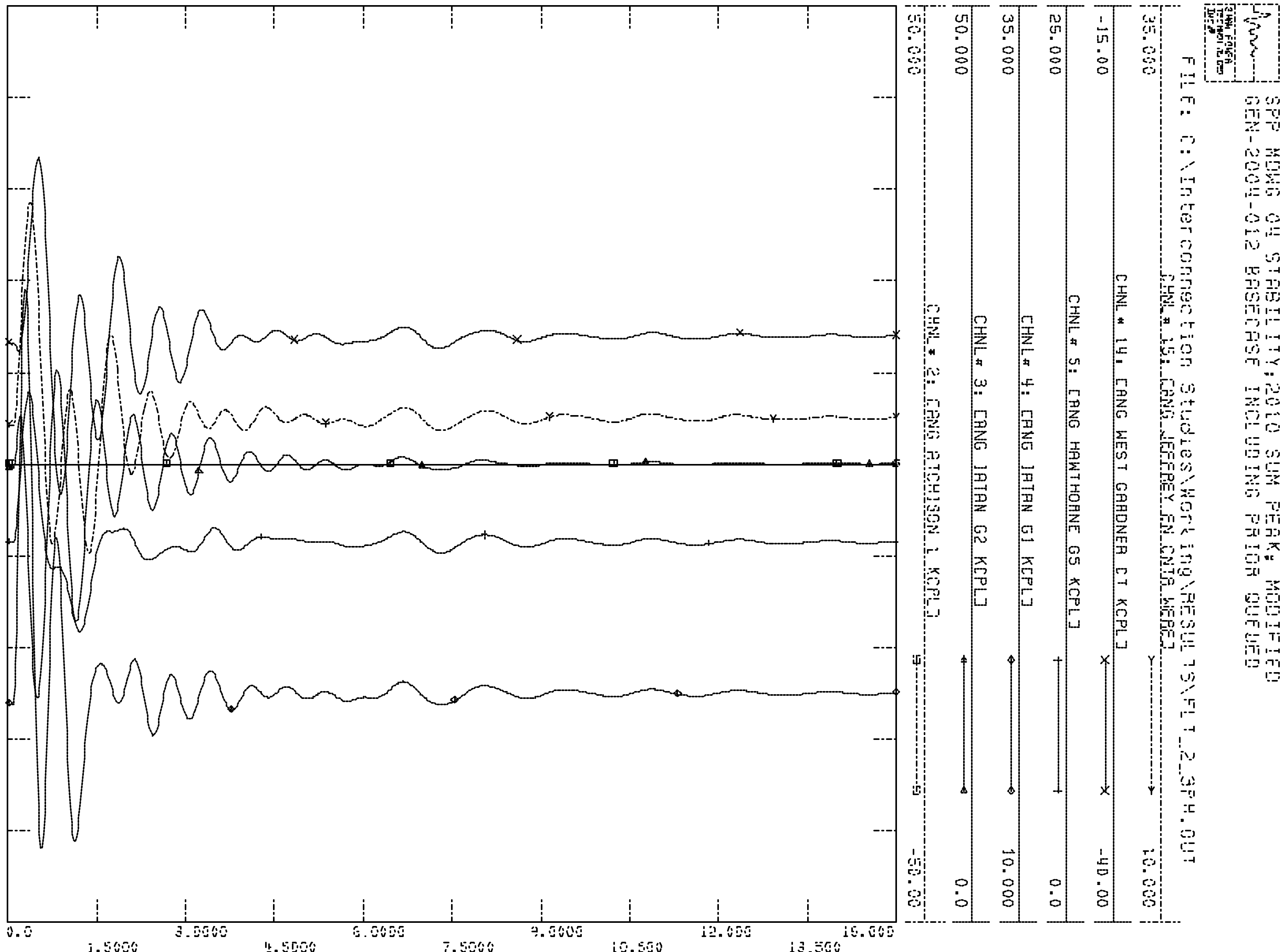


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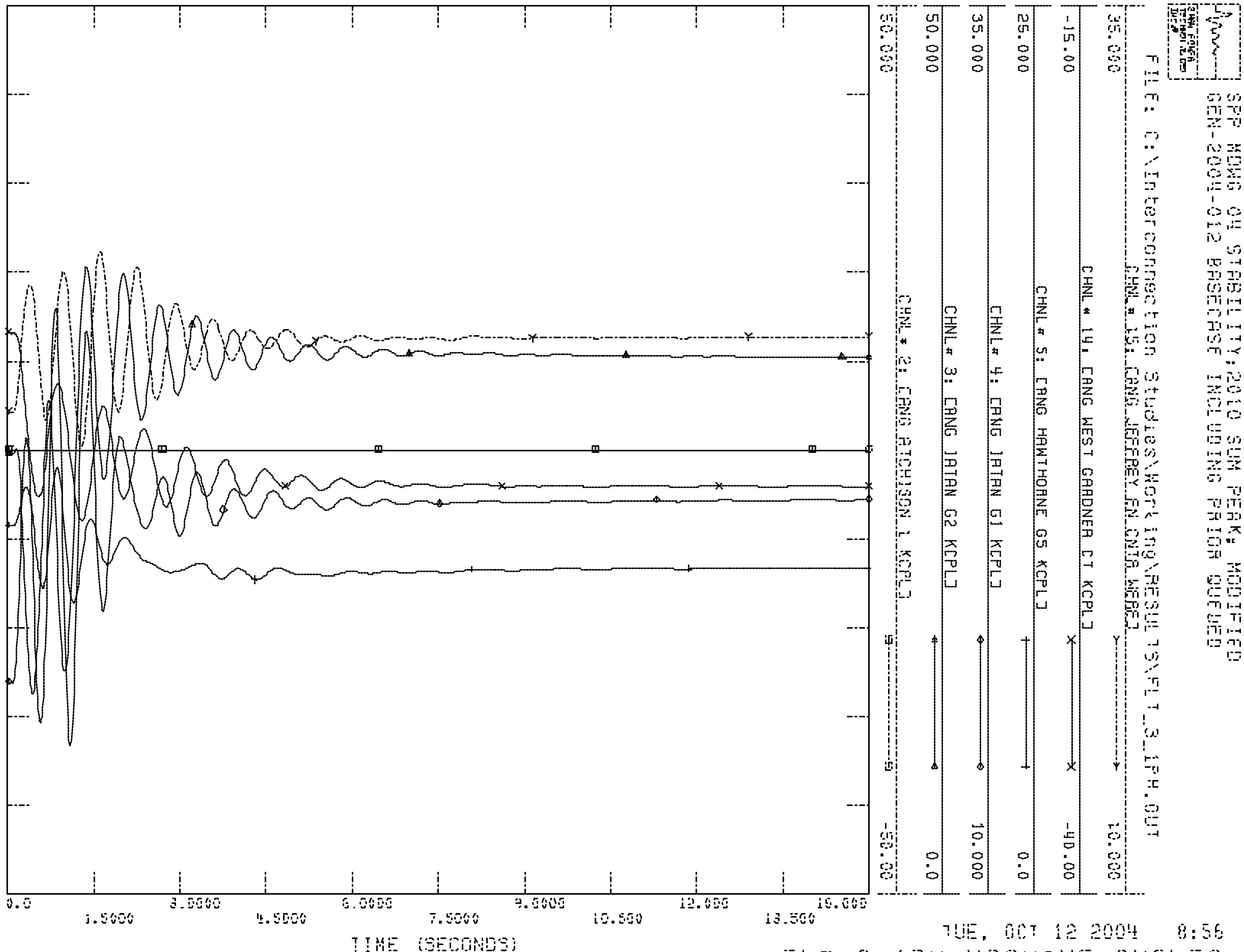


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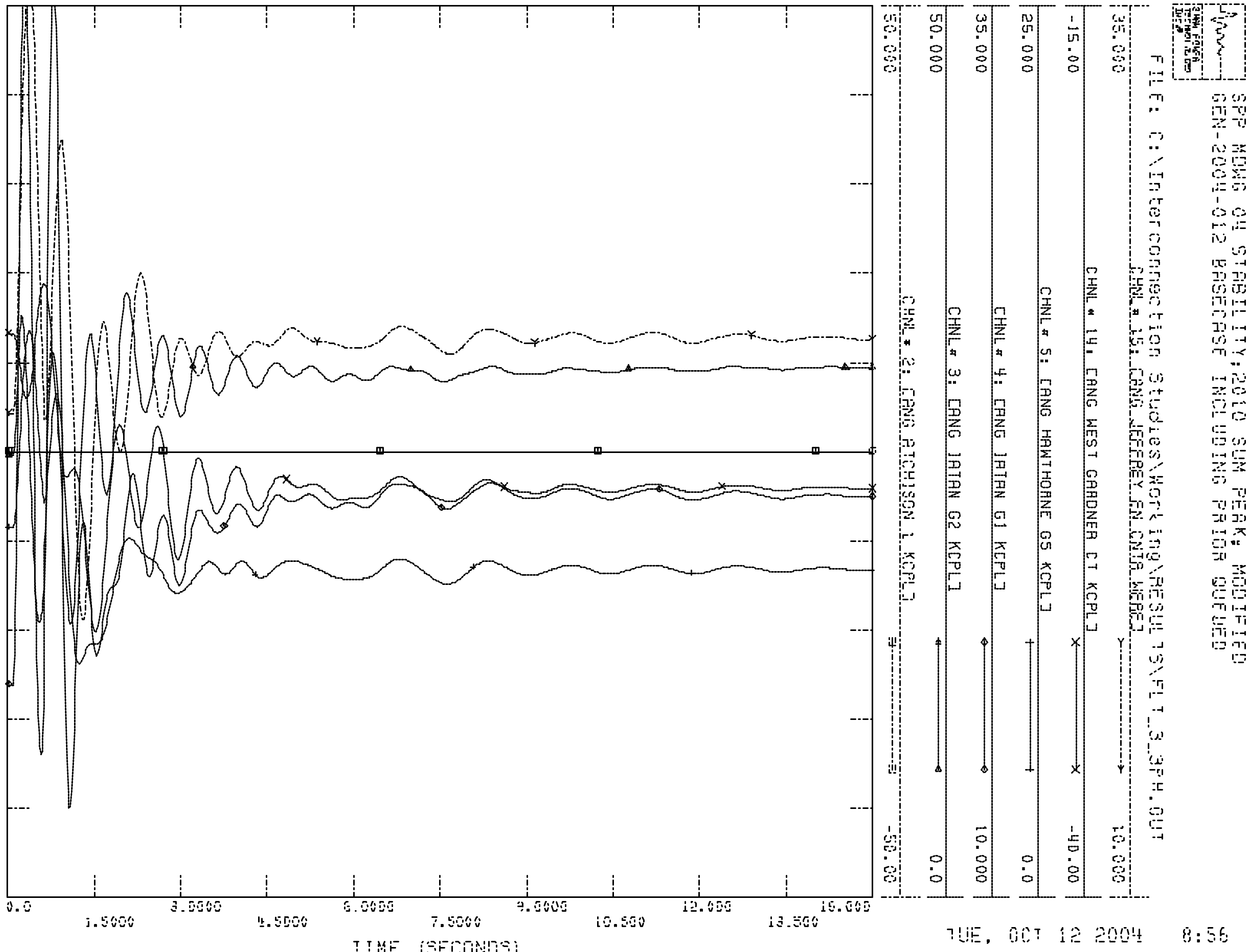


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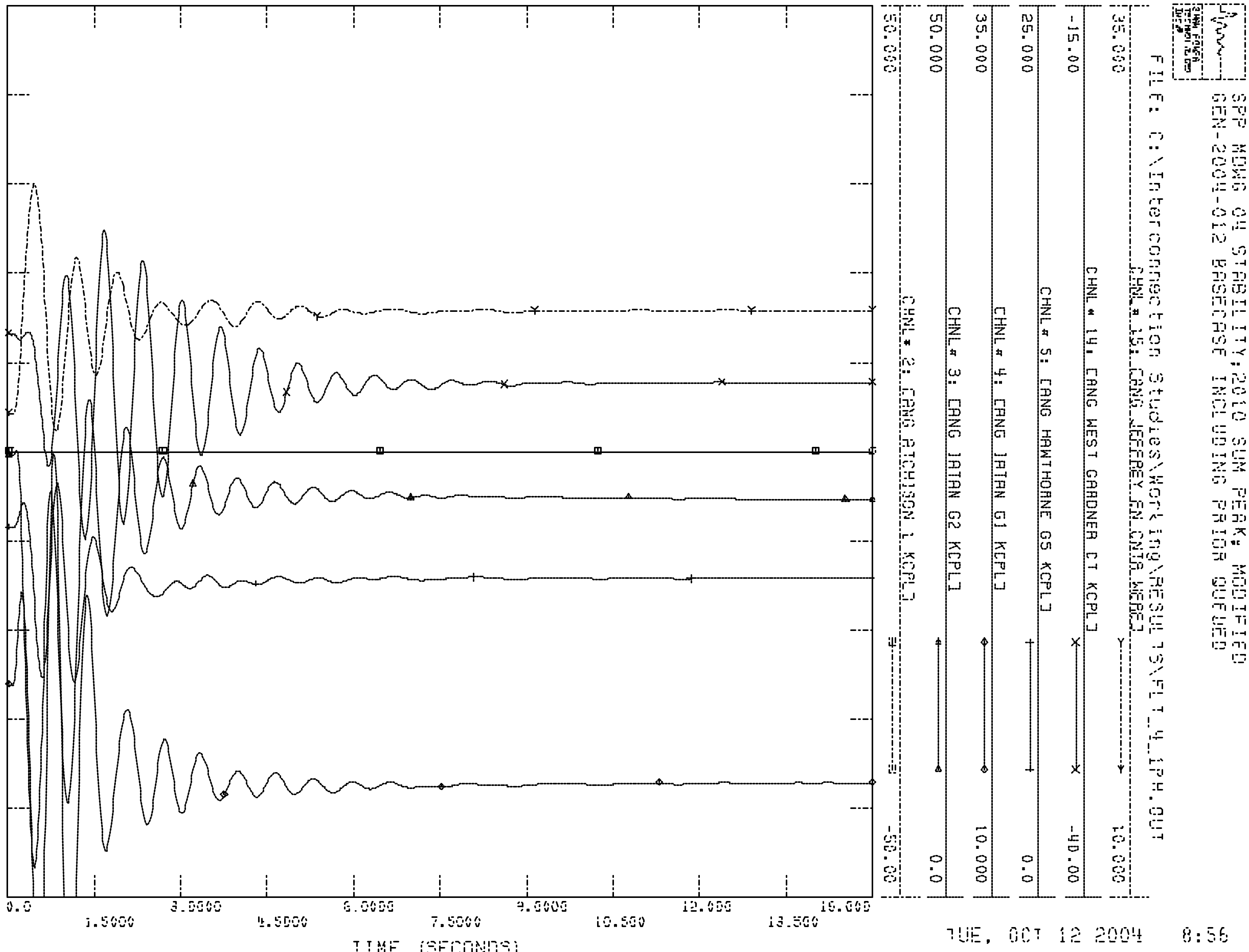


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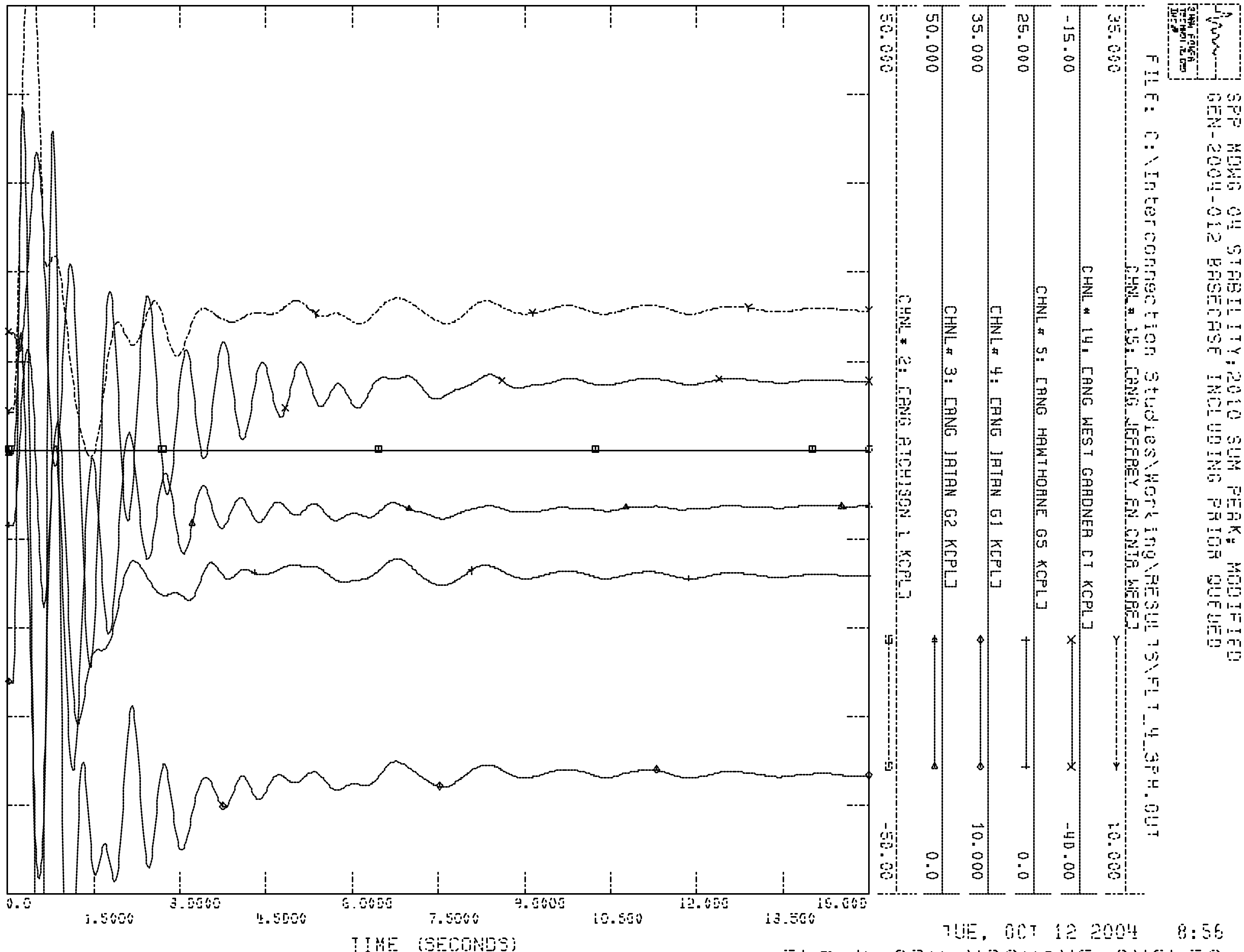


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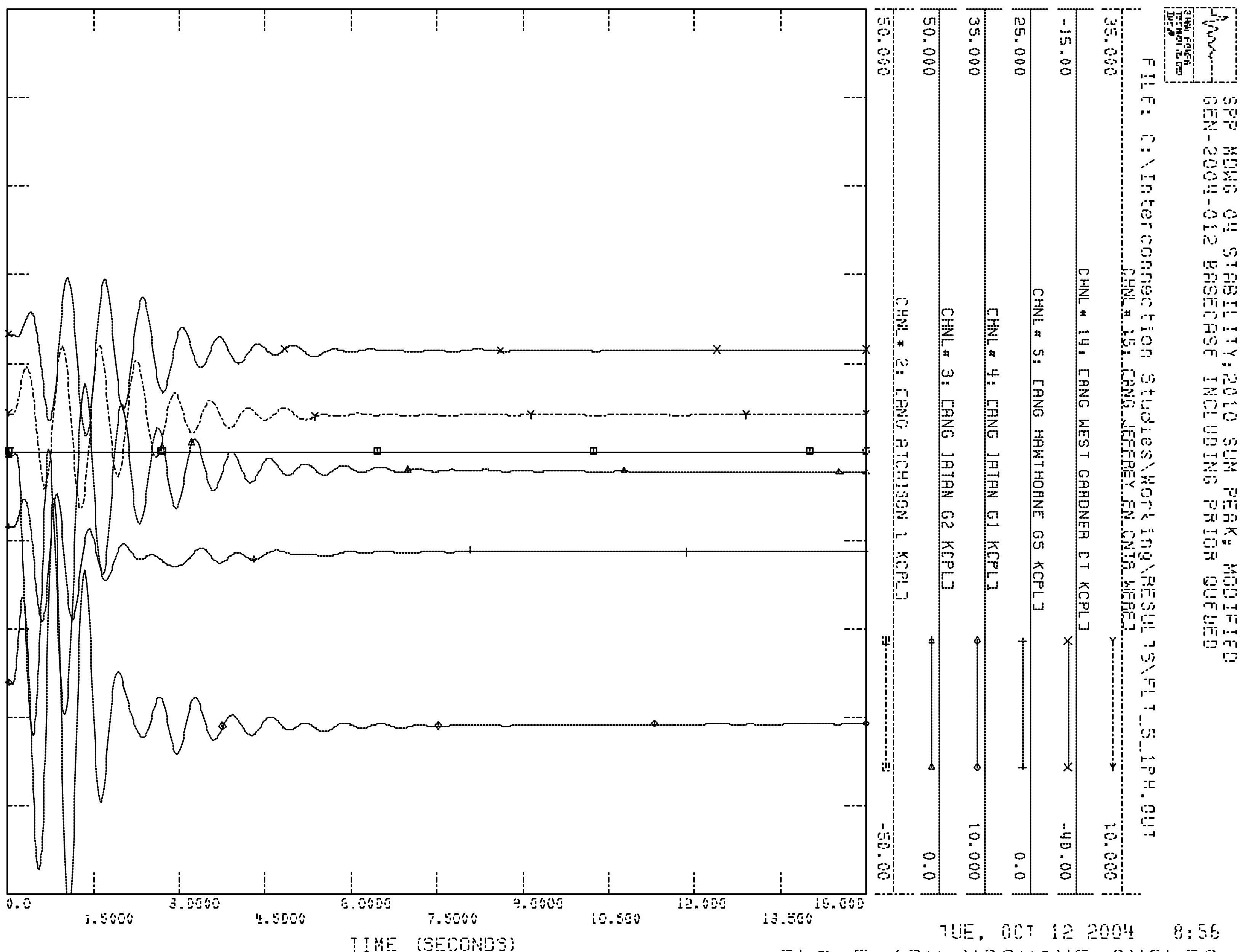


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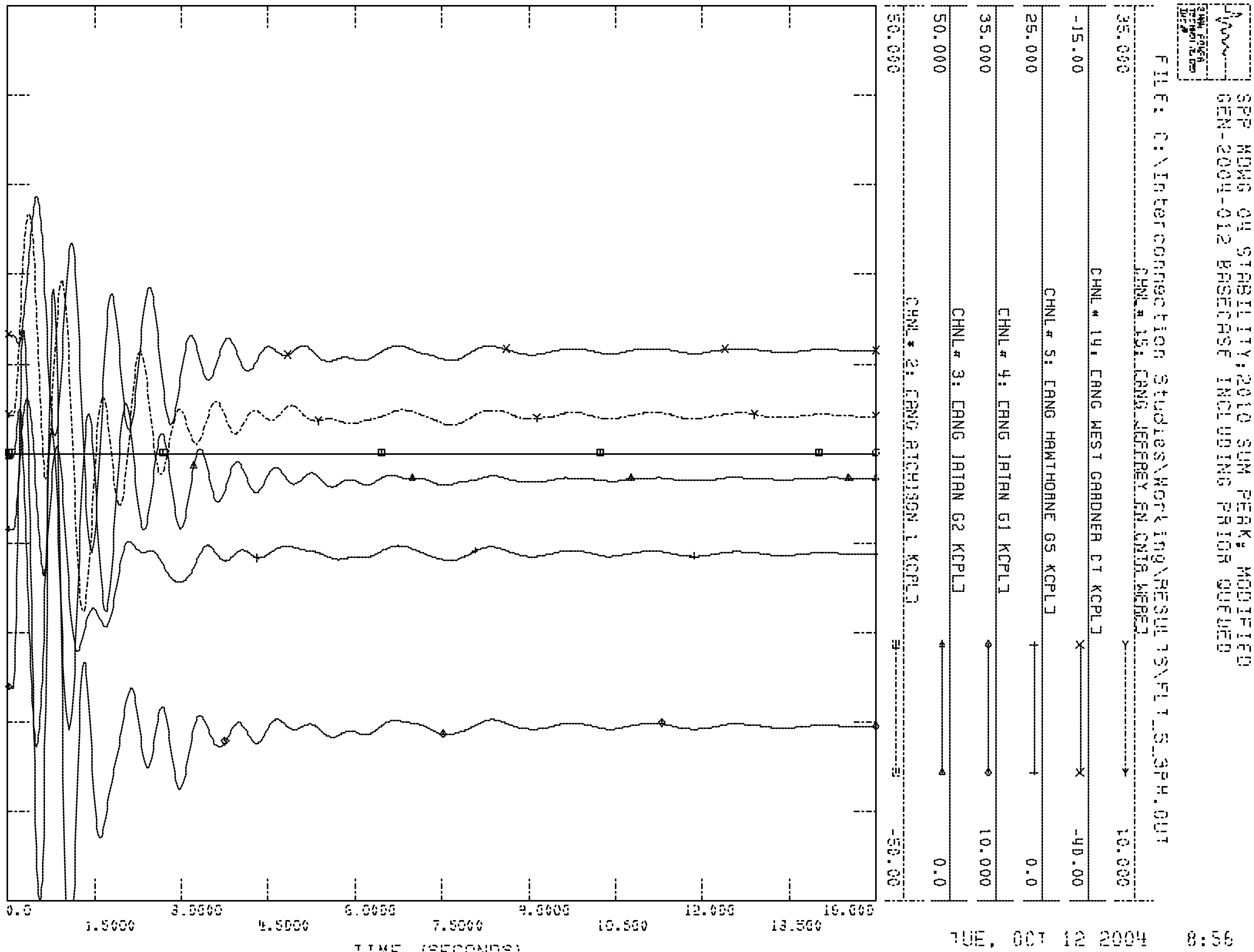


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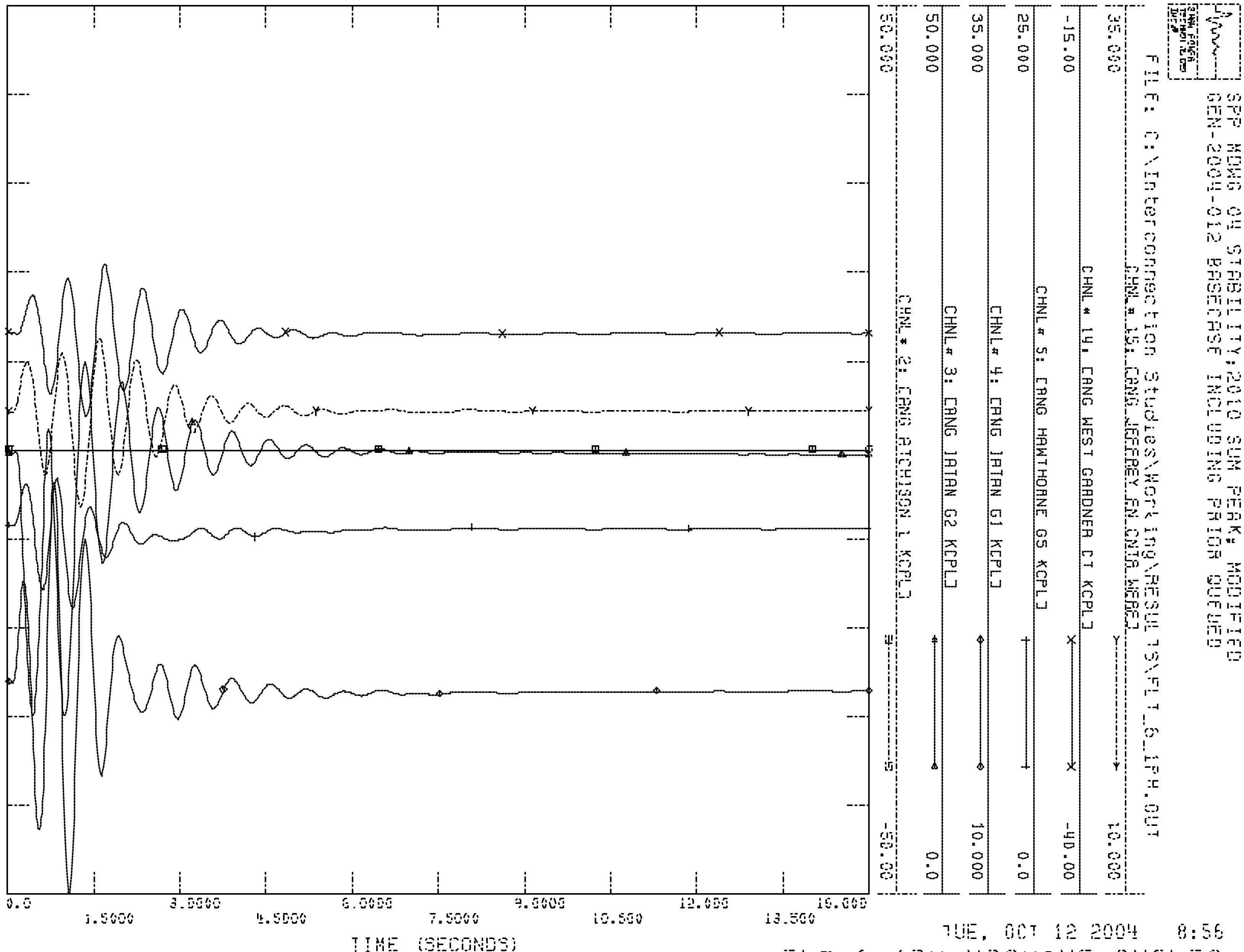


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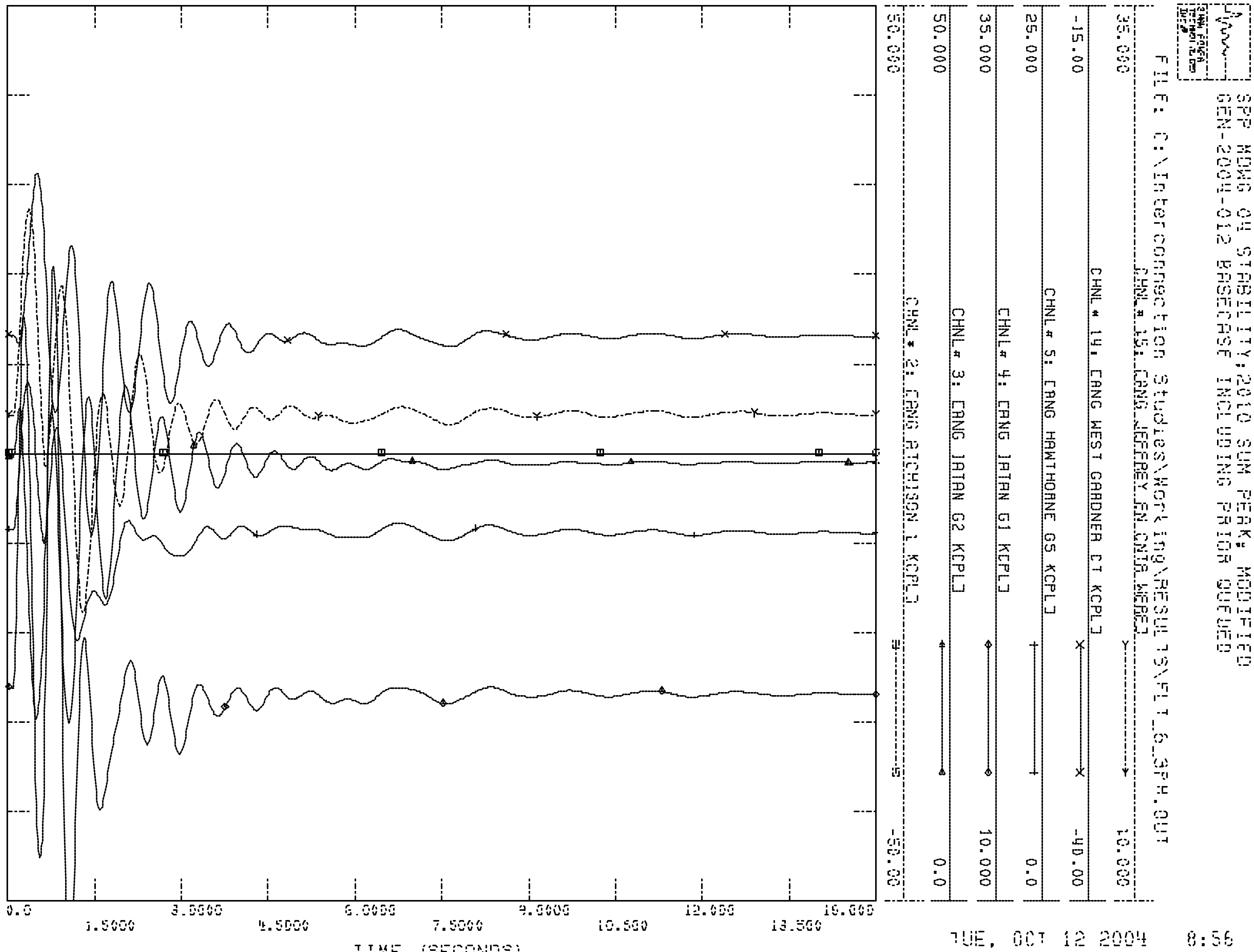


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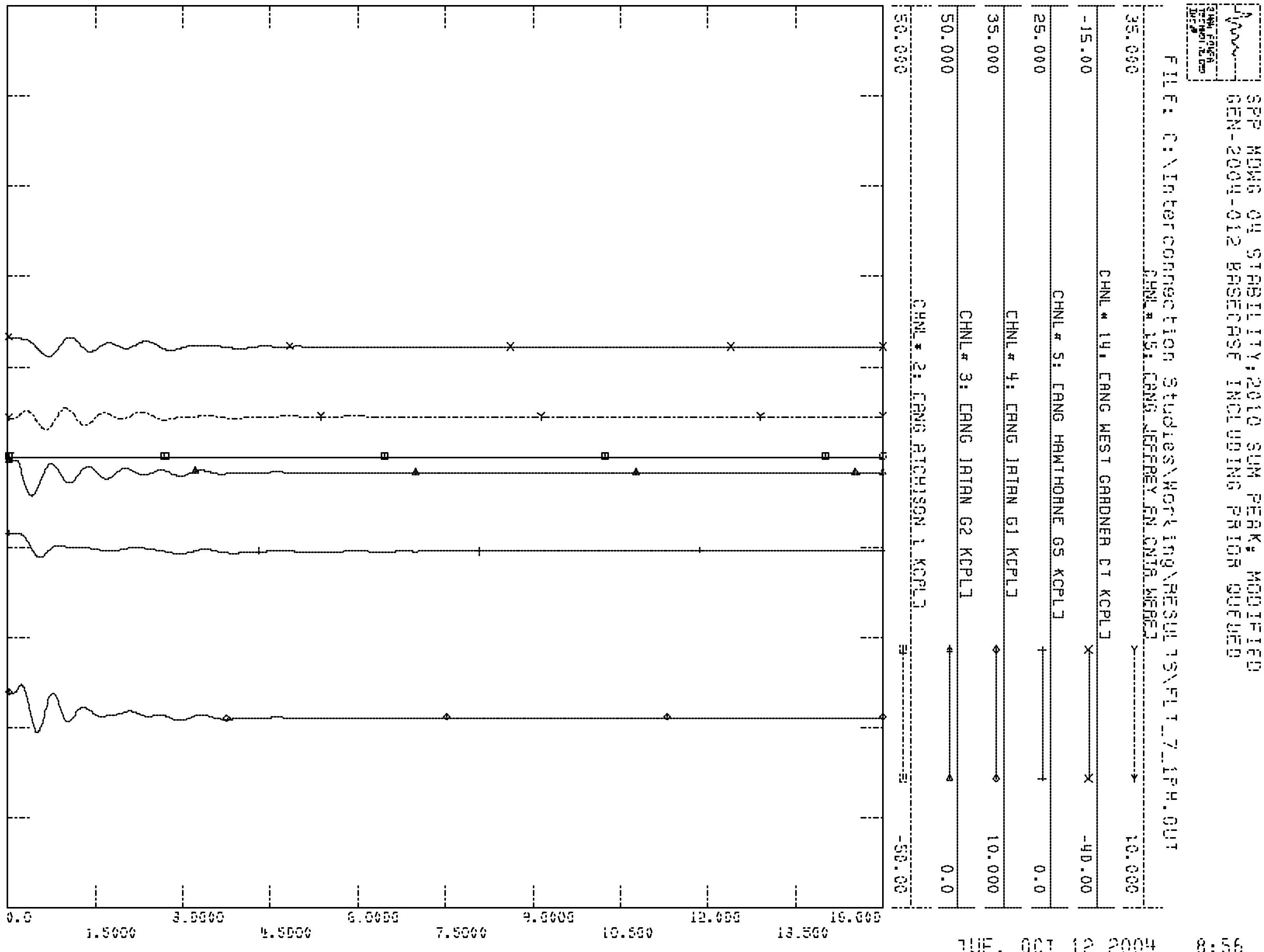


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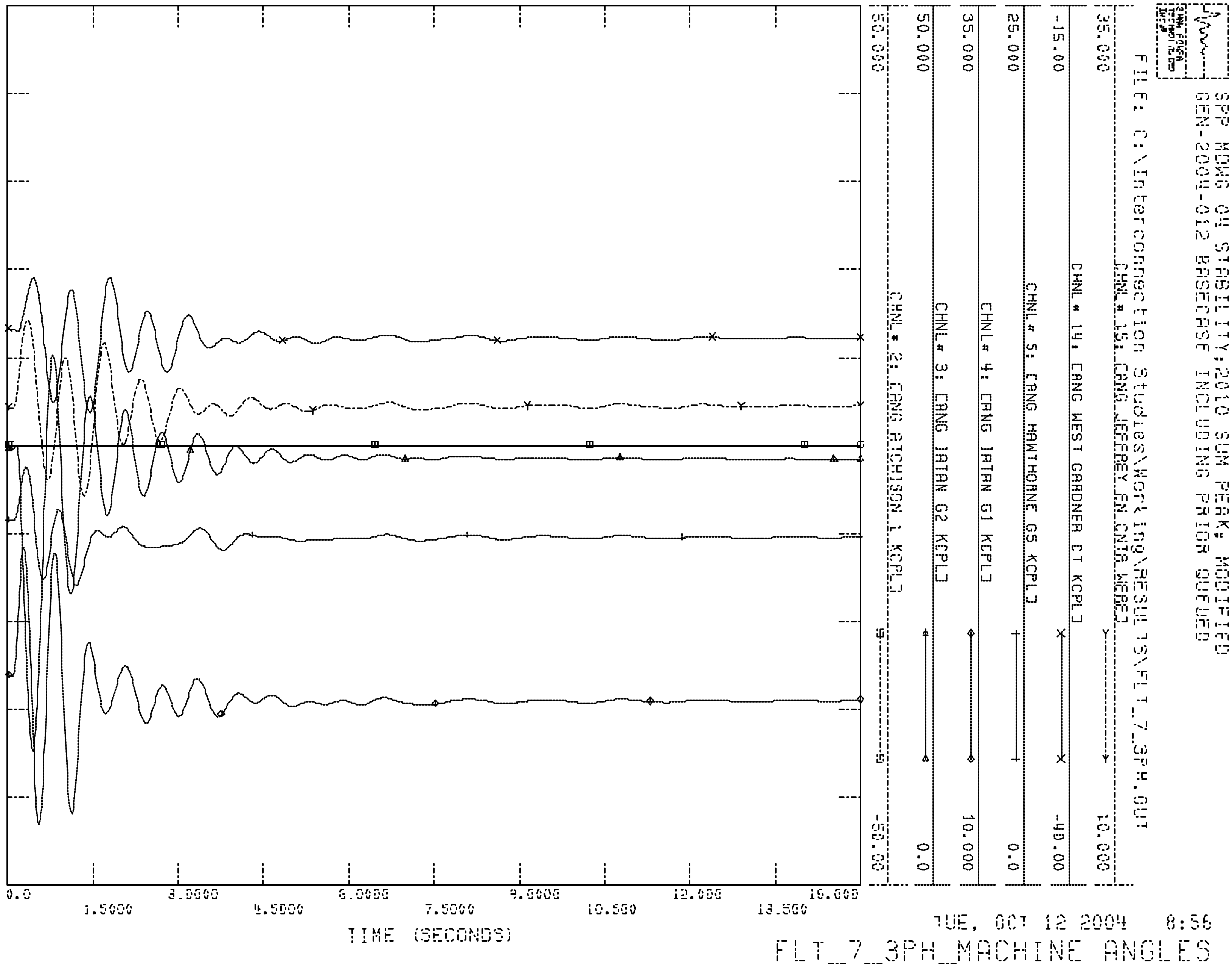
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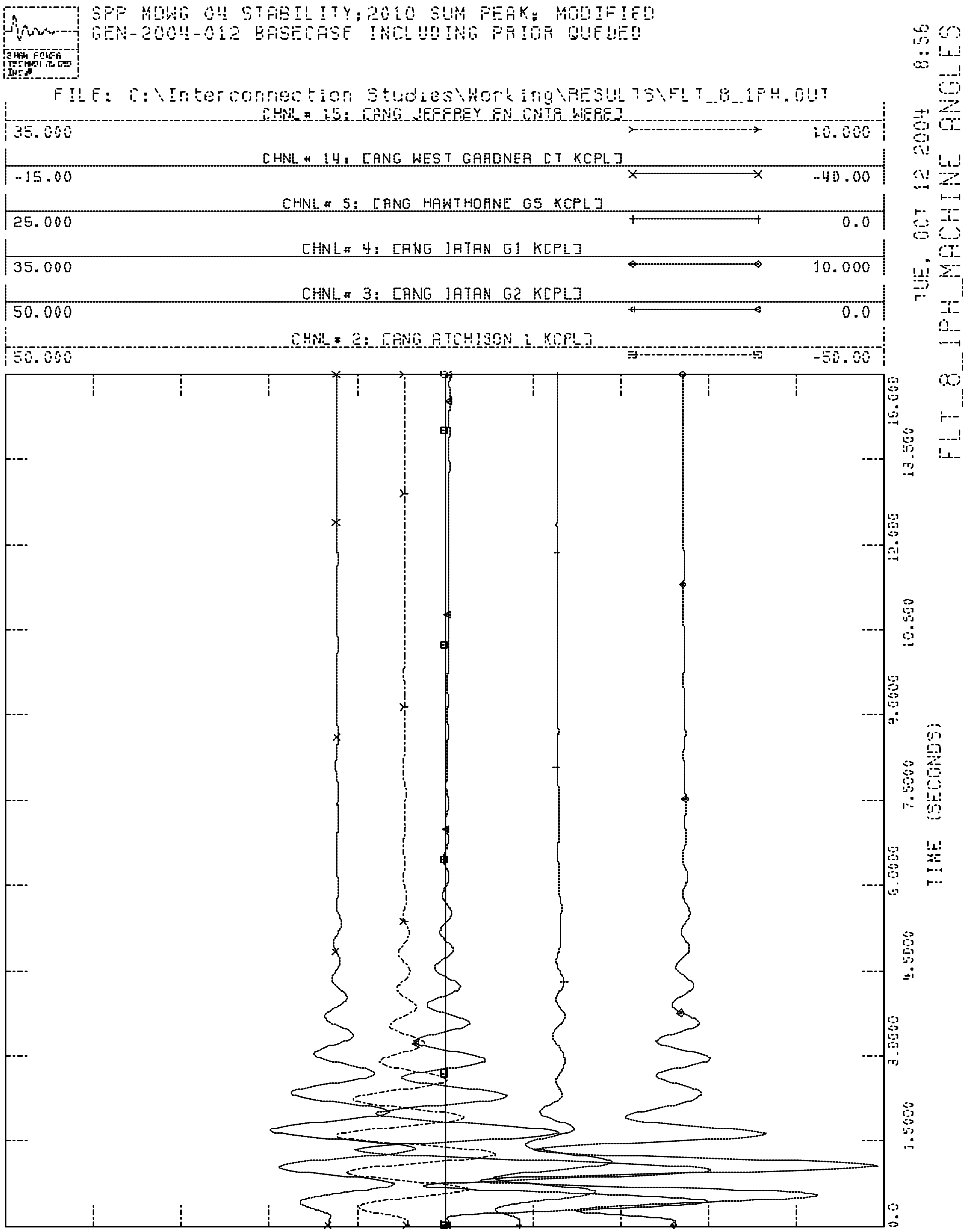
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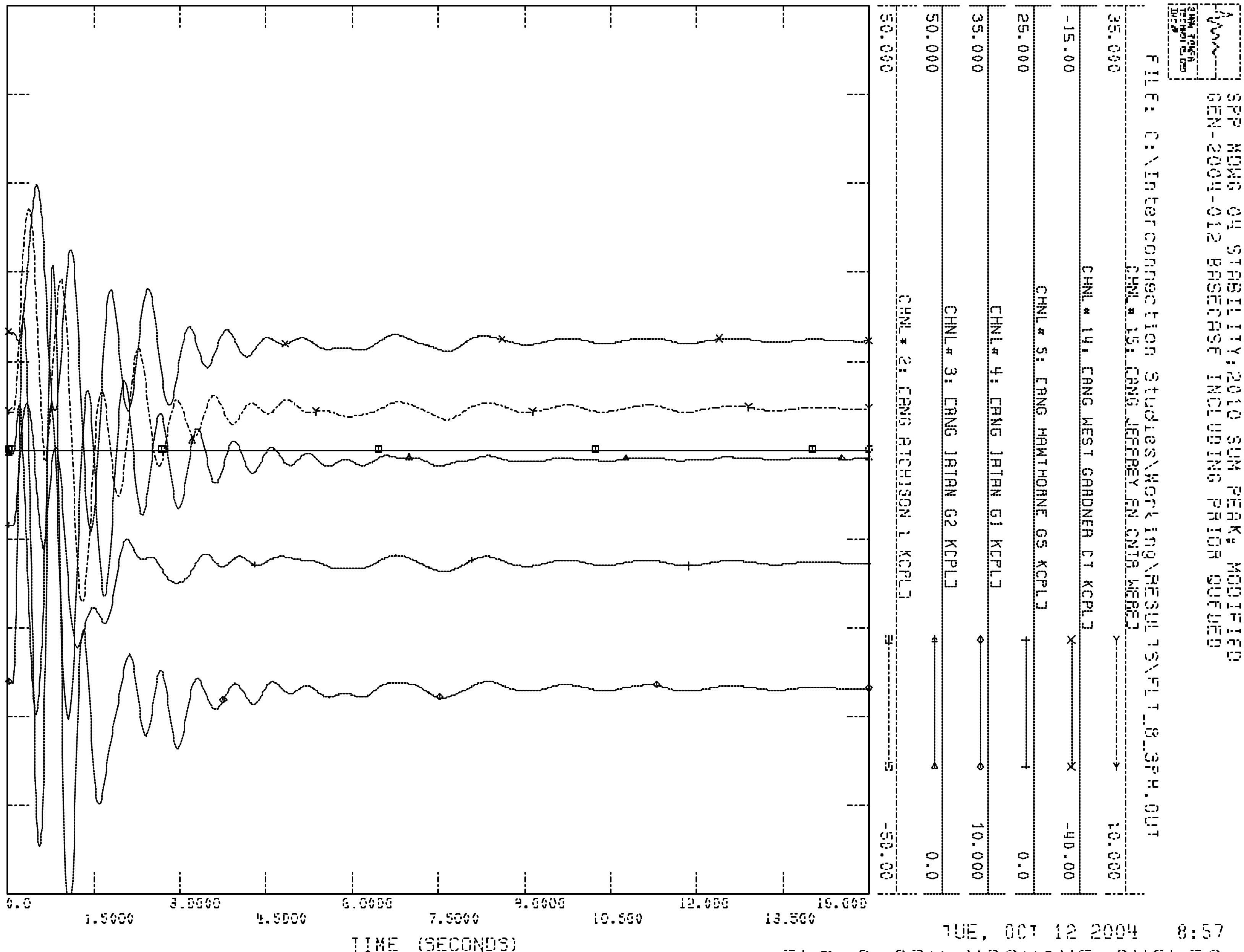


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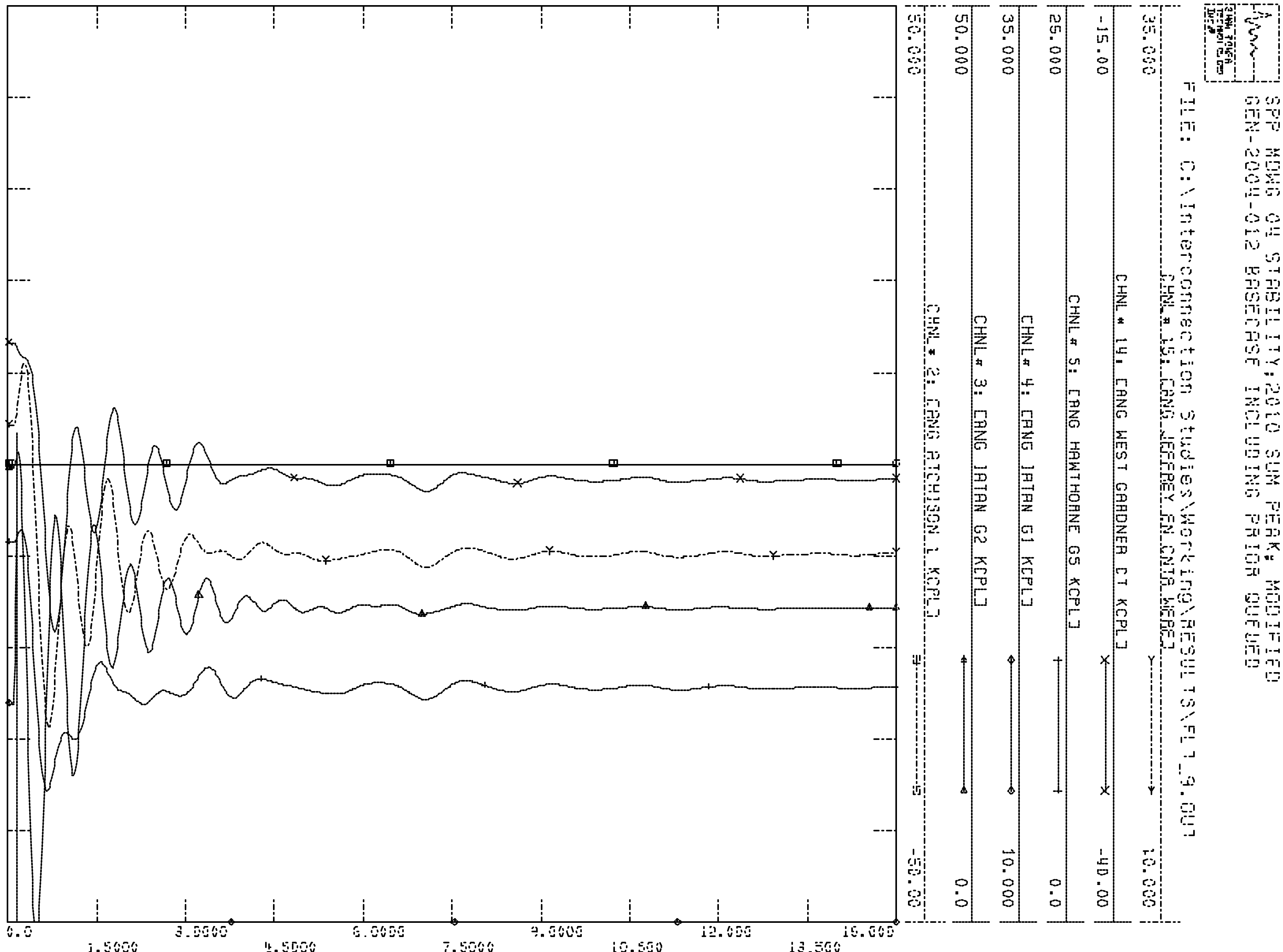


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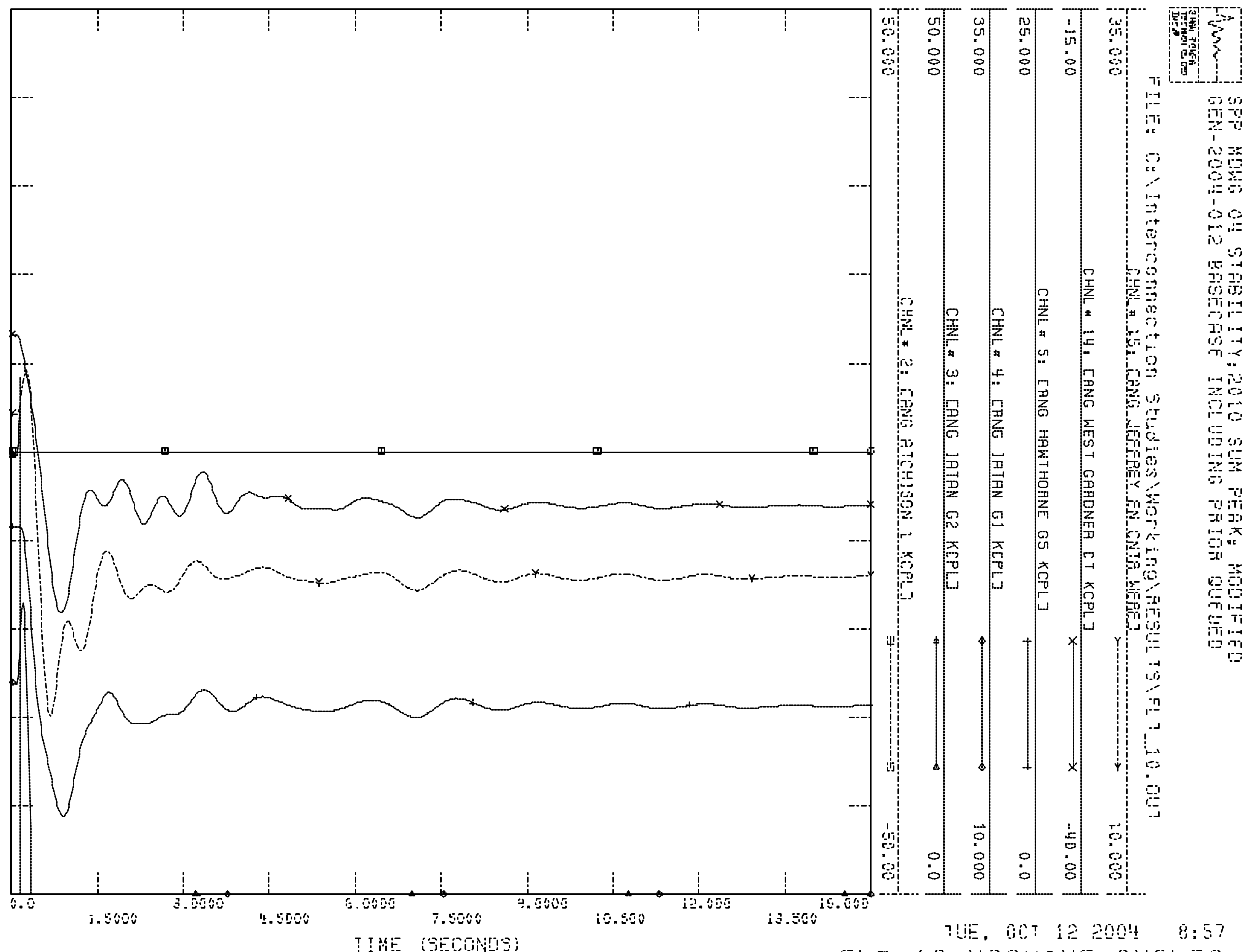


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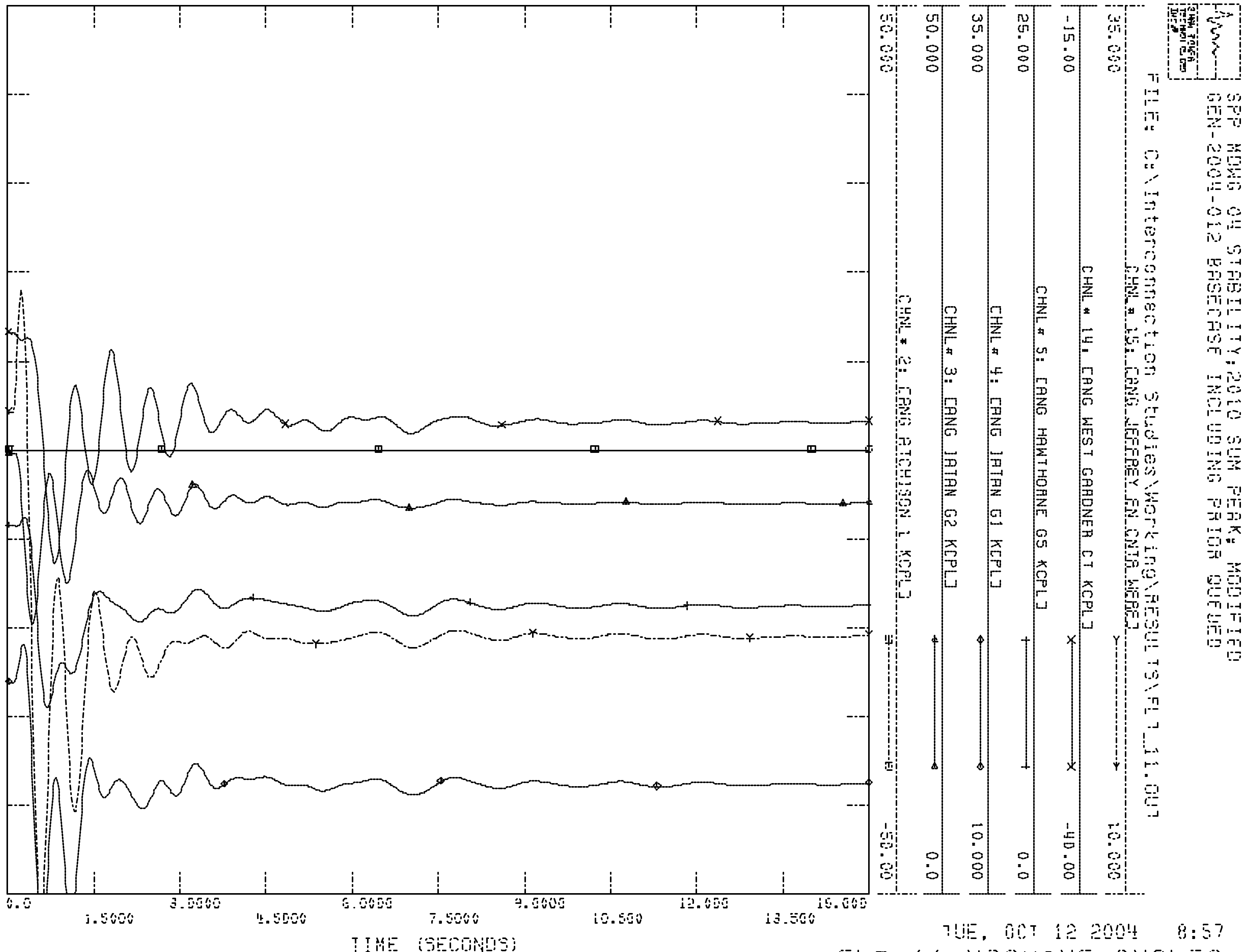


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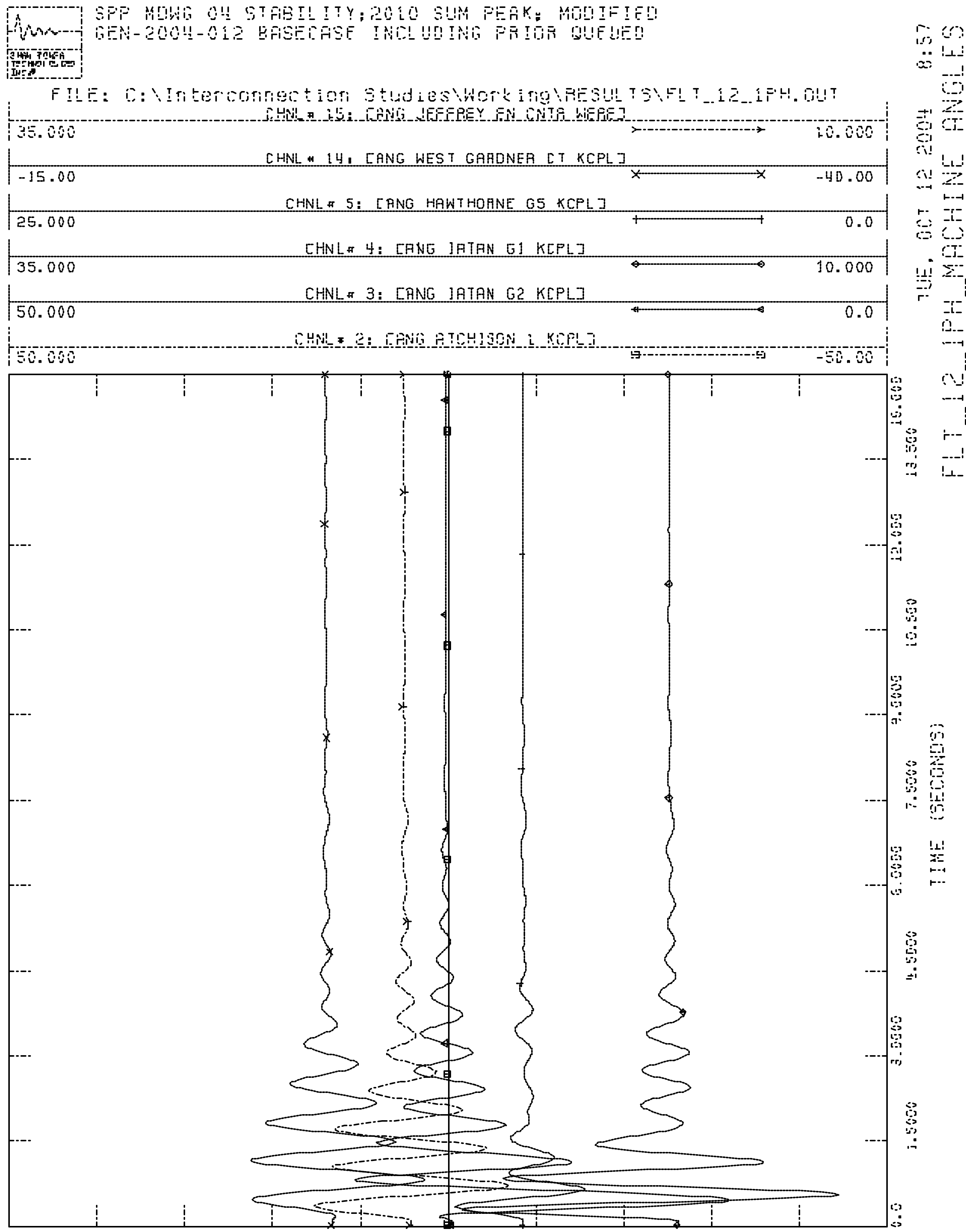
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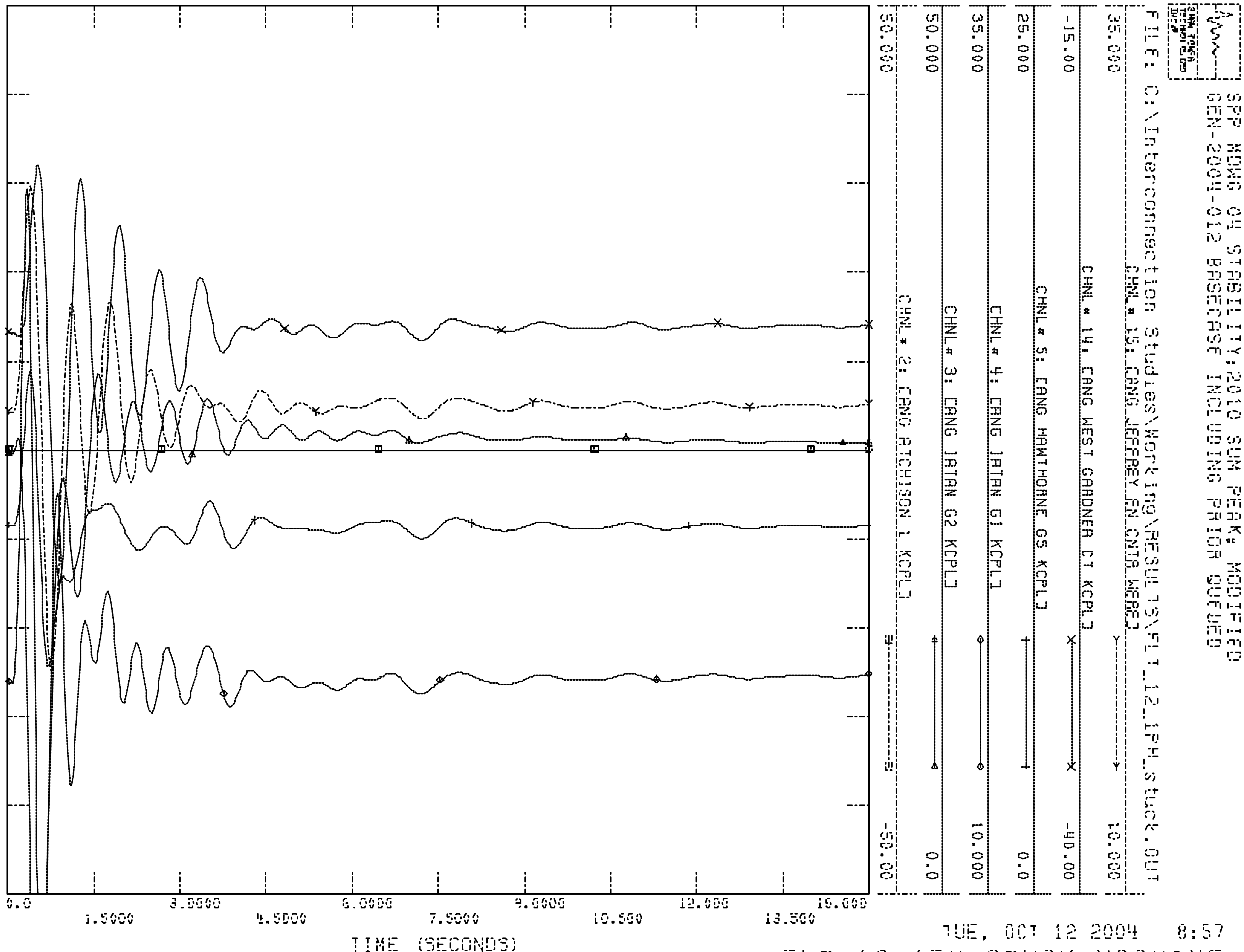
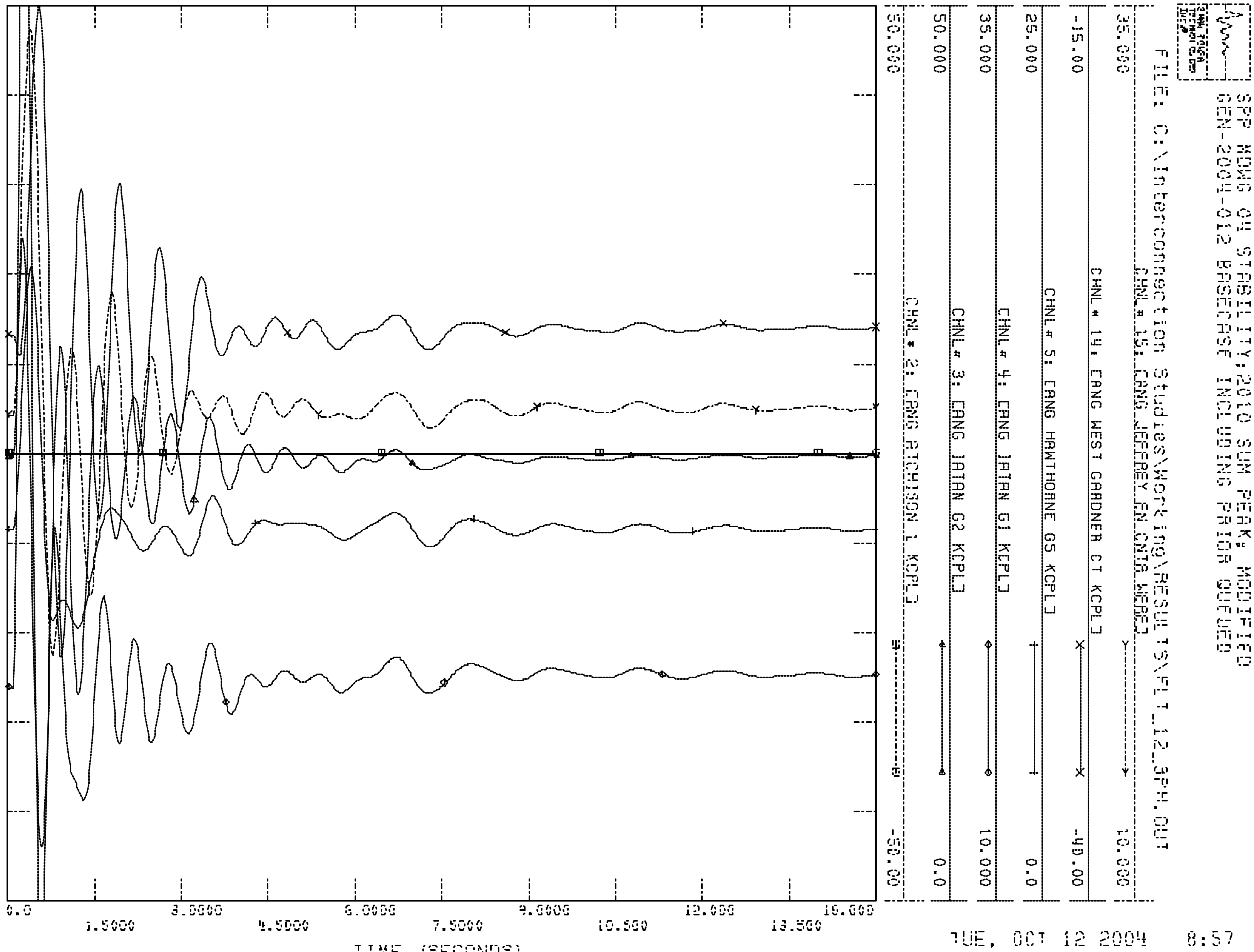
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 8:57
FLT_12_1PH_MACHINE ANGLES



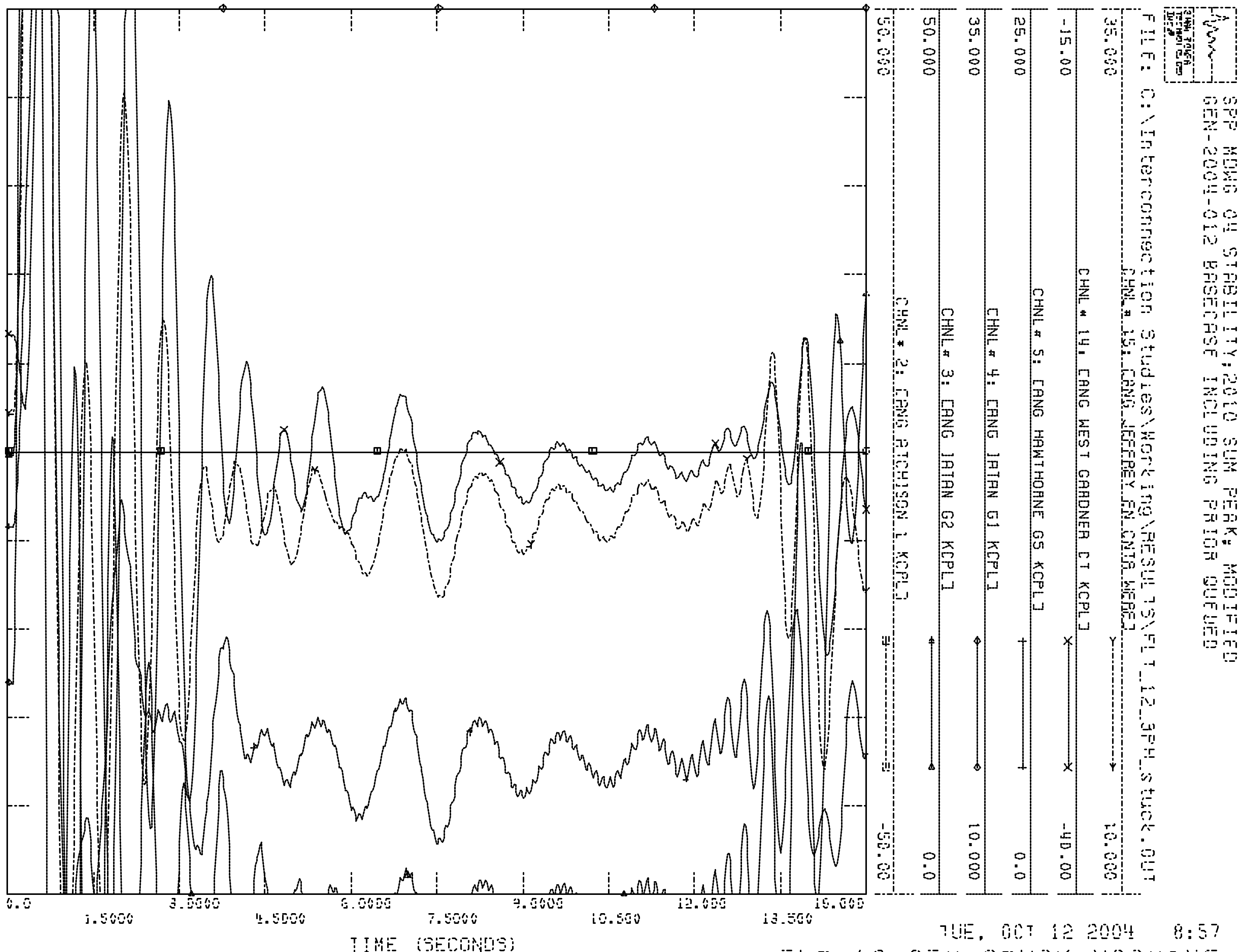

TUE, OCT 12 2004 8:57

FLT_12_1PH_STUCK_MACHINE




TUE, OCT 12 2004 8:57

FLT_12_3PH_MACHINE ANGLES




TUE, OCT 12 2004 8:57

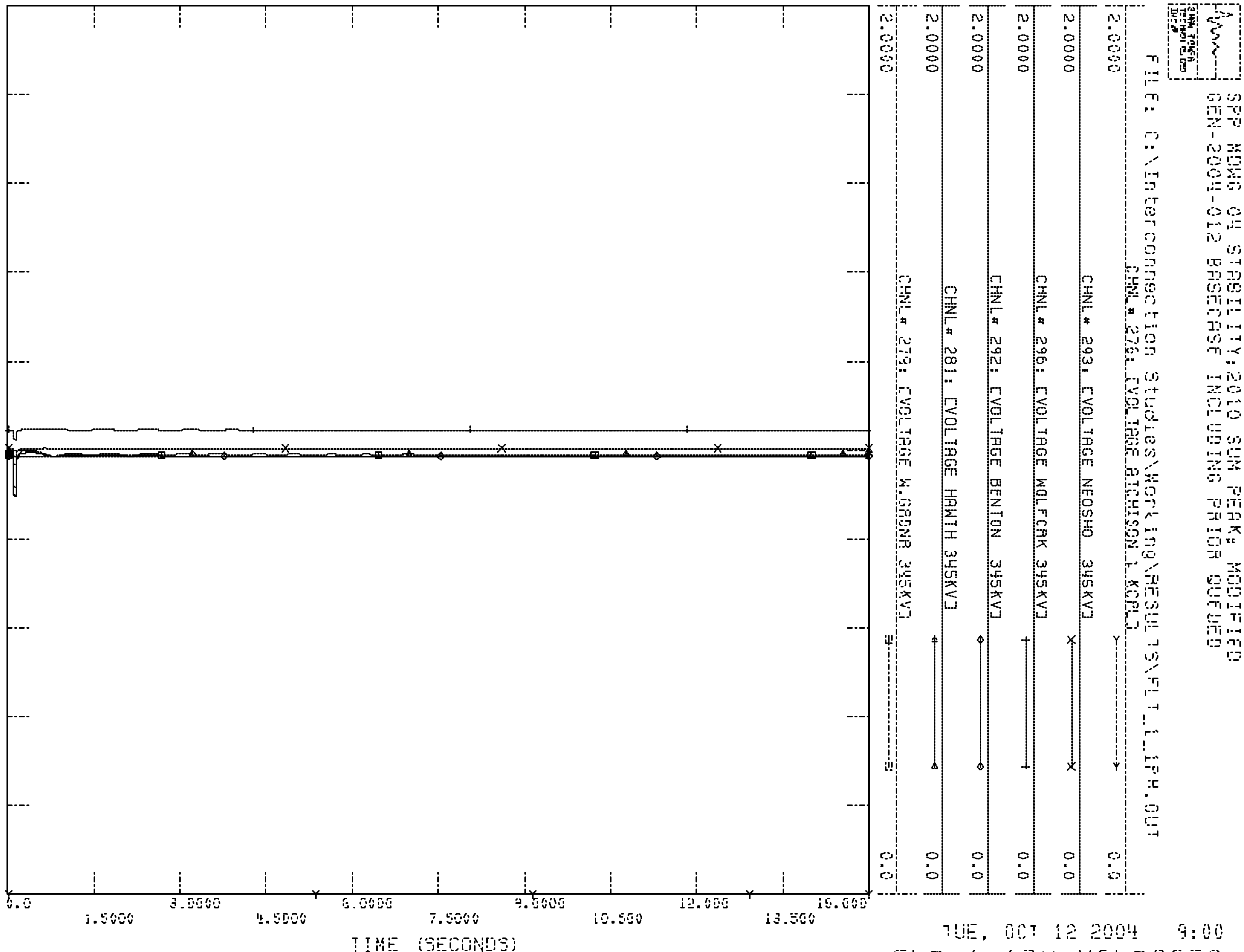
FLT_12_3PH_STUCK_MACHINE

# Appendix A-2

# Plots of Fault Simulations

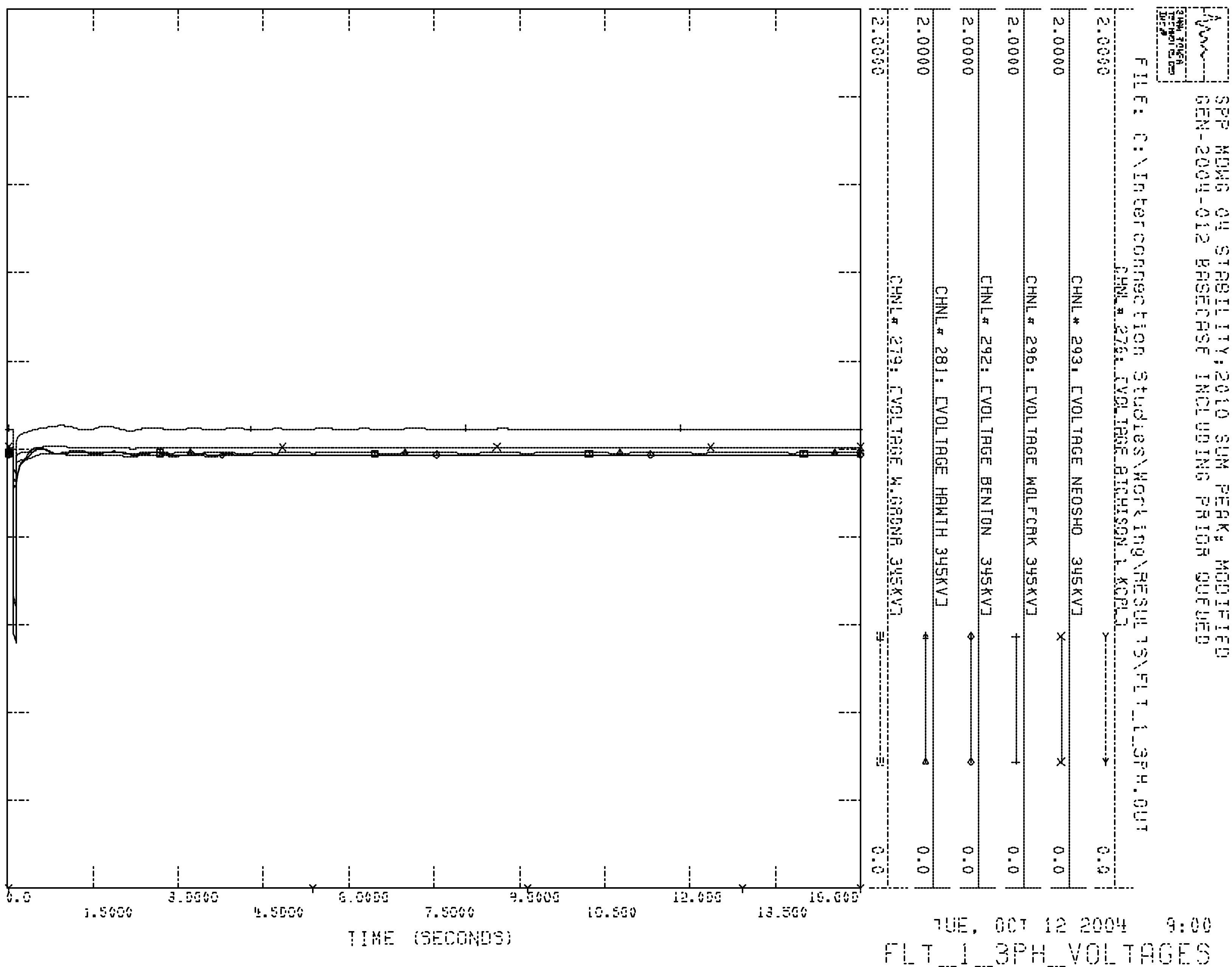
**Plots of selected bus voltage response during faults**

**Scenario:**
**2010 Summer Peak**
**Basecase**

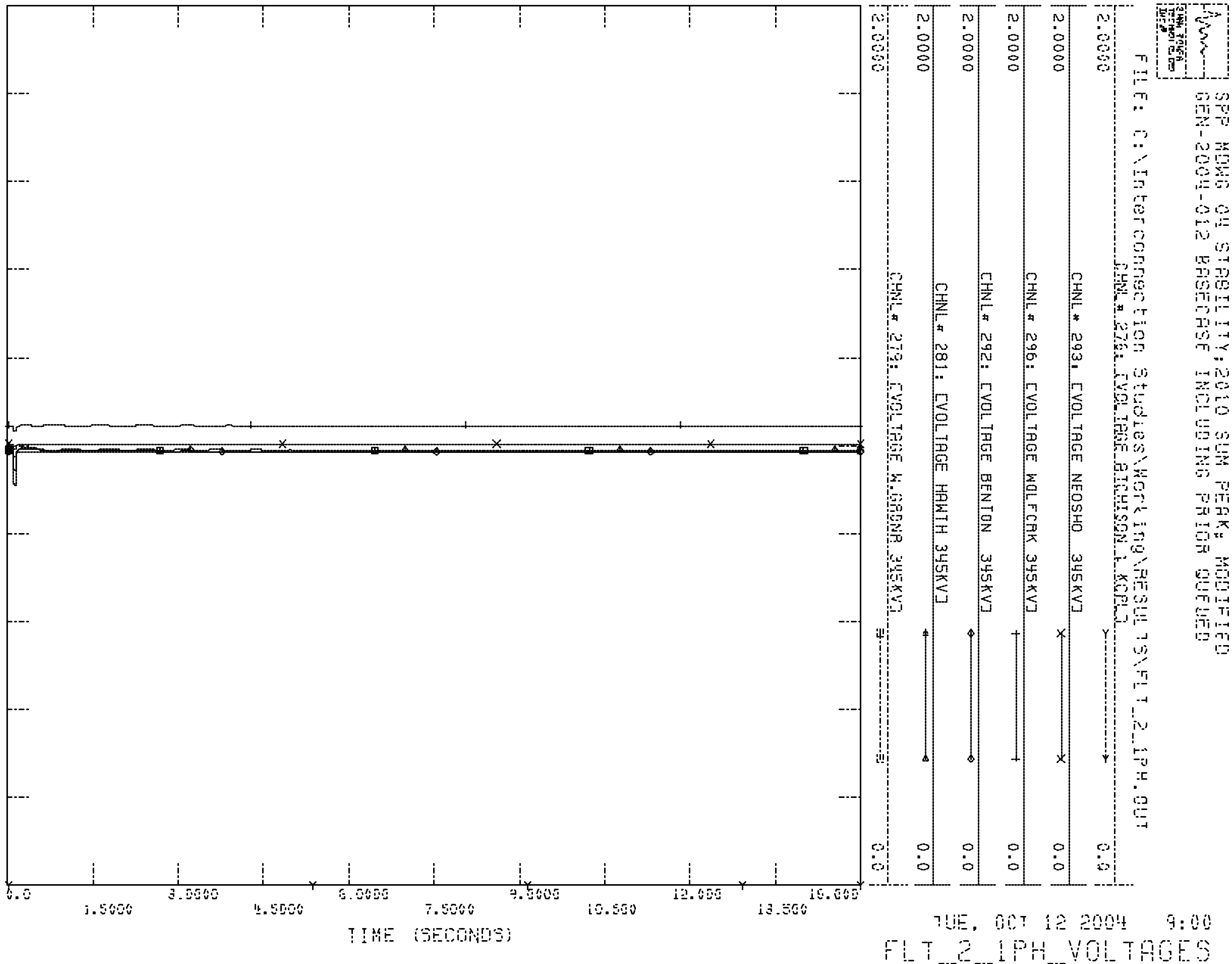



TUE, OCT 12 2004 9:00

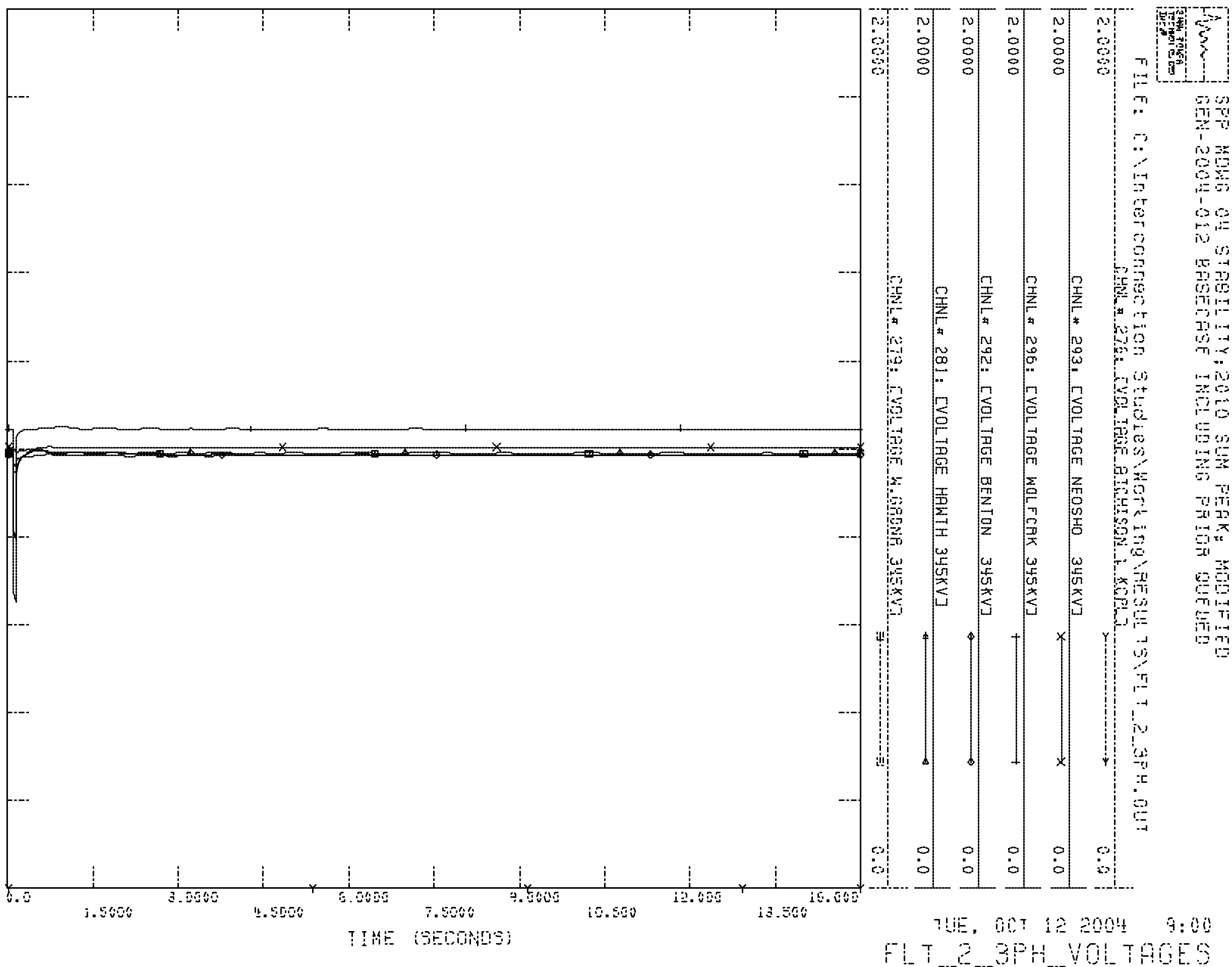
FLT_1_1PH_VOLTAGES



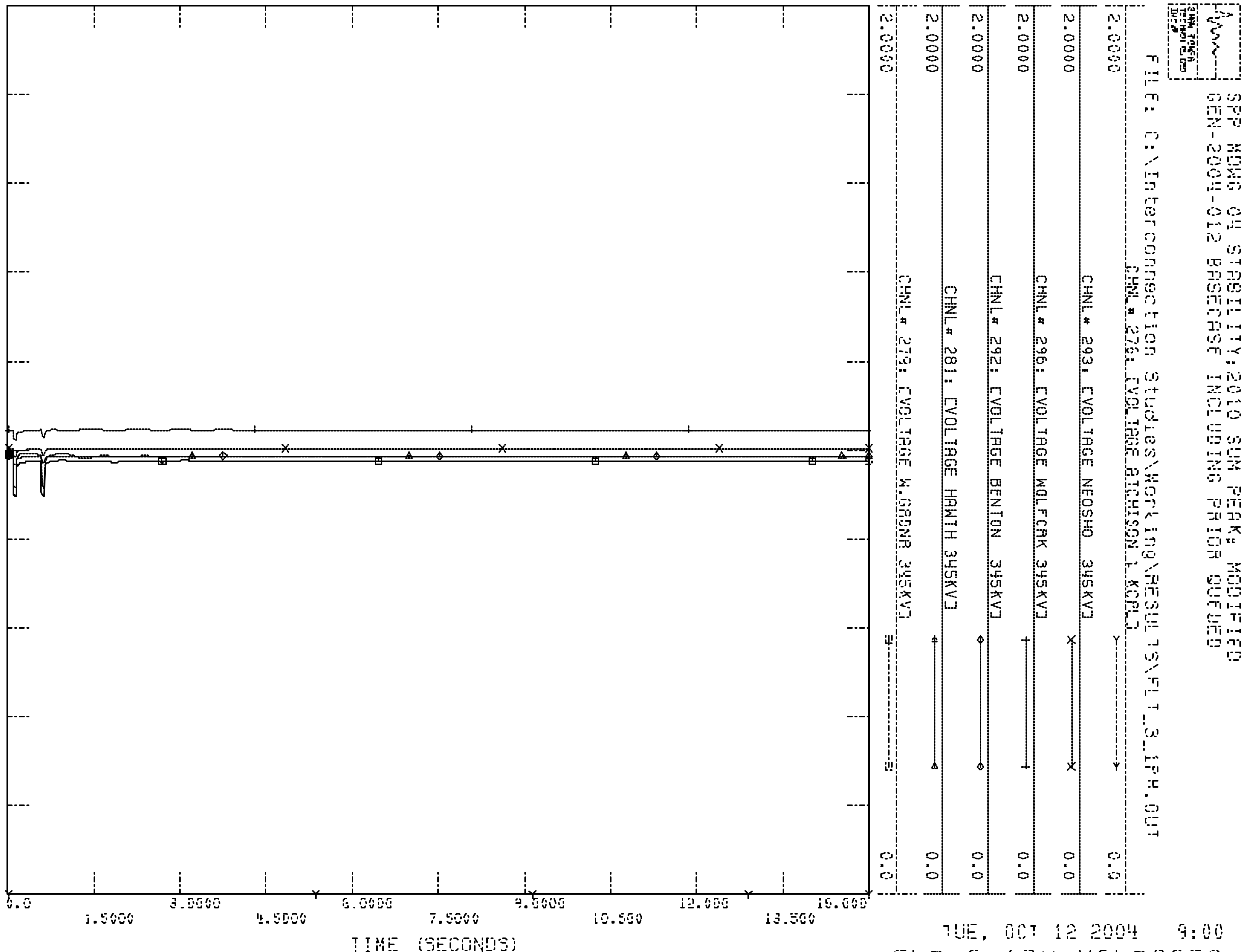
SPP MDWG 04 STABILITY, 2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_1_3PH.OUT
CHNL# 276: [VOLTAGE ATCHISON 1 KCPL]
CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_1_3PH_VOLTAGES



SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_2_1PH.OUT
CHNL# 276: [VOLTAGE ATCHISON 1 KCPL]
2.0000 0.0
CHNL# 293: [VOLTAGE NEOSHO 345KV]
2.0000 0.0
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000 0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000 0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000 0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000 0.0
0.0 1.5000 3.0000 4.5000 6.0000 7.5000 9.0000 10.500 12.000 13.500 15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_2_1PH_VOLTAGES

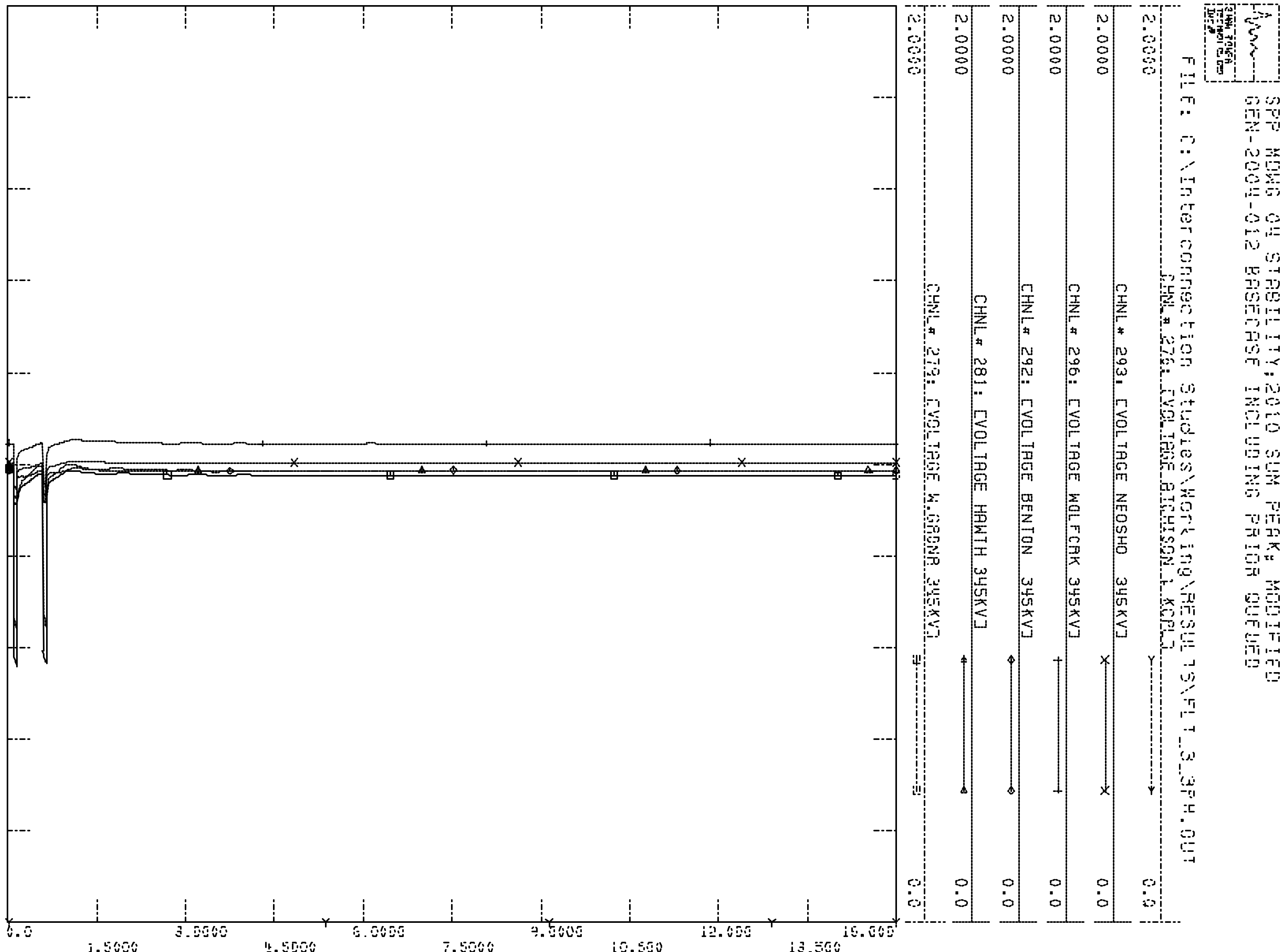


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_2_3PH.OUT
CHNL# 276: [VOLTAGE ATCHISON_1 KCPL]
CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_2_3PH_VOLTAGES



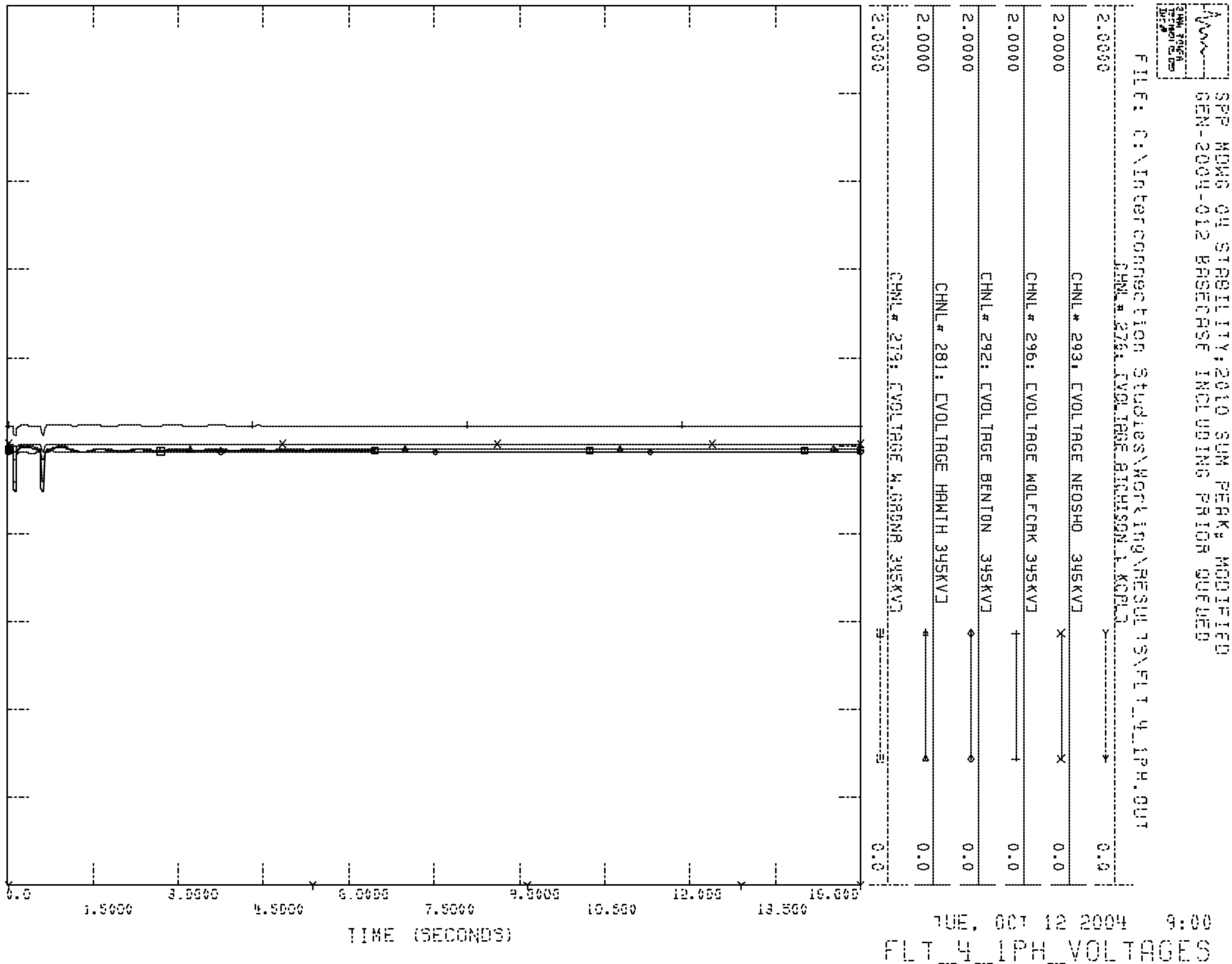

TUE, OCT 12 2004 9:00

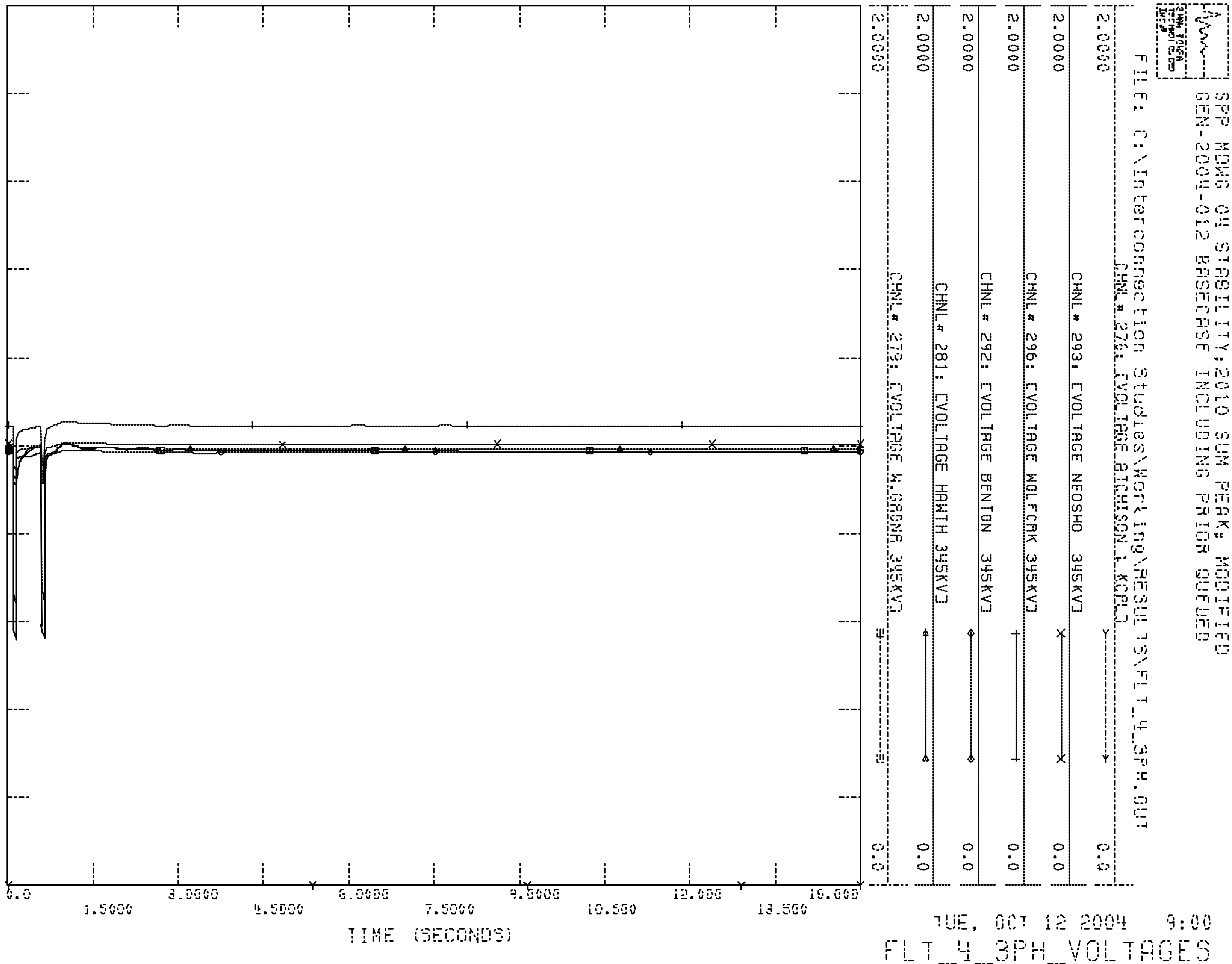
FLT_3_1PH_VOLTAGES



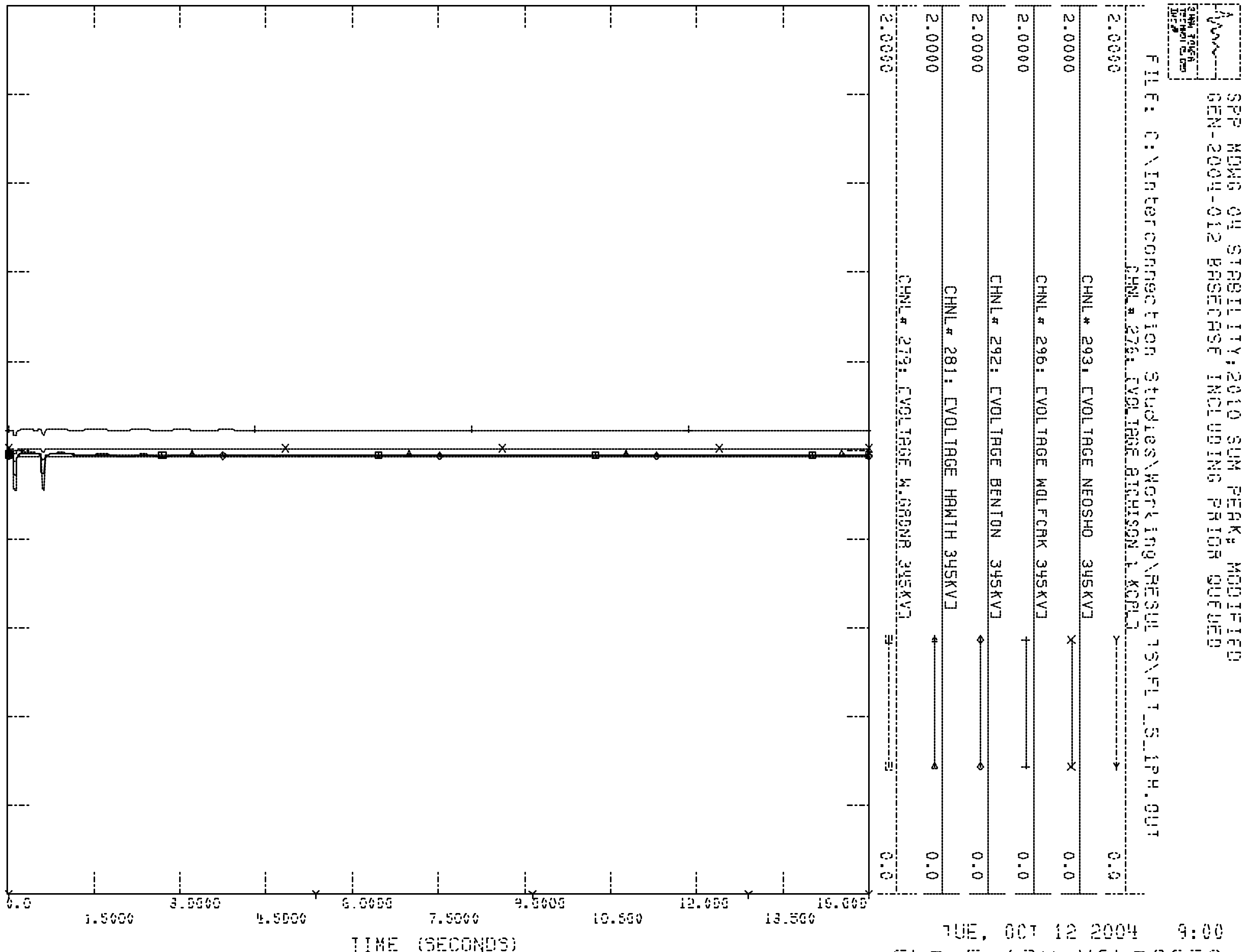

TUE, OCT 12 2004 9:00

FLT_3_3PH_VOLTAGES


SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\interconnection Studies\Working\RESULTS\FLT_4_1PH.OUT
CHNL# 276: [VOLTAGE ATCHISON_1 KCPL]
CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_4_1PH_VOLTAGES

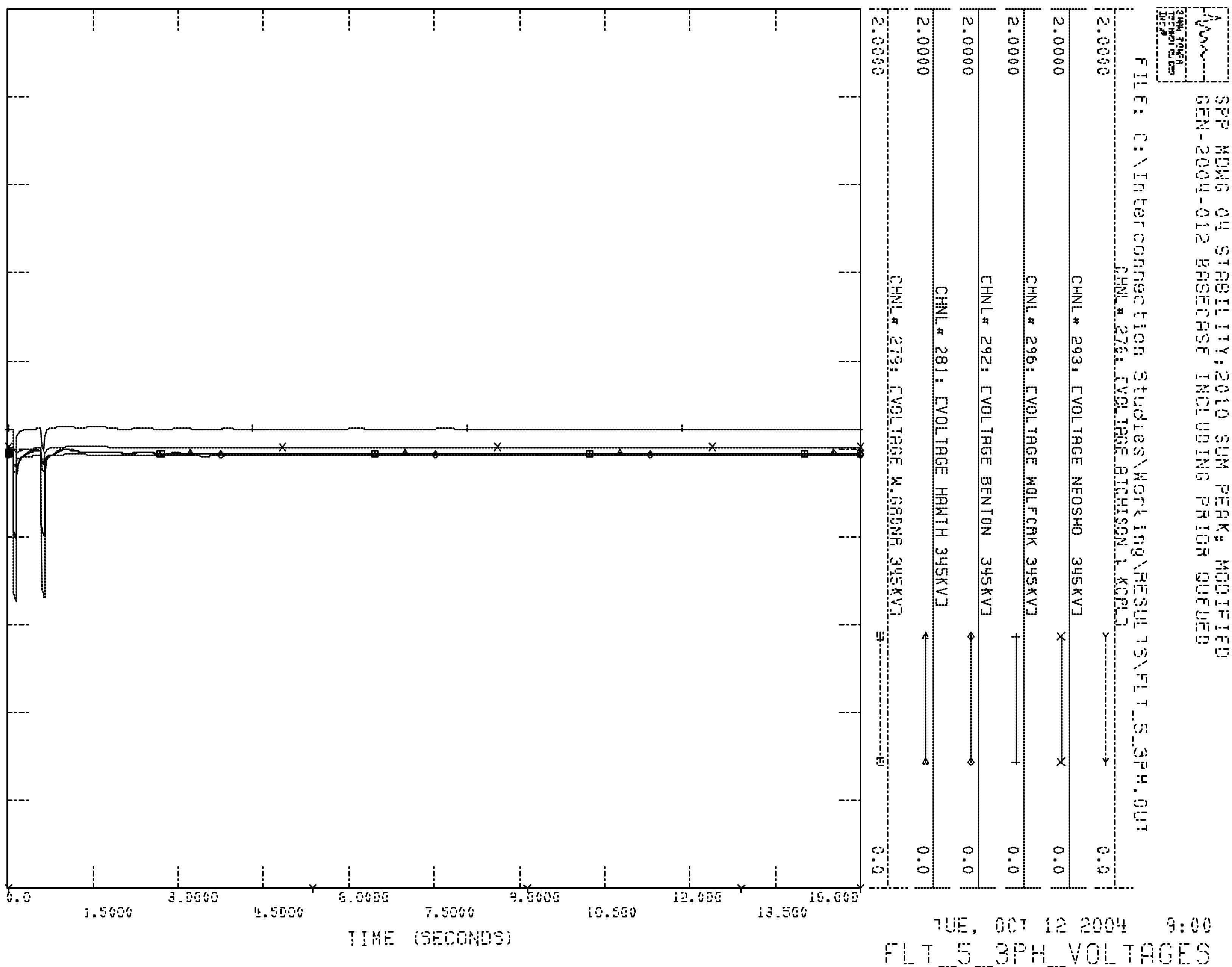


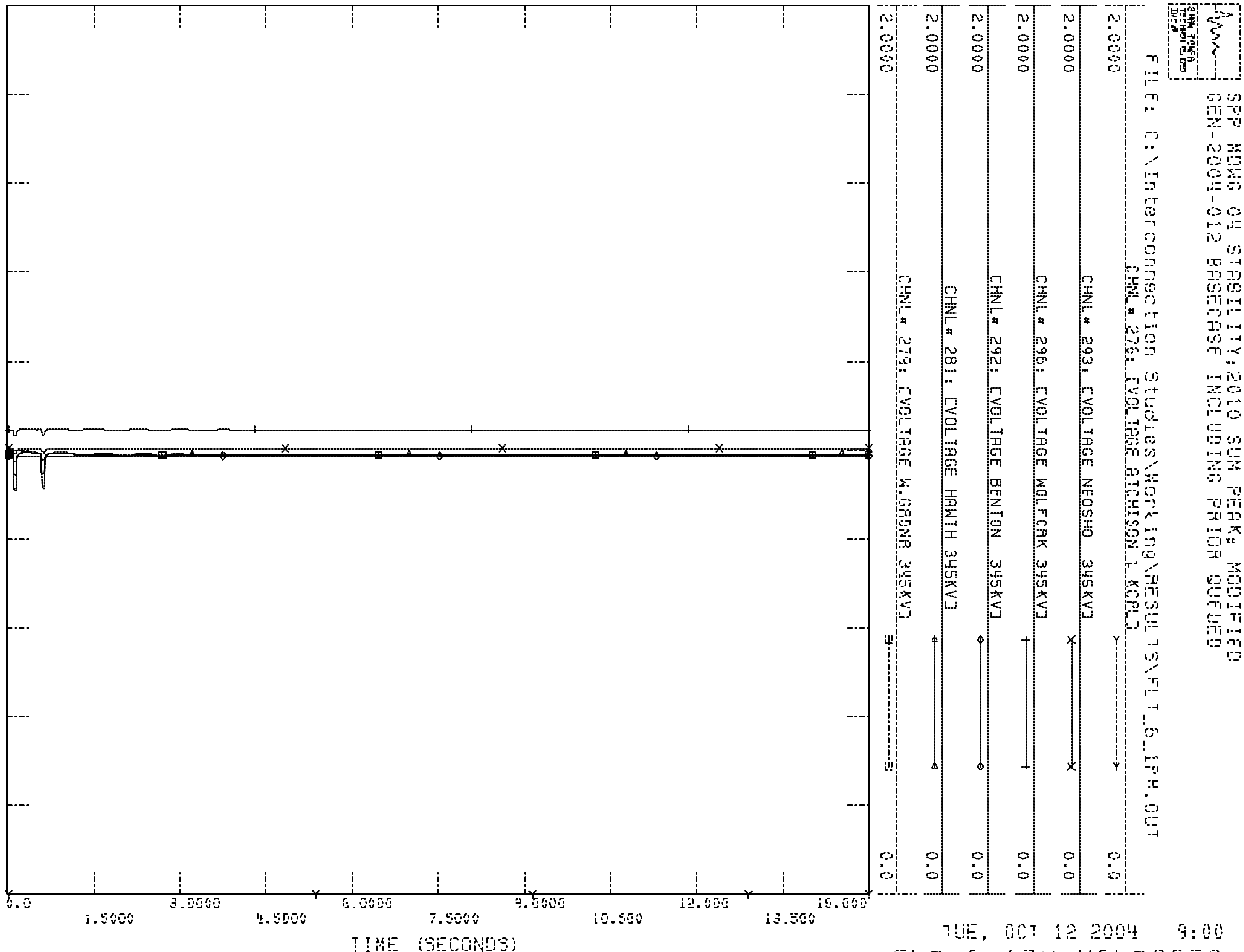
SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_4_3PH.OUT
CHNL# 276: [VOLTAGE ATCHISON_1 KCPL]
2.0000
0.0
CHNL# 293: [VOLTAGE NEOSHO 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_4_3PH_VOLTAGES




TUE, OCT 12 2004 9:00

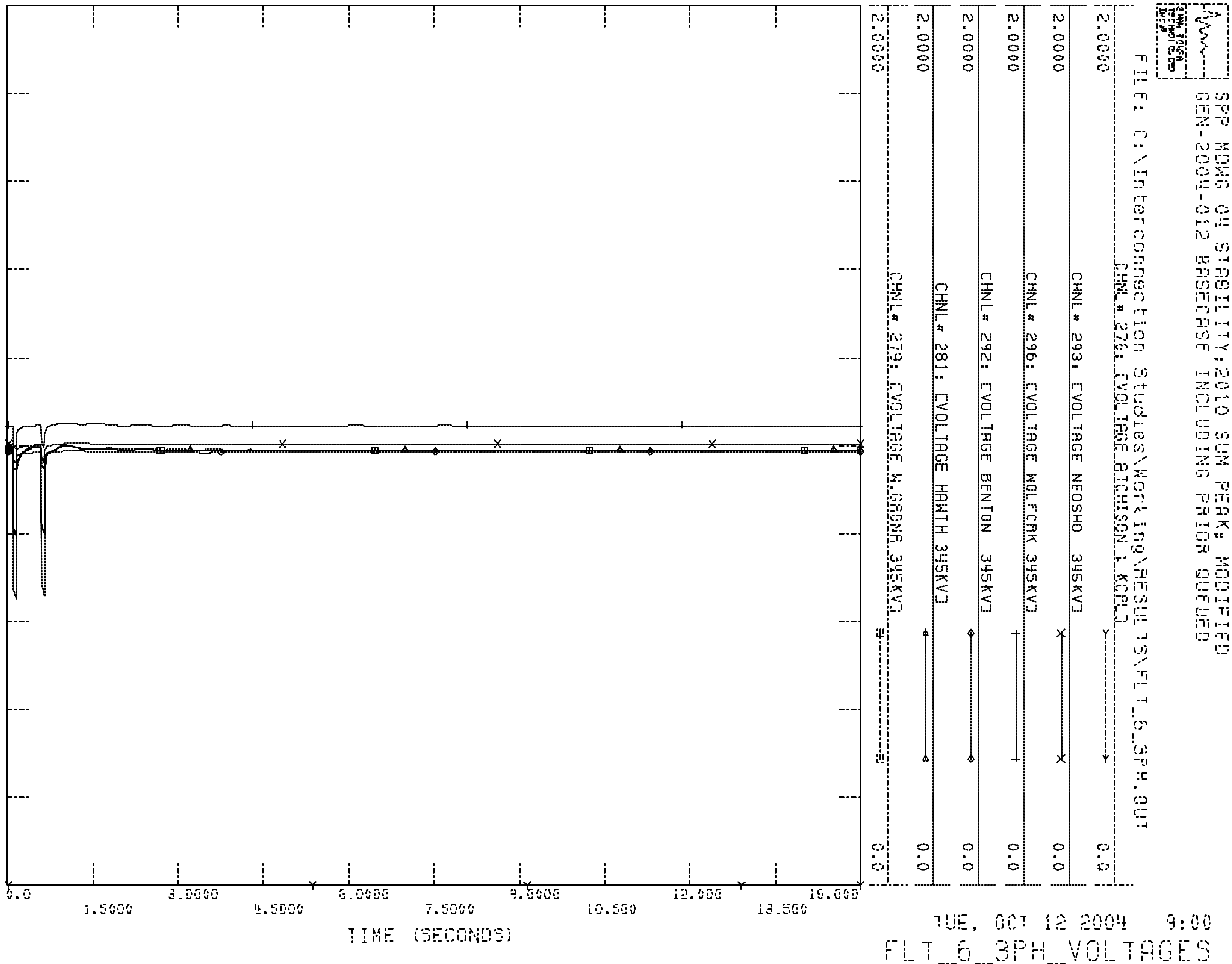
FLT_5_1PH_VOLTAGES

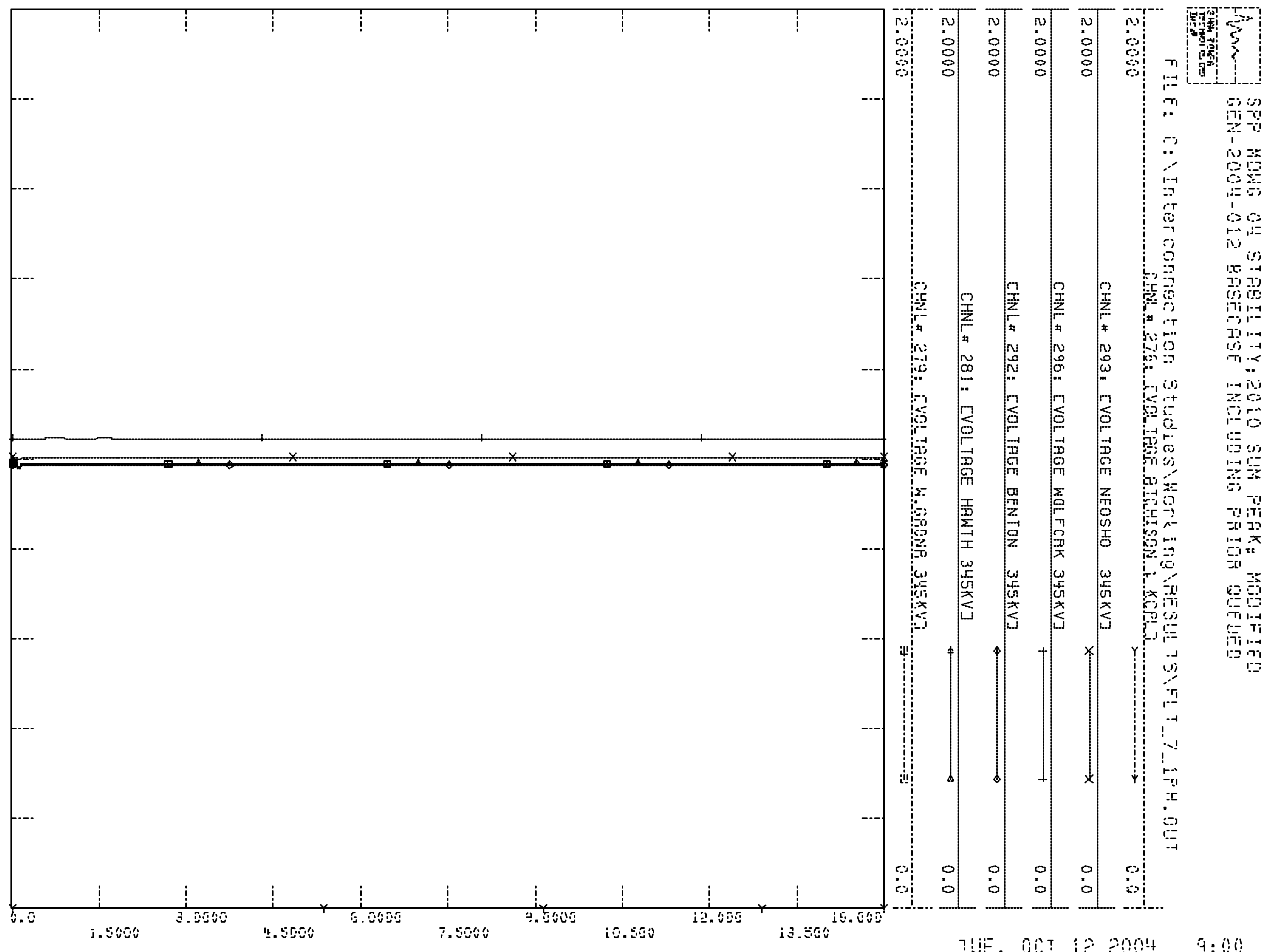

SPP MDWG 04 STABILITY, 2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_5_3PH.OUT
CHNL# 276: [VOLTAGE ATCHISON_1 KCPL]
CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_5_3PH_VOLTAGES



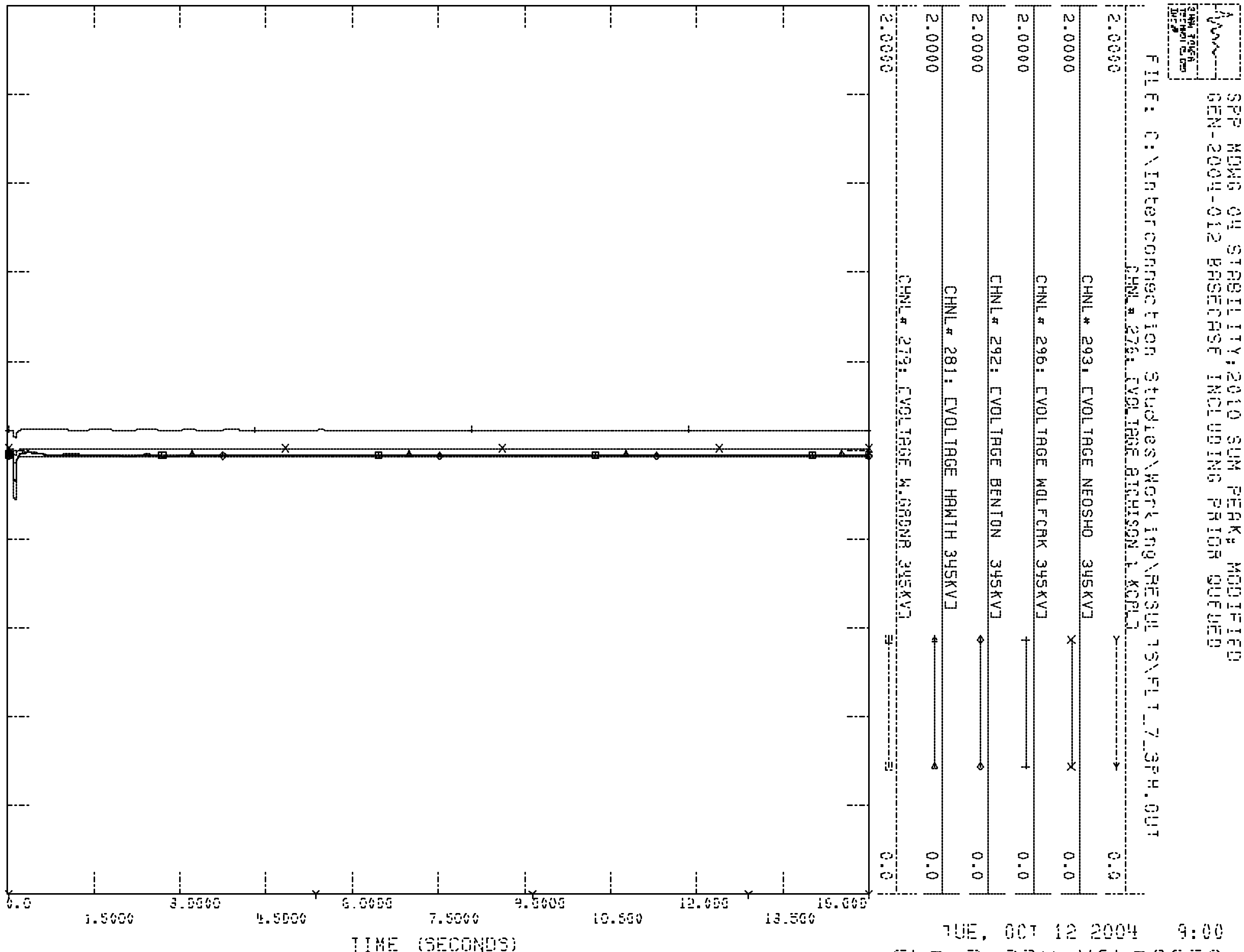

TUE, OCT 12 2004 9:00

FLT_6_1PH_VOLTAGES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_6_3PH.OUT
CHNL# 276: [VOLTAGE ATCHISON 1 KCPL]
CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_6_3PH_VOLTAGES

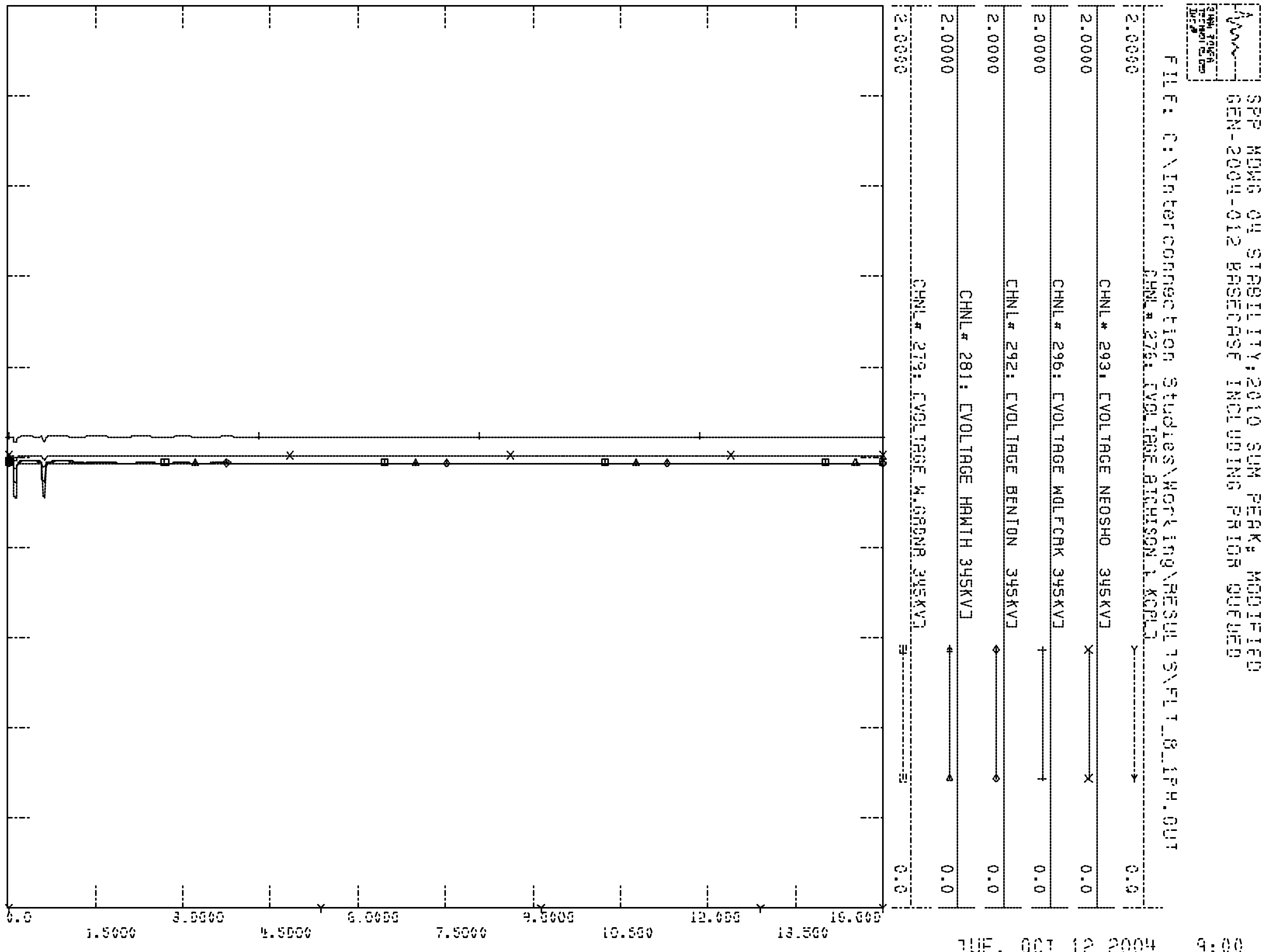



FLT_7_1PH_VOLTAGES

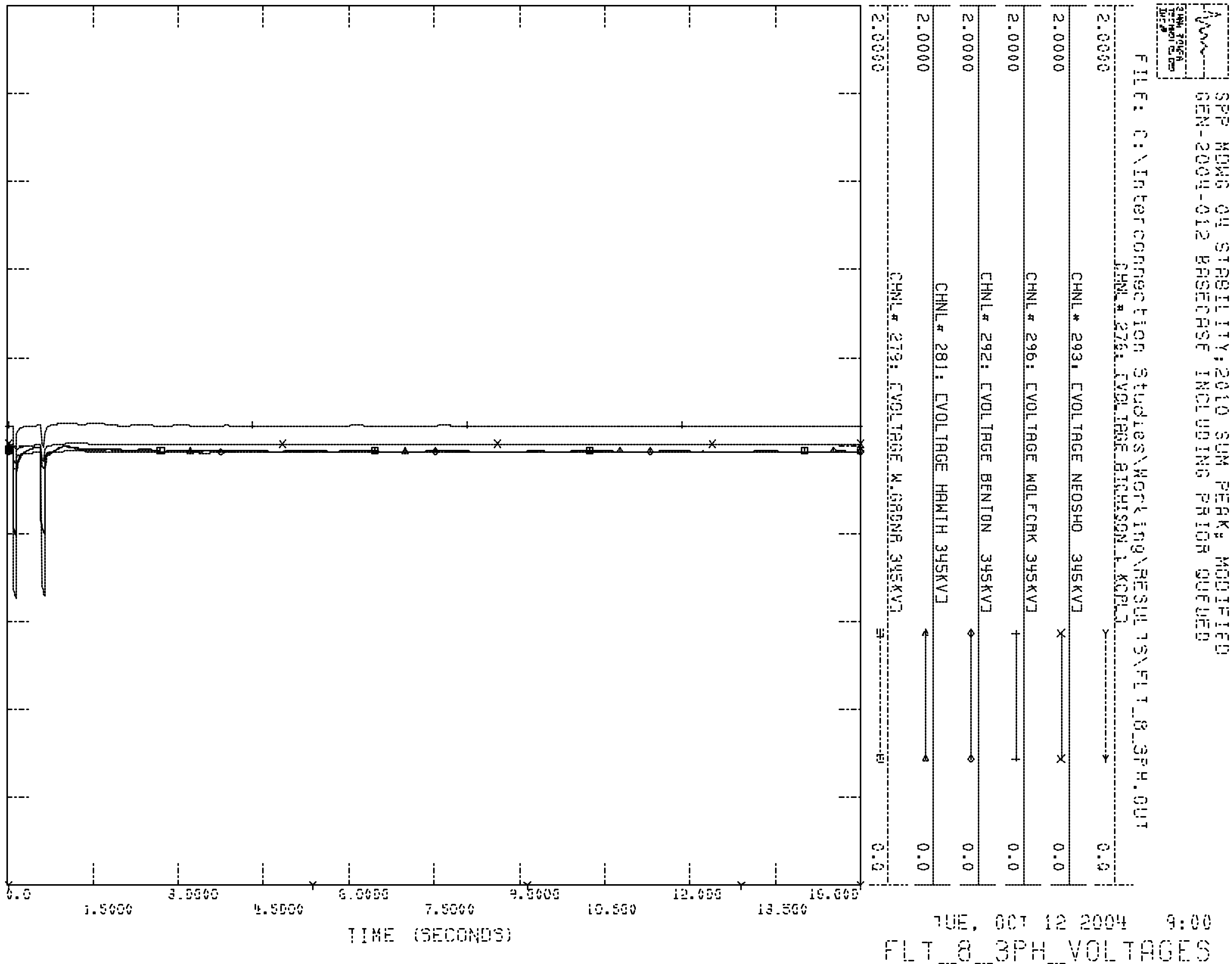


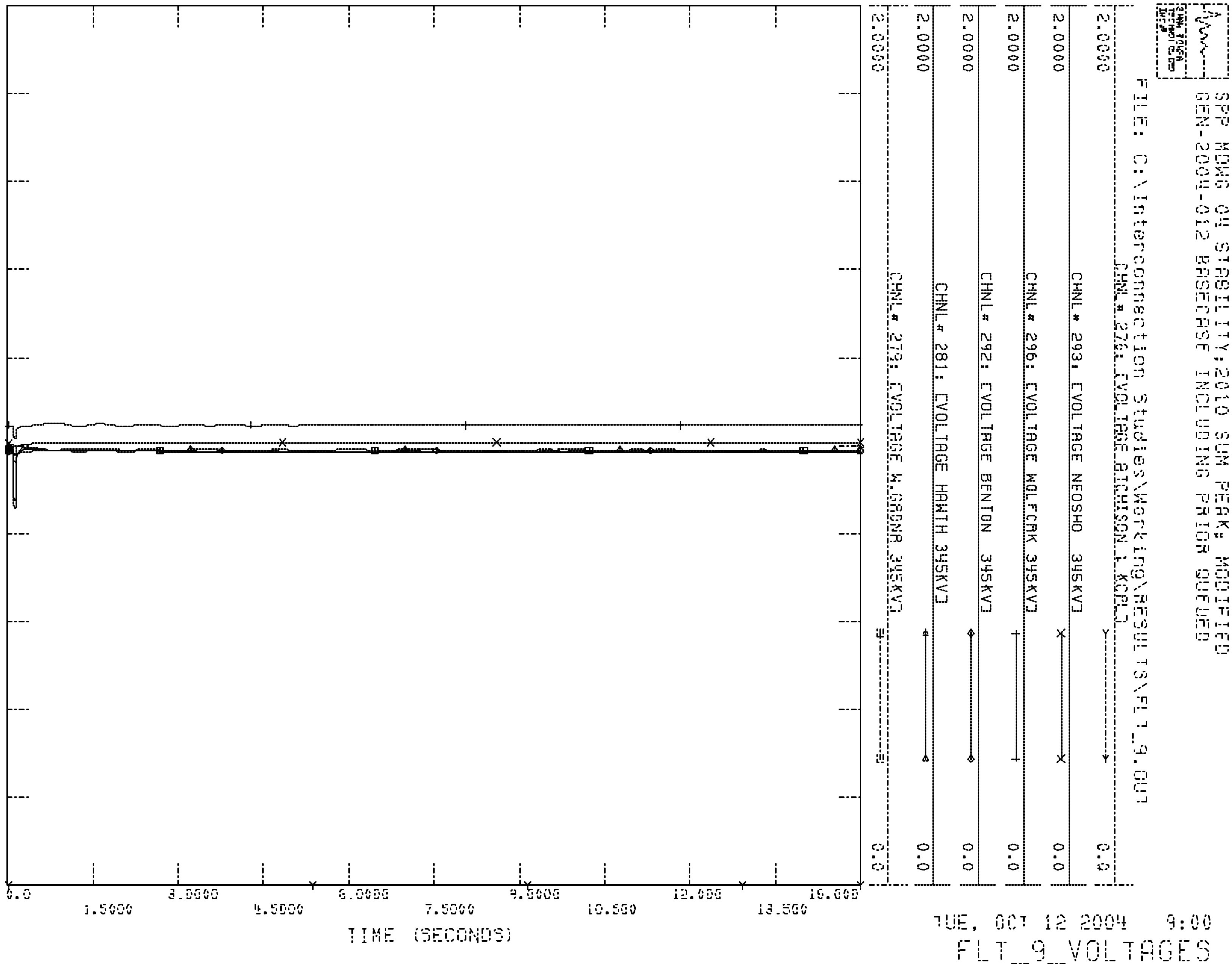

TUE, OCT 12 2004 9:00

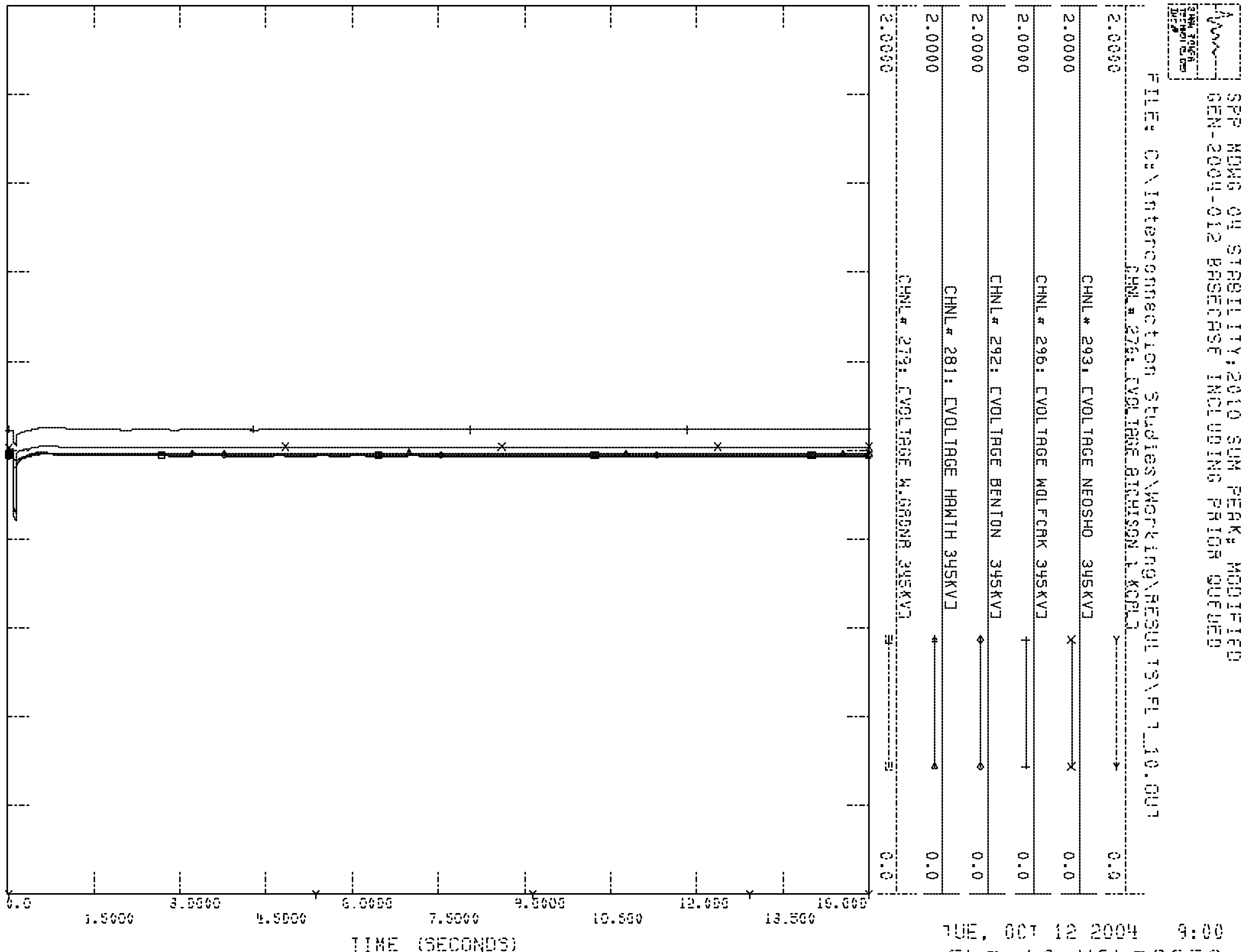
FLT_7_3PH_VOLTAGES




FLT_8_1PH_VOLTAGES

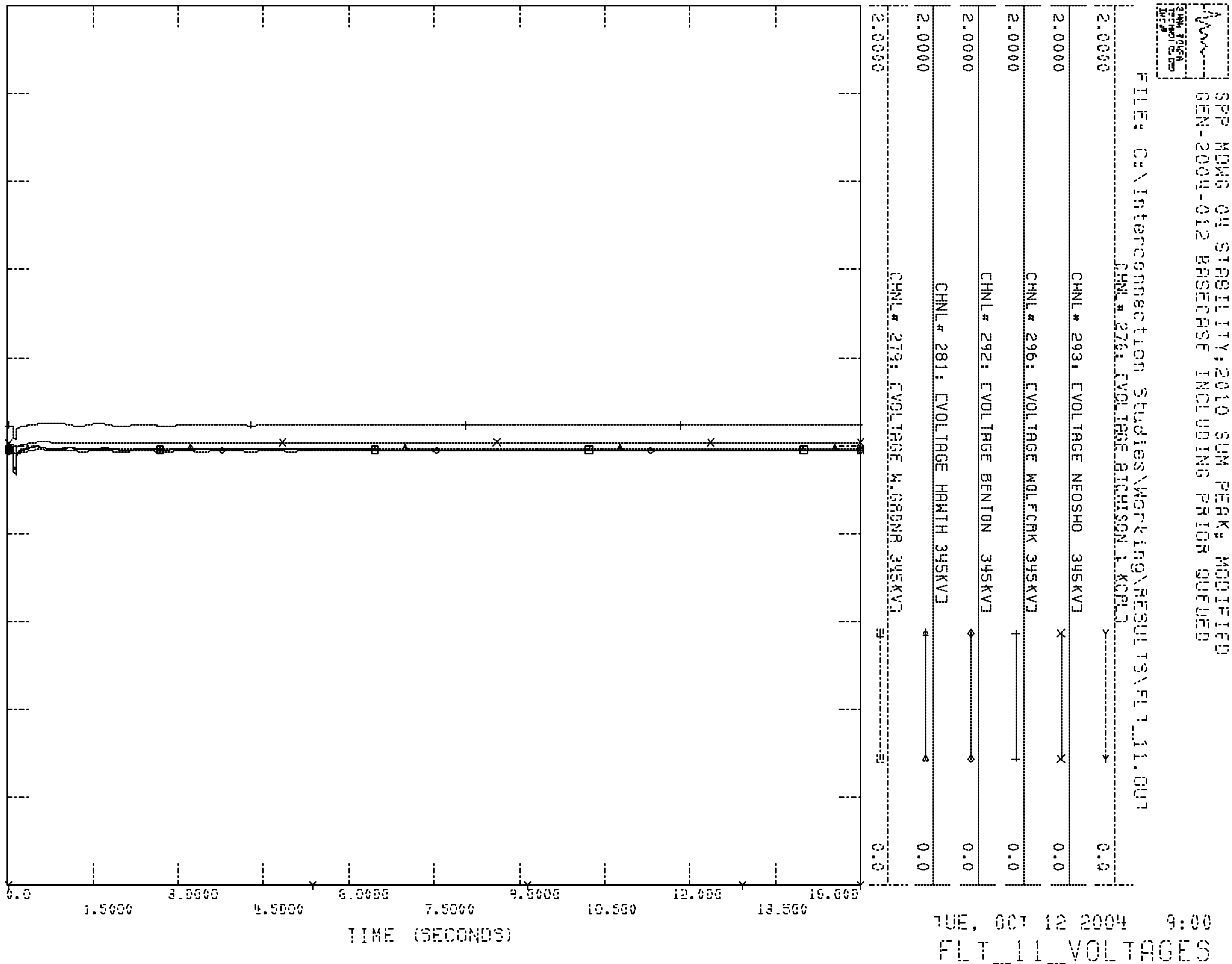

SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_8_3PH.OUT
CHNL# 276: [VOLTAGE ATCHISON 1 KCPL]
CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_8_3PH_VOLTAGES

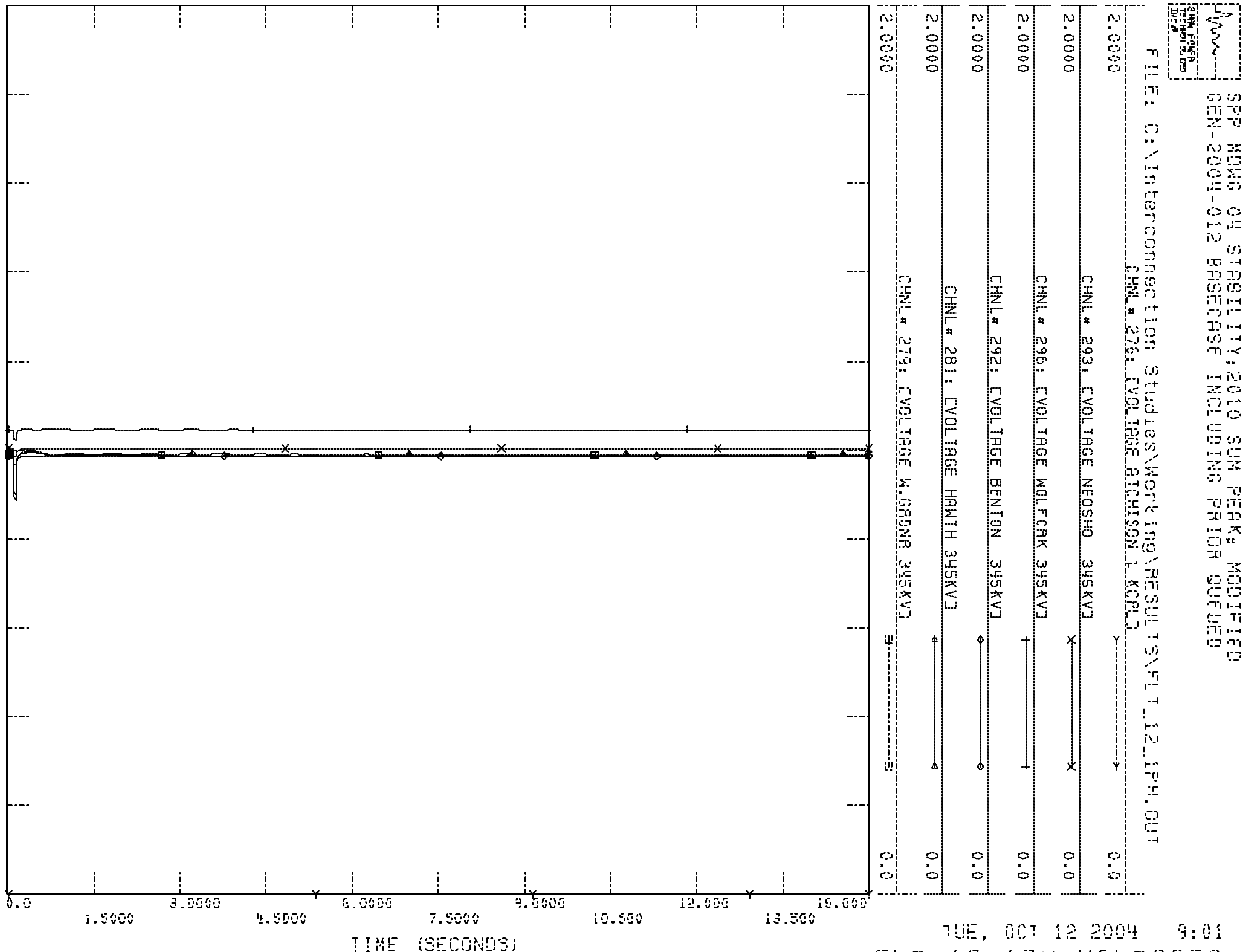

SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_9.OUT
CHNL# 276: [VOLTAGE ATCHISON 1 KCPL]
CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_9_VOLTAGES




TUE, OCT 12 2004 9:00

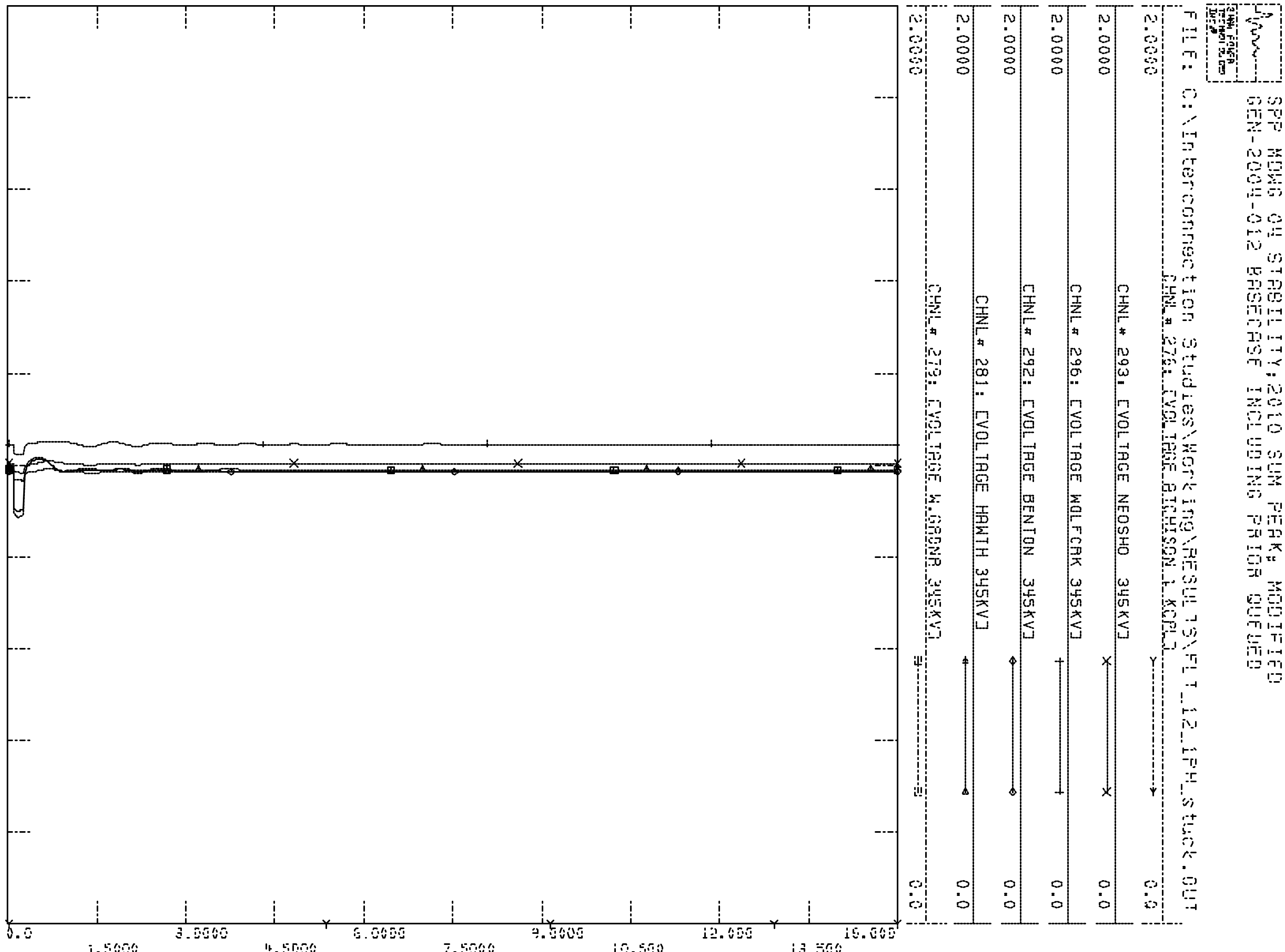
FLT_10_VOLTAGES


SPP MDWG 04 STABILITY;2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_11.OUT
CHNL# 276: [VOLTAGE ATCHISON 1 KCPL]
CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:00
FLT_11_VOLTAGES



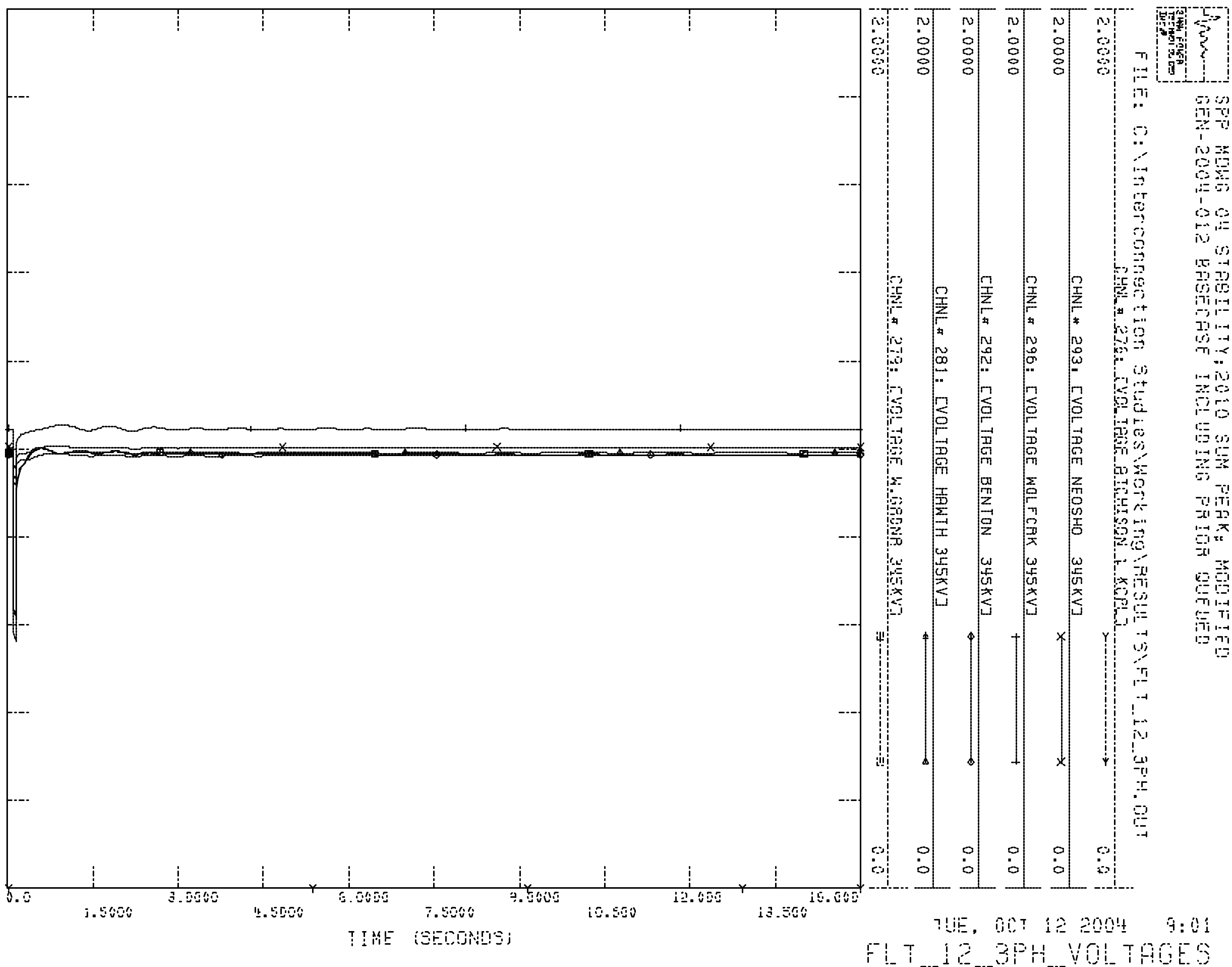

TUE, OCT 12 2004 9:01

FLT_12_1PH_VOLTAGES

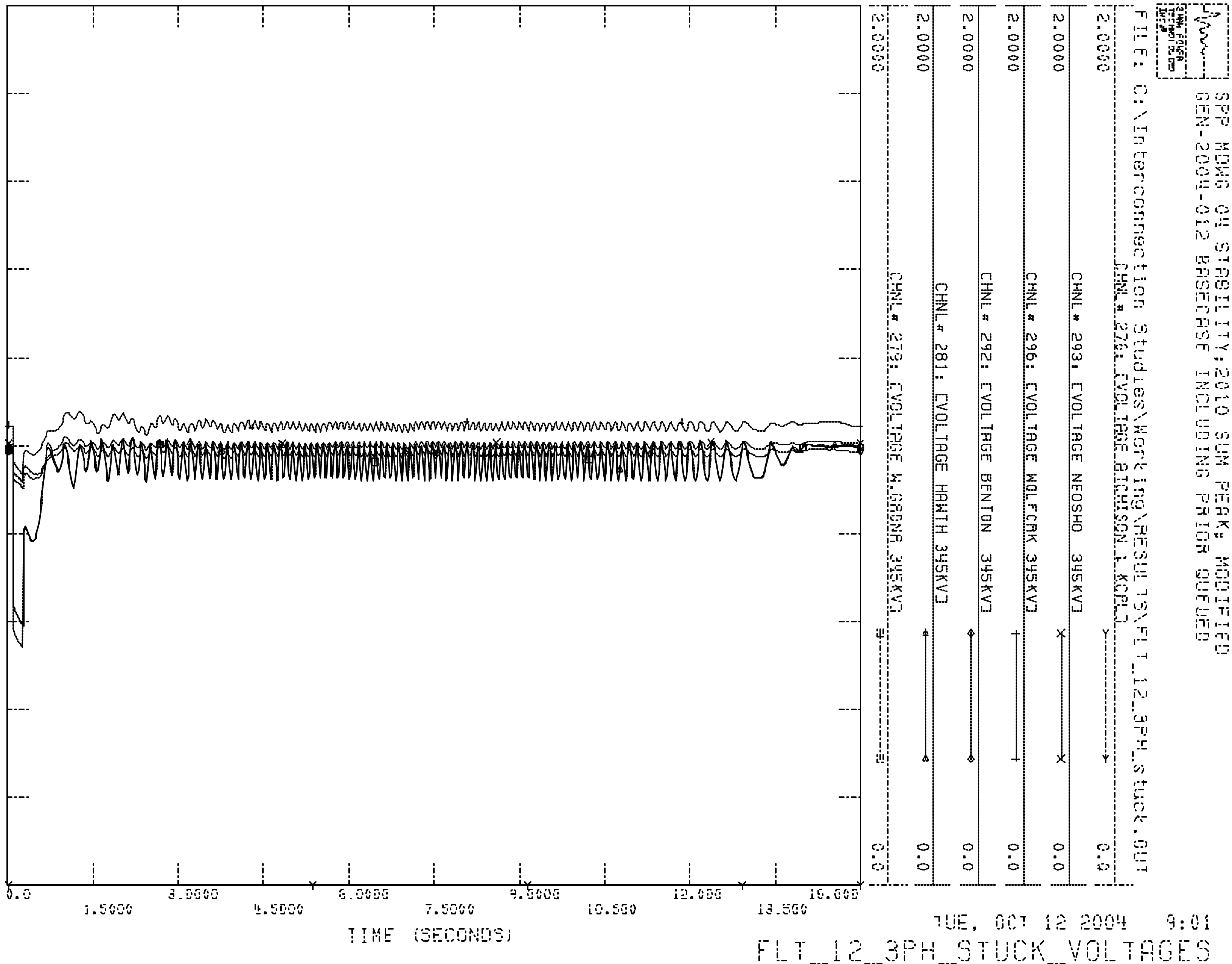



TUE, OCT 12 2004 9:01

FLT_12_1PH_STUCK_VOLTAGES



SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_12_3PH.OUT
CHNL# 276: [VOLTAGE ATCHISON 1 KCPL]
2.0000
0.0
CHNL# 293: [VOLTAGE NEOSHO 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:01
FLT_12_3PH_VOLTAGES



SPP MDWG 04 STABILITY, 2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_12_3PH_stuck.OUT
CHNL # 276: [VOLTAGE ATCHISON 1 KCPL]
CHNL # 293: [VOLTAGE NEOSHO 345KV]
CHNL # 296: [VOLTAGE WOLFCRK 345KV]
CHNL # 292: [VOLTAGE BENTON 345KV]
CHNL # 281: [VOLTAGE HAWTH 345KV]
CHNL # 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, OCT 12 2004 9:01
FLT_12_3PH_STUCK_VOLTAGES

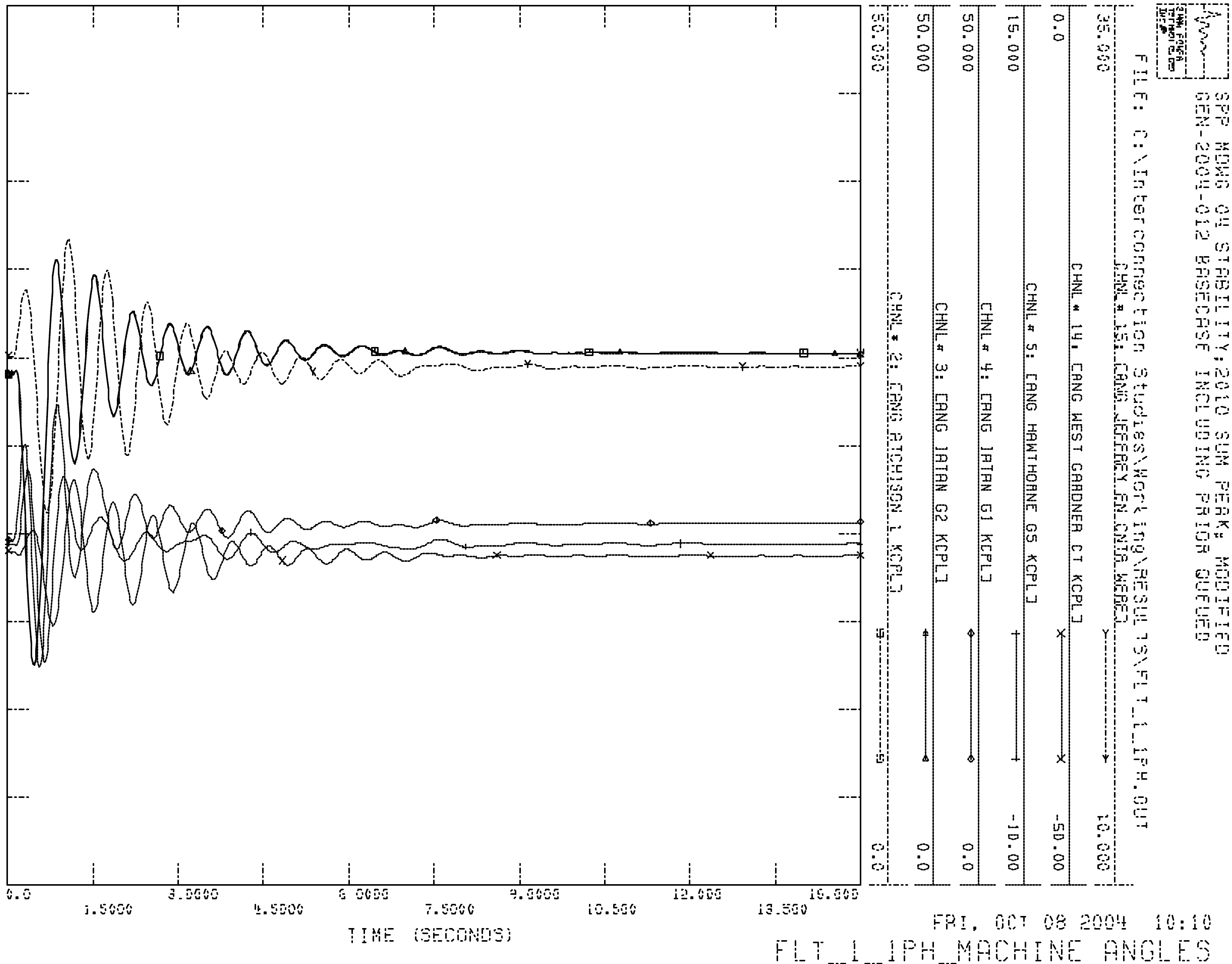
# Appendix B-1

# Plots of Fault Simulations

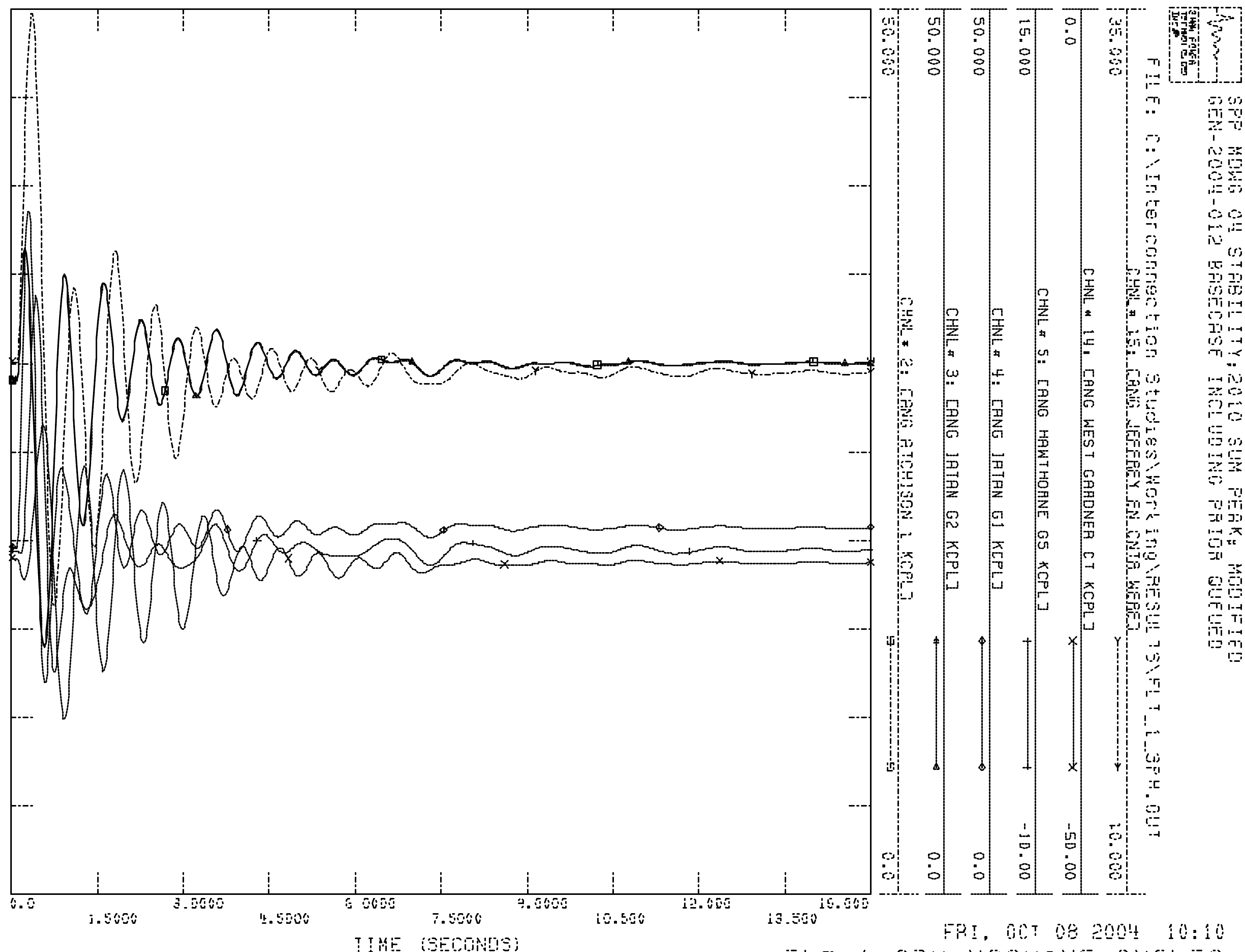
**Plots of selected machine angle response during faults**

**Scenario:**
**2010 Summer Peak**

**[Customer plant at 900MW]**

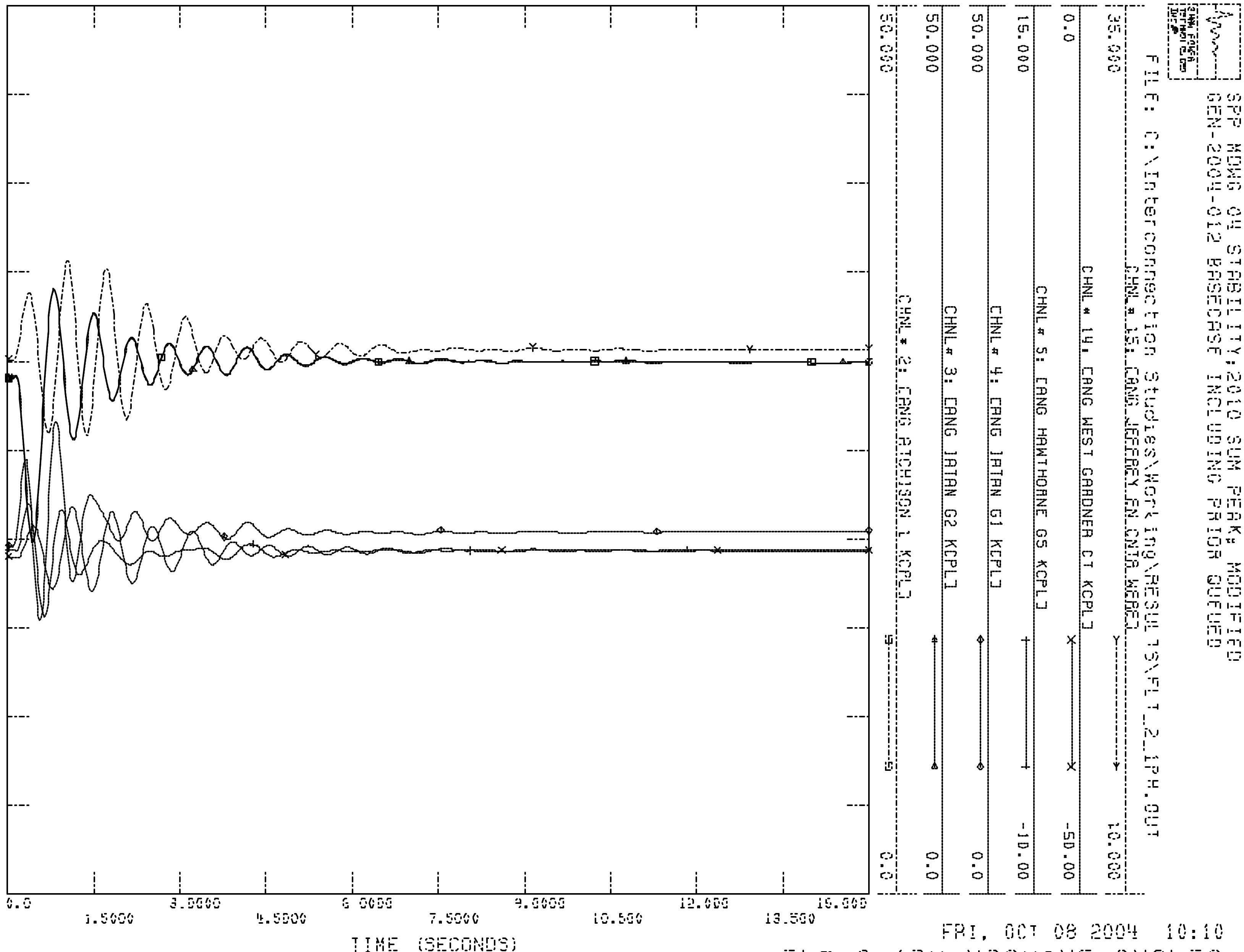


SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_1_1PH.OUT
CHNL# 15: [ANG JEFFREY EN CNTR WERE]
35.000
10.000
CHNL# 14: [ANG WEST GARDNER CT KCPL]
0.0
-50.00
CHNL# 5: [ANG HAWTHORNE G5 KCPL]
15.000
-10.00
CHNL# 4: [ANG IATAN G1 KCPL]
50.000
0.0
CHNL# 3: [ANG IATAN G2 KCPL]
50.000
0.0
CHNL# 2: [ANG ATCHISON 1 KCPL]
50.000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
FRI, OCT 08 2004 10:10
FLT_1_1PH_MACHINE ANGLES



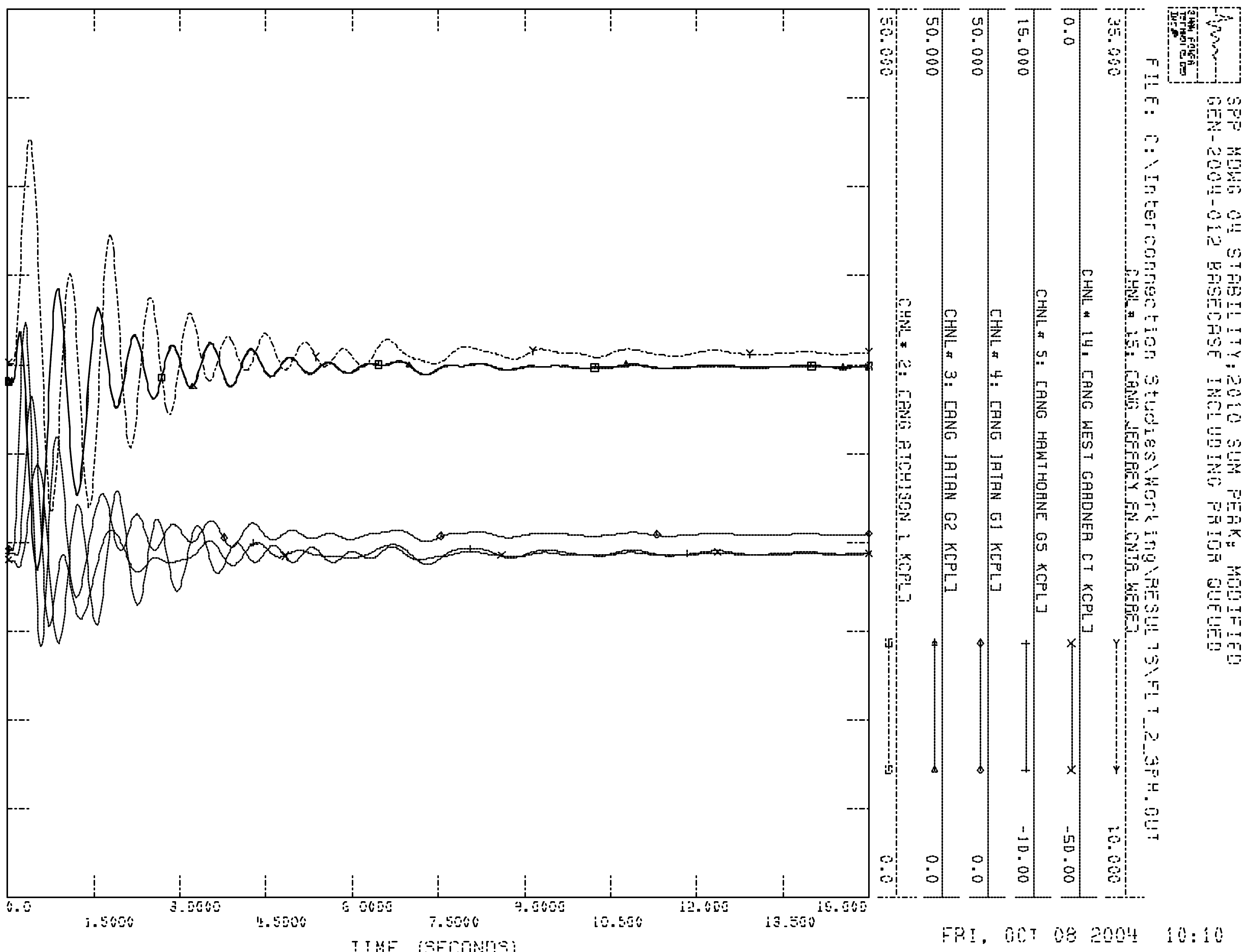

FRI, OCT 08 2004 10:10

FLT_1_3PH_MACHINE ANGLES



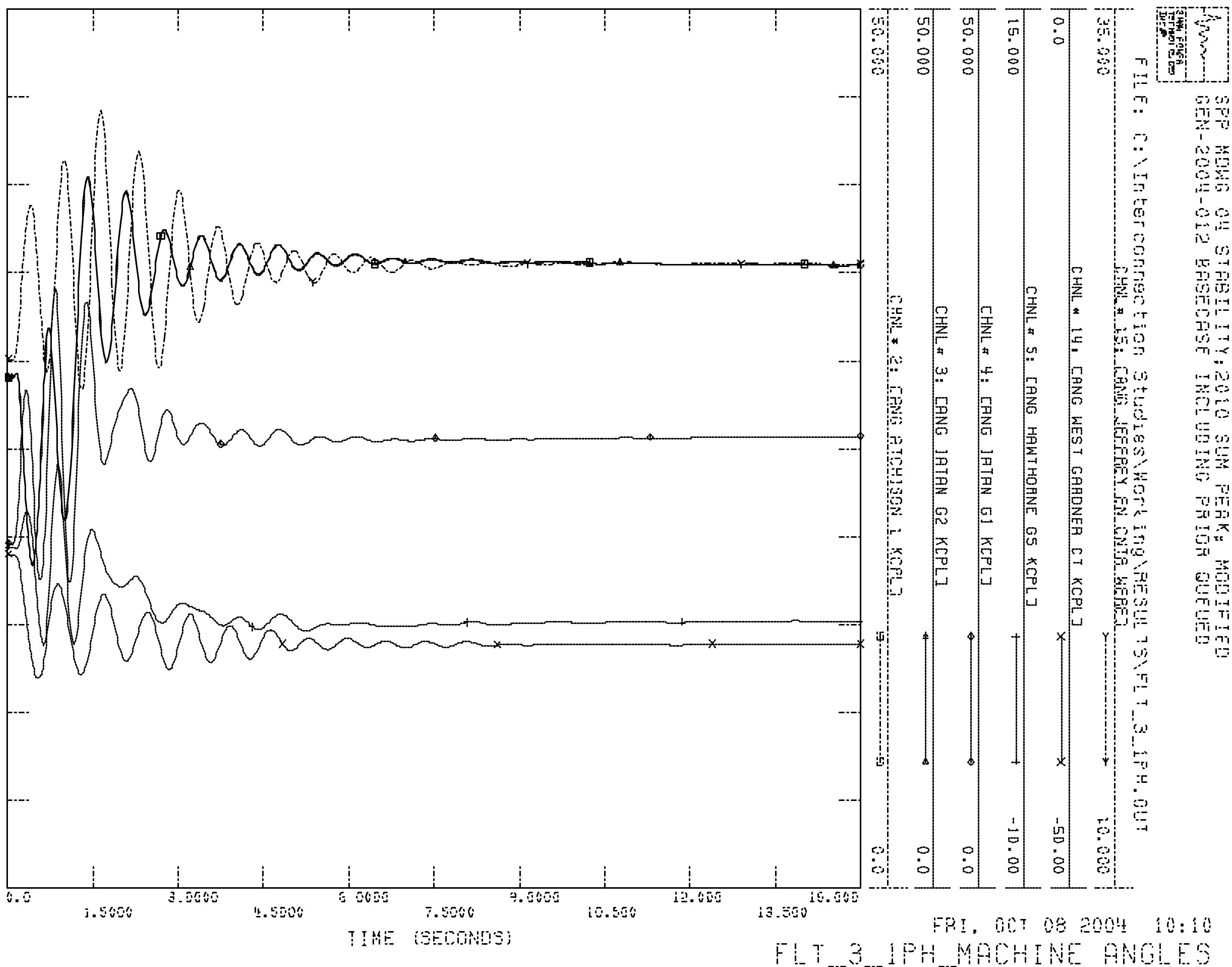

FRI, OCT 08 2004 10:10

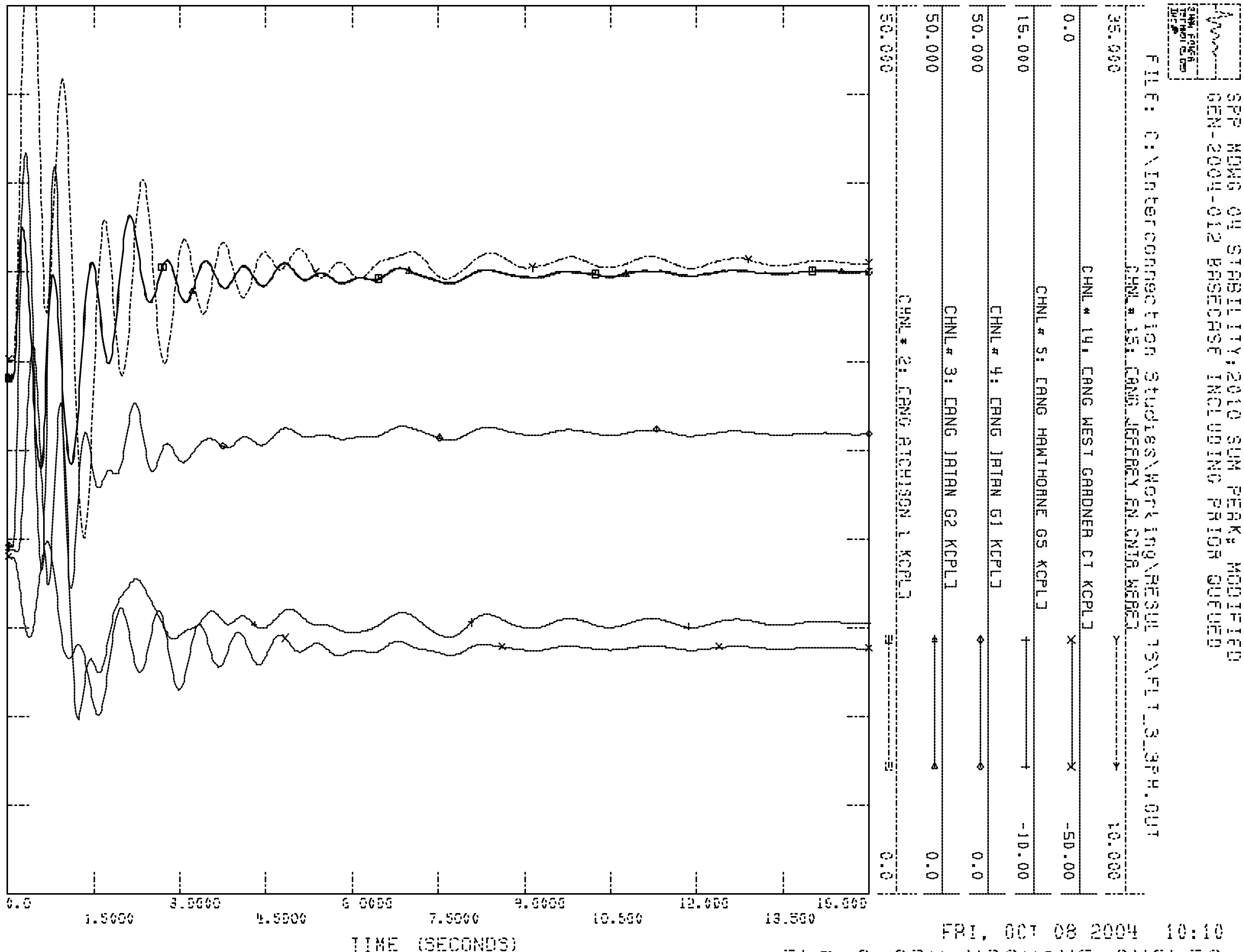
FLT_2_1PH_MACHINE ANGLES




FRI, OCT 08 2004 10:10

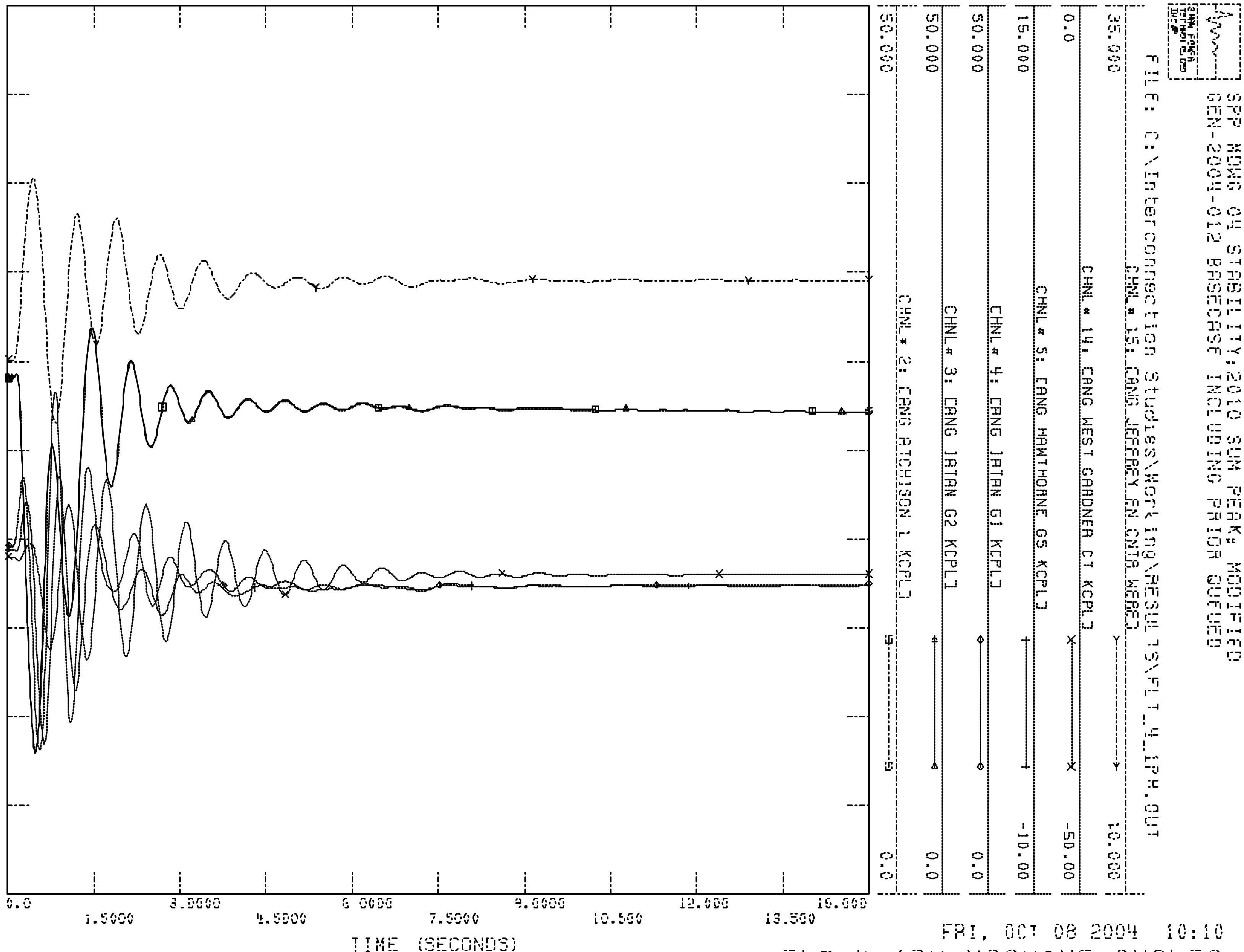
FLT_2_3PH_MACHINE ANGLES


SPP MDWG 04 STABILITY, 2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_3_1PH.OUT
CHNL # 15: [ANG JEFFREY EN CNTR WERE]
35.000
10.000
CHNL # 14: [ANG WEST GARDNER CT KCPL]
0.0
-50.00
CHNL # 5: [ANG HAWTHORNE G5 KCPL]
15.000
-10.00
CHNL # 4: [ANG IATAN G1 KCPL]
50.000
0.0
CHNL # 3: [ANG IATAN G2 KCPL]
50.000
0.0
CHNL # 2: [ANG ATCHISON 1 KCPL]
50.000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
FRI, OCT 08 2004 10:10
FLT_3_1PH_MACHINE ANGLES



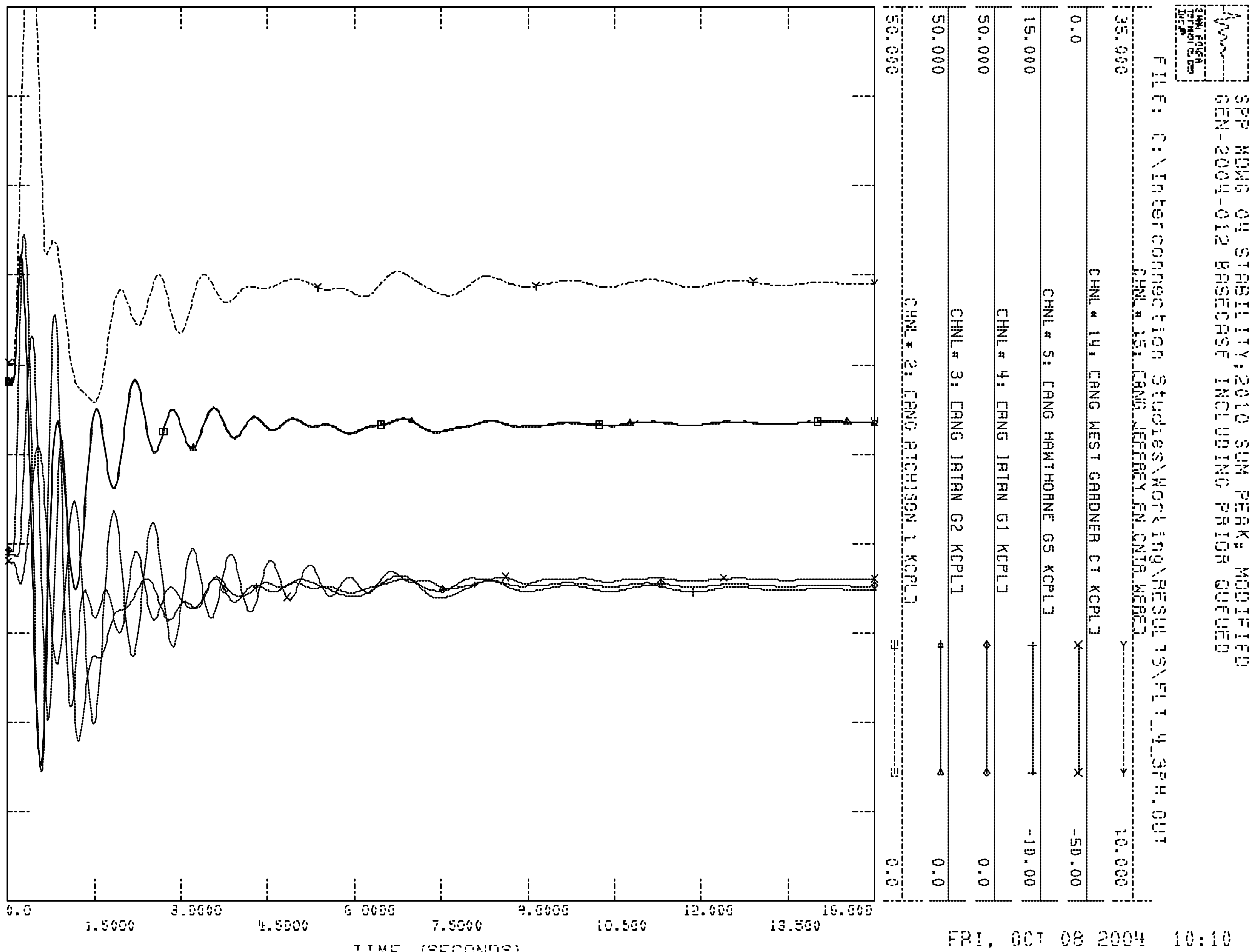

FRI, OCT 08 2004 10:10

FLT_3_3PH_MACHINE ANGLES



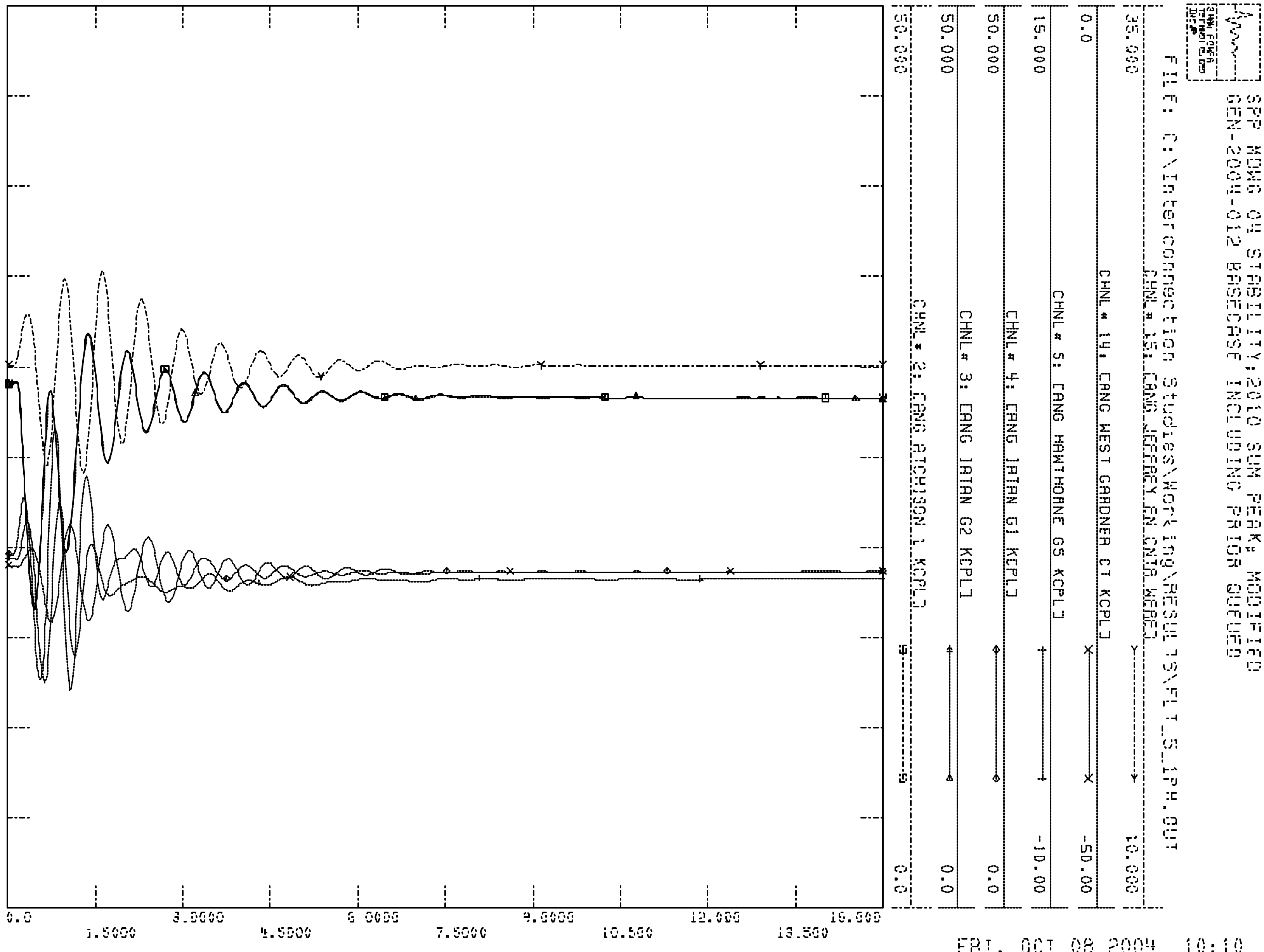

FRI, OCT 08 2004 10:10

FLT_4_1PH_MACHINE ANGLES




FRI, OCT 08 2004 10:10

FLT_4_3PH_MACHINE ANGLES

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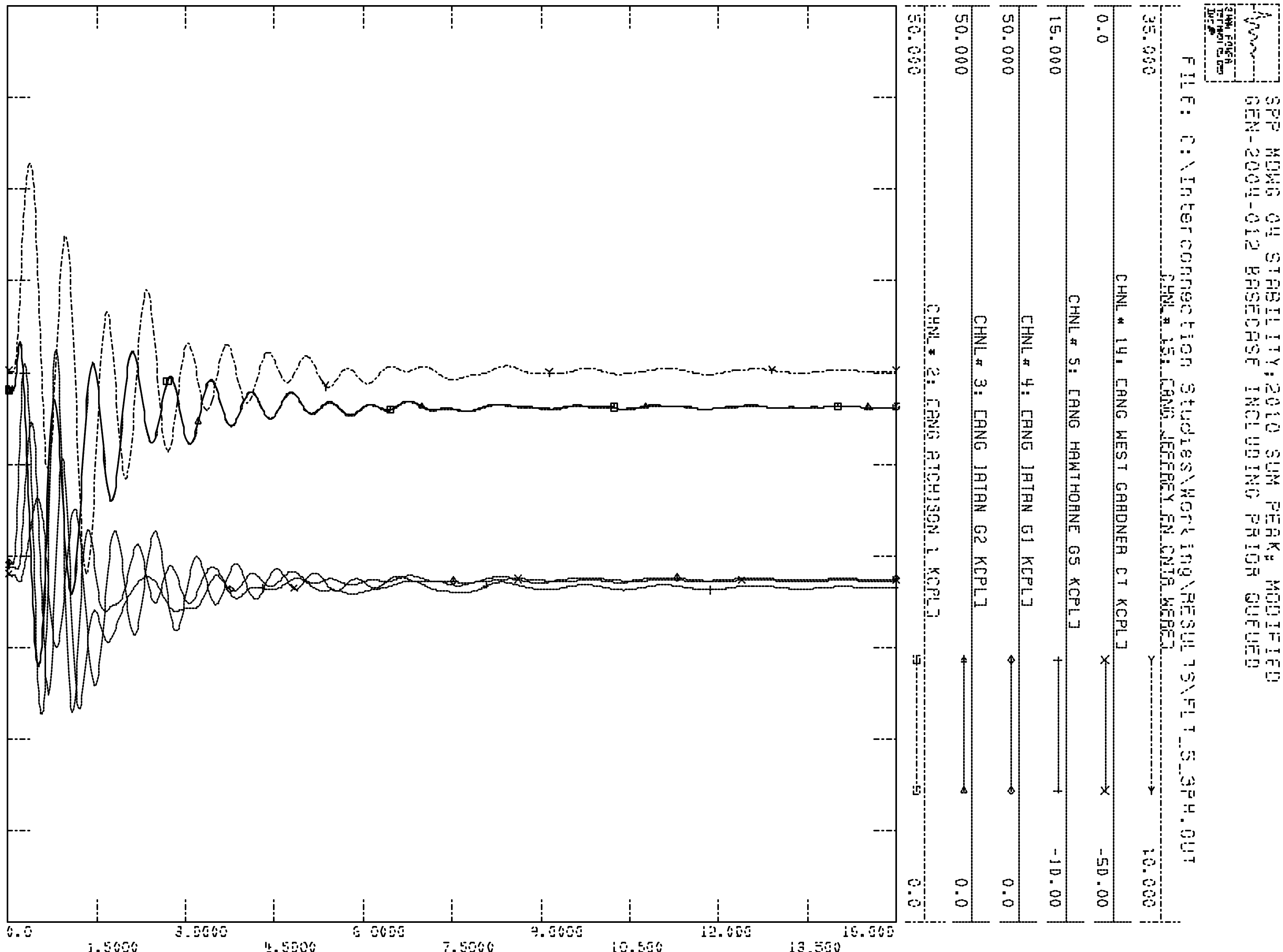


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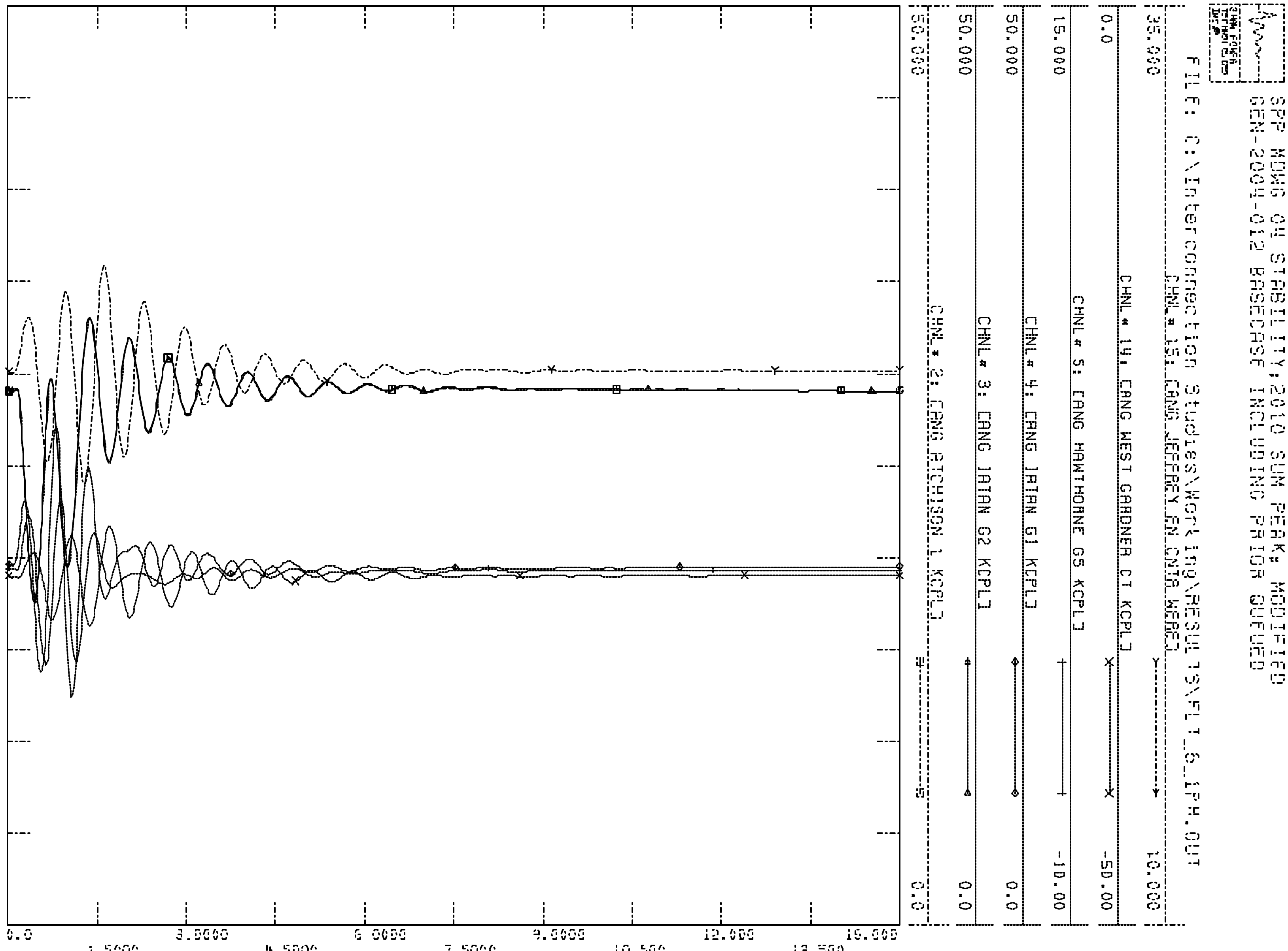


FRI, OCT 08 2004 10:10

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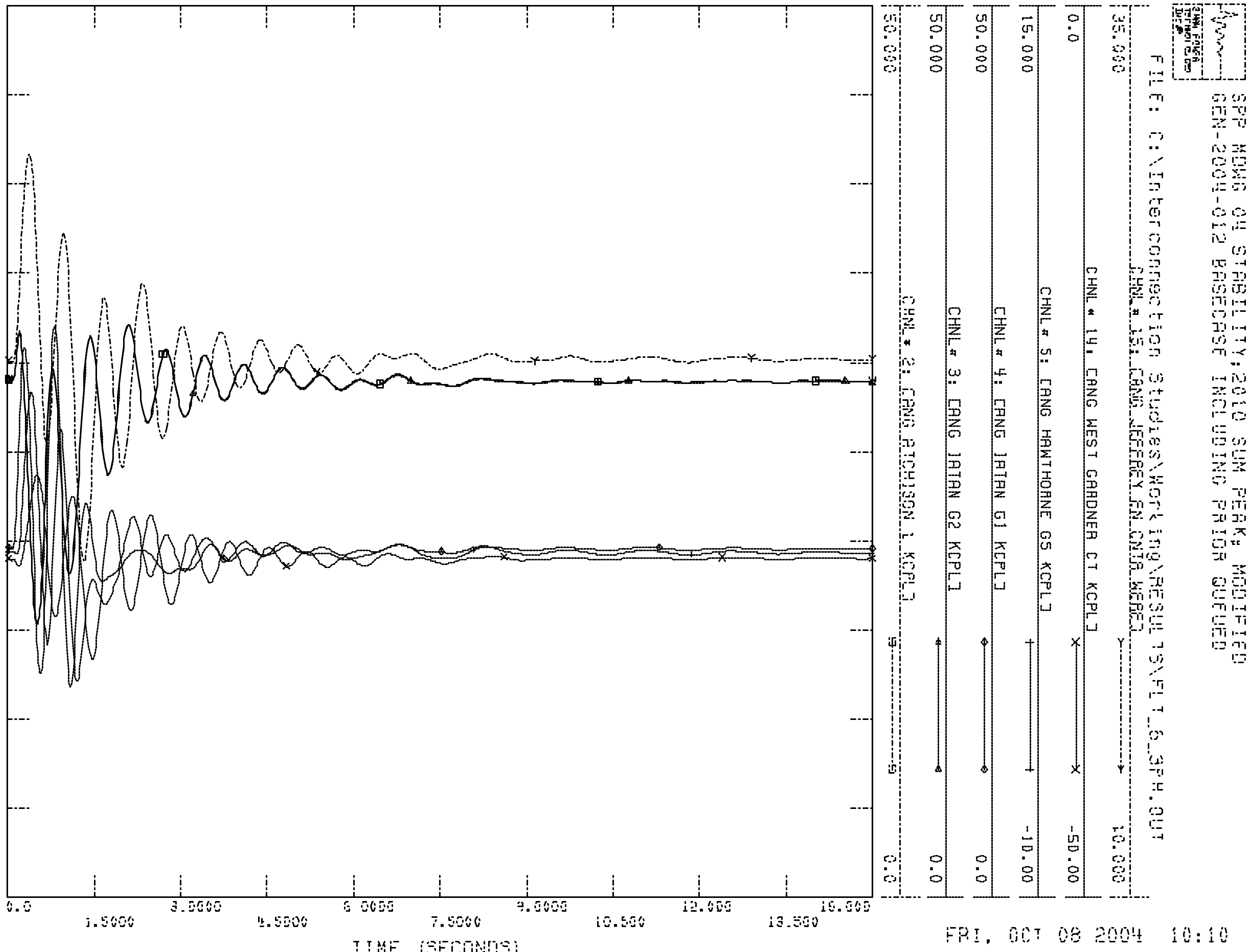


FRI, OCT 08 2004 10:10

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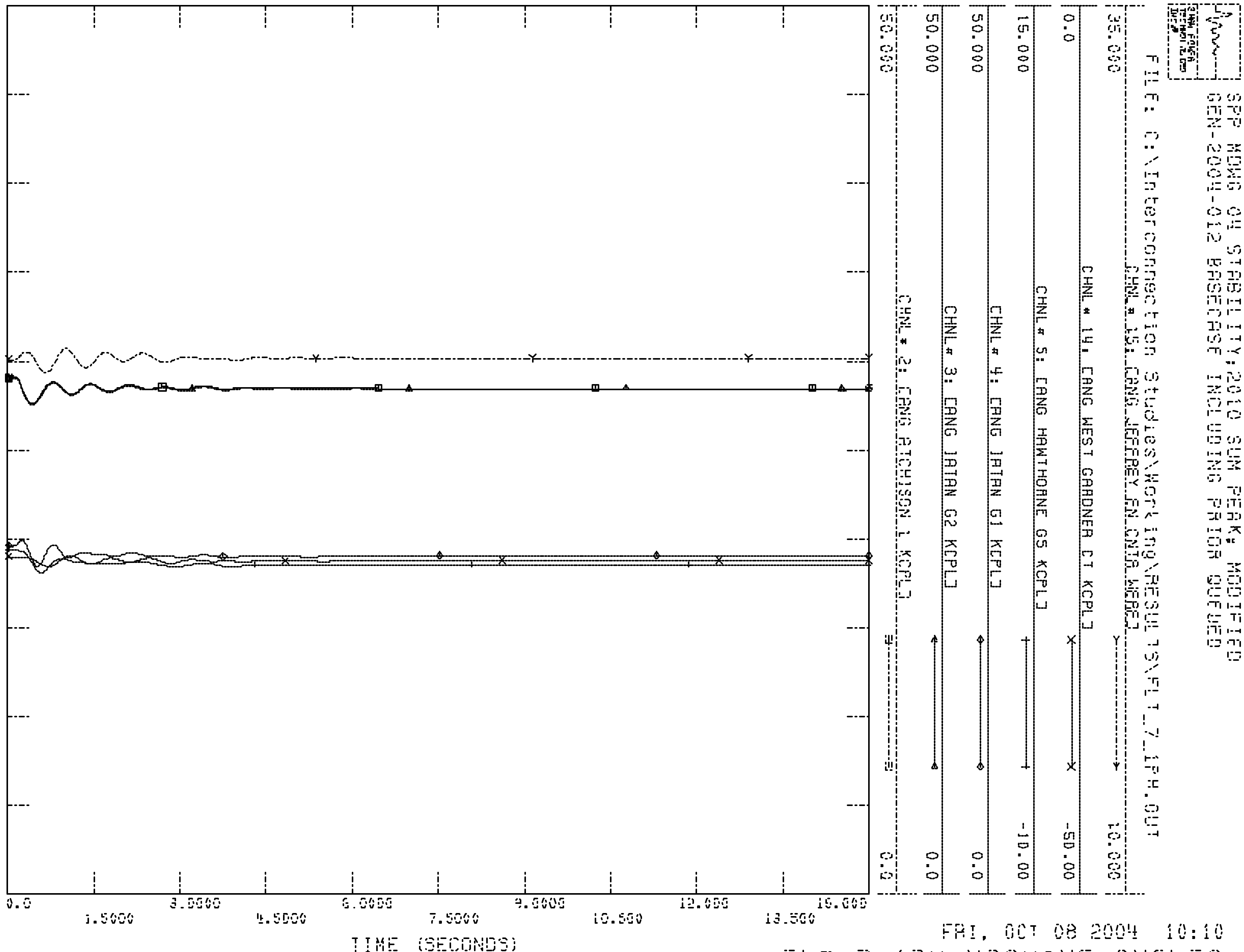


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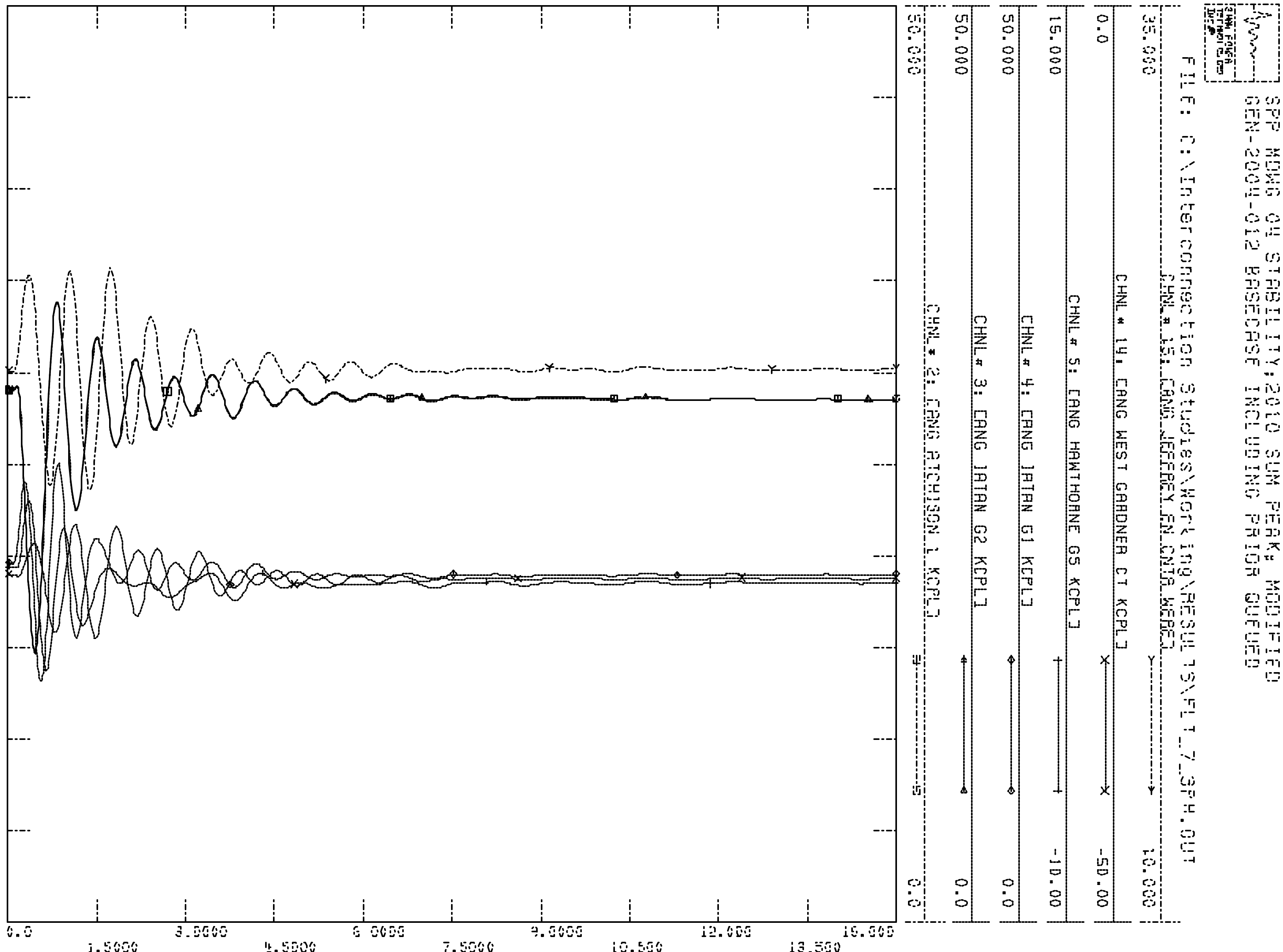


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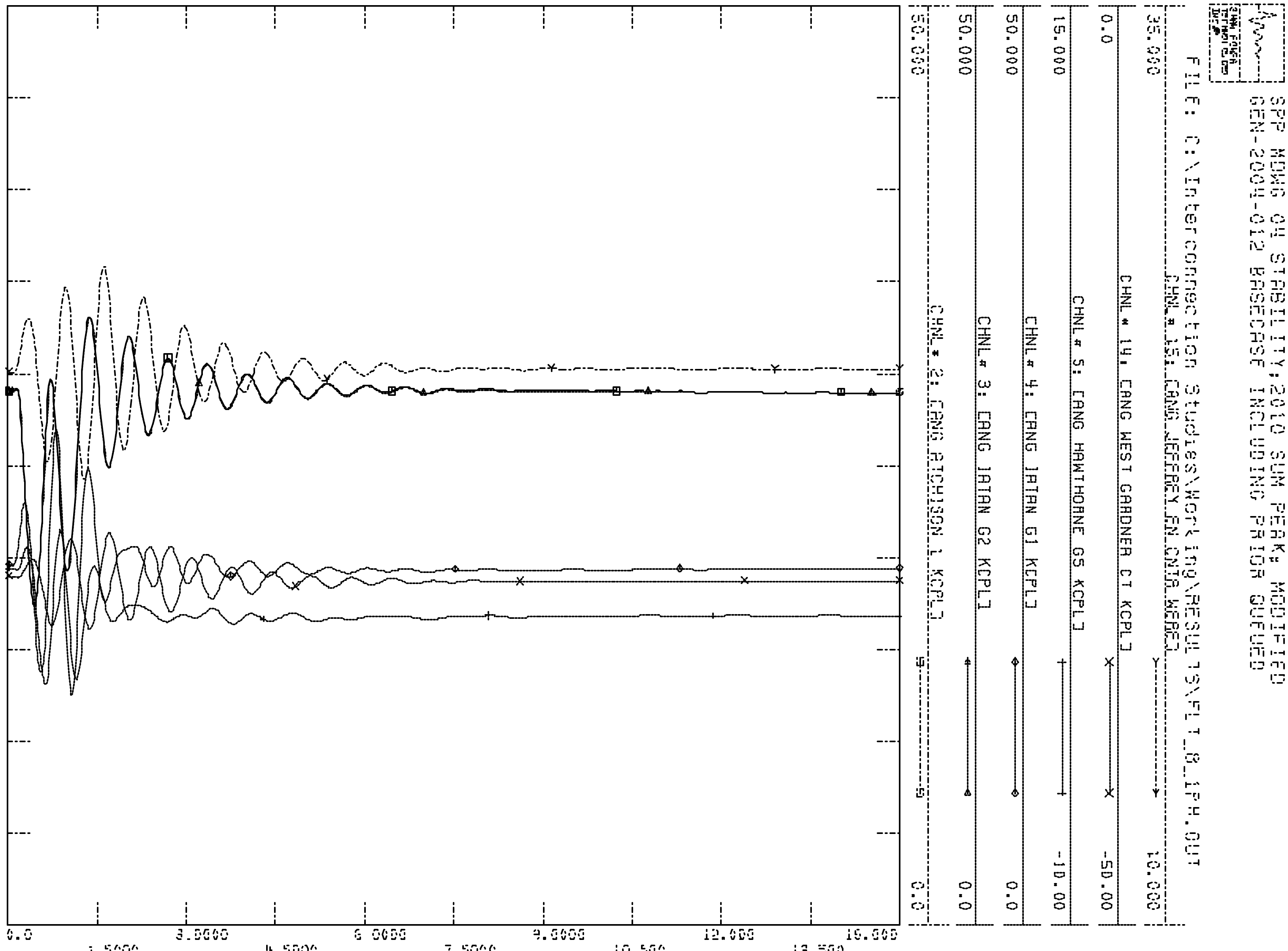


FRI, OCT 08 2004 10:10

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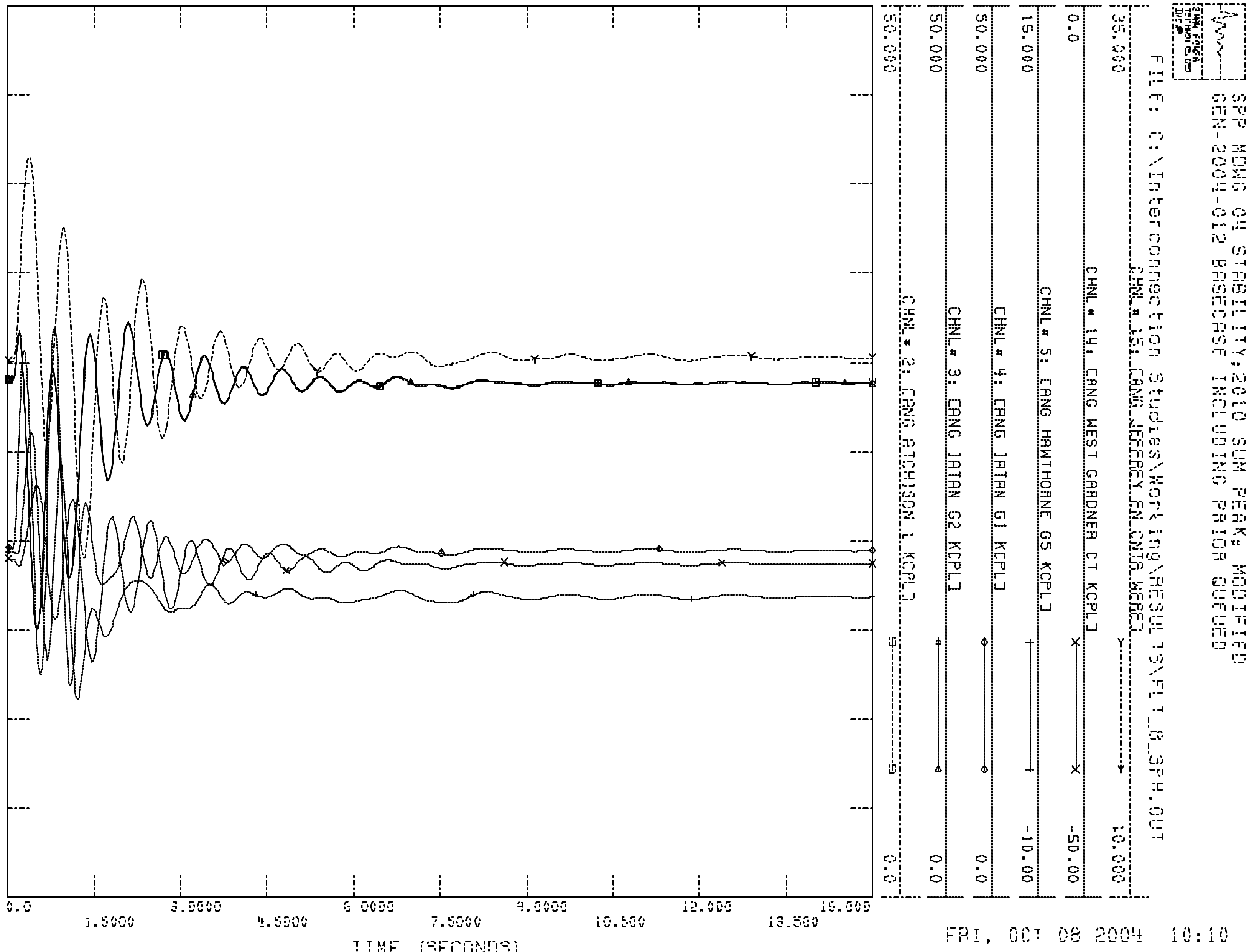


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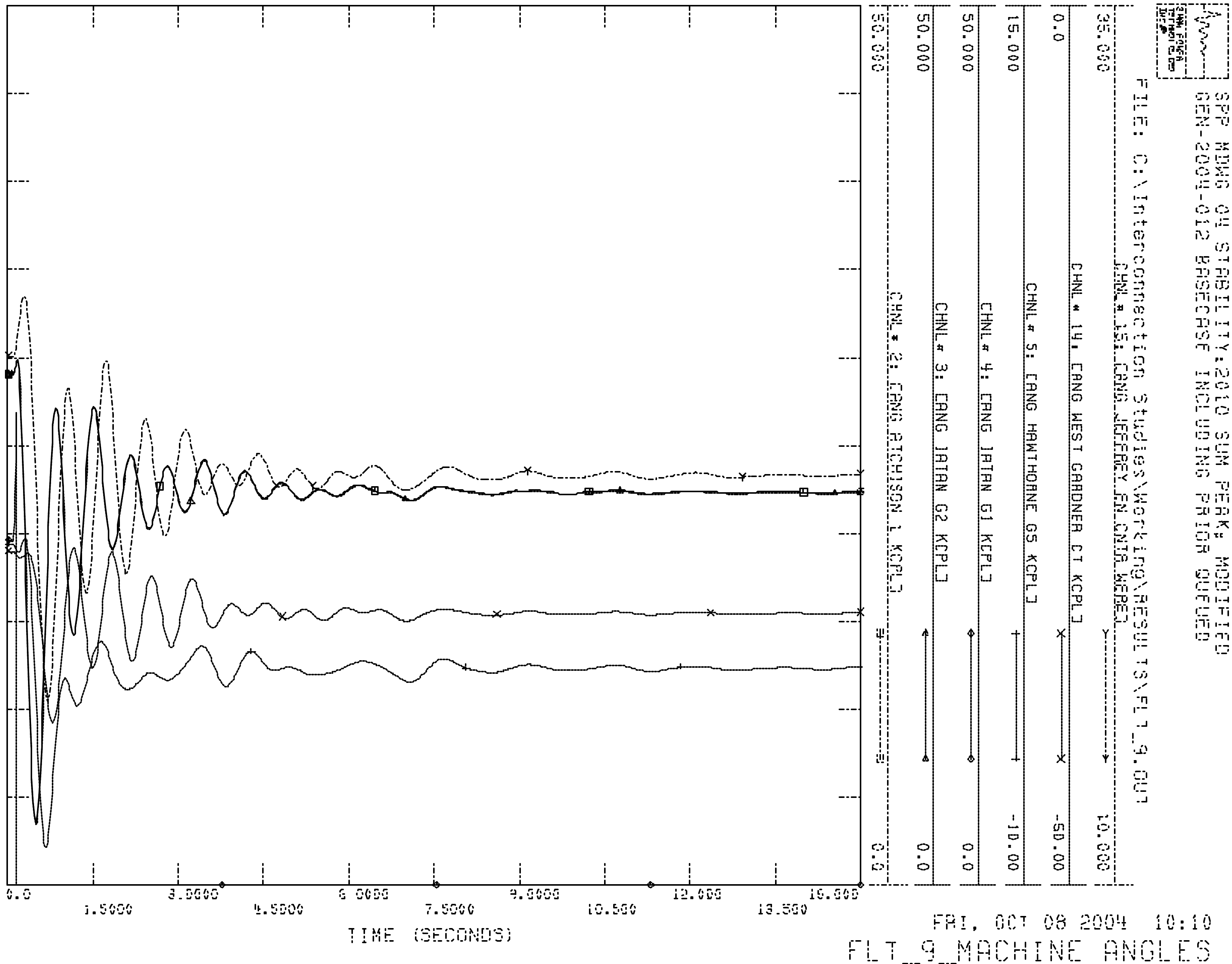
SPP MDWG 04 STABILITY:2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_9.OUT
35.000 CHNL # 15: [ANG JEFFREY EN CNTR WEREC] 10.000
0.0 CHNL # 14: [ANG WEST GARDNER CT KCPL] -50.00
15.000 CHNL # 5: [ANG HAWTHORNE G5 KCPL] -10.00
50.000 CHNL # 4: [ANG IATAN G1 KCPL] 0.0
50.000 CHNL # 3: [ANG IATAN G2 KCPL] 0.0
50.000 CHNL # 2: [ANG ATCHISON 1 KCPL] 0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
FRI, OCT 08 2004 10:10
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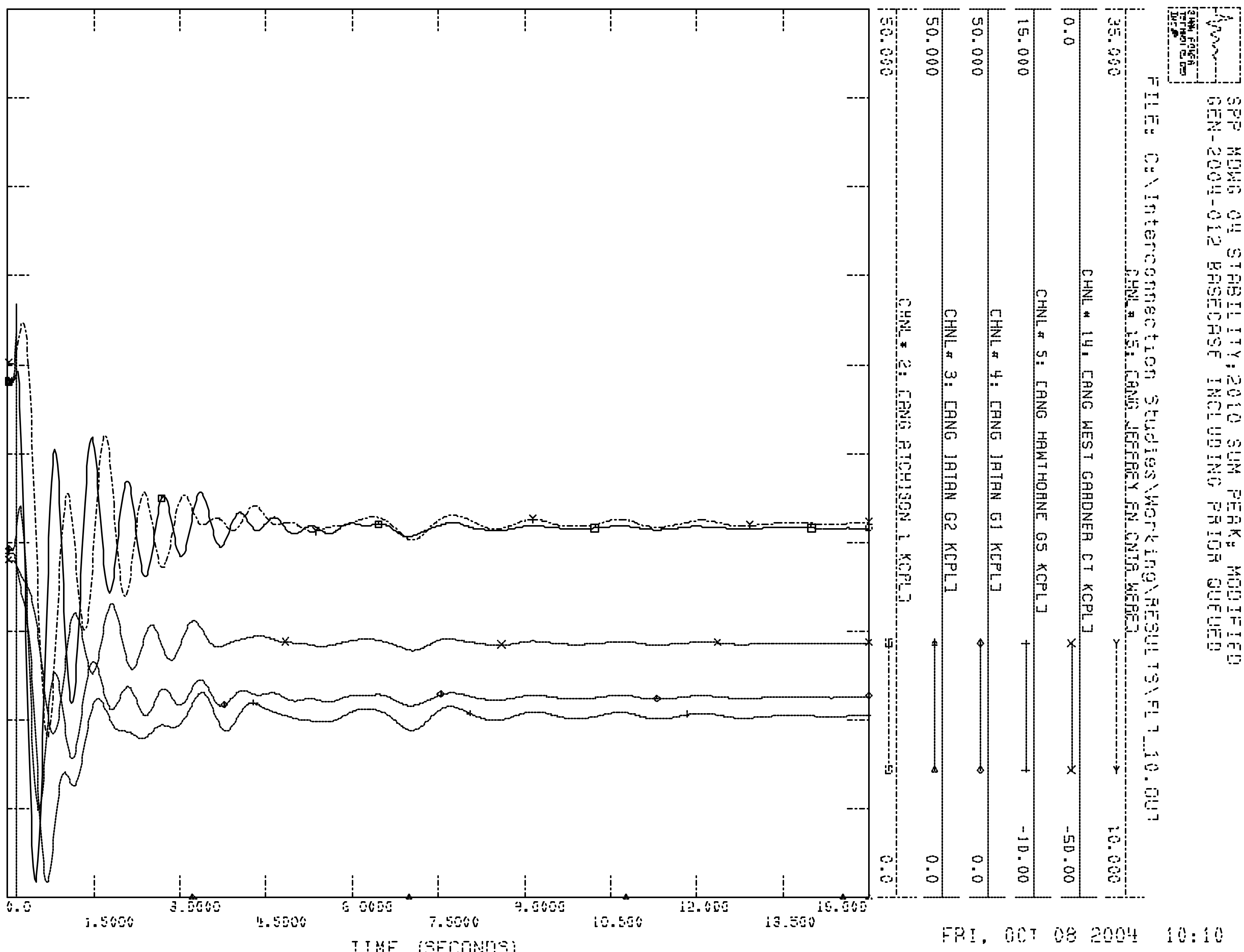


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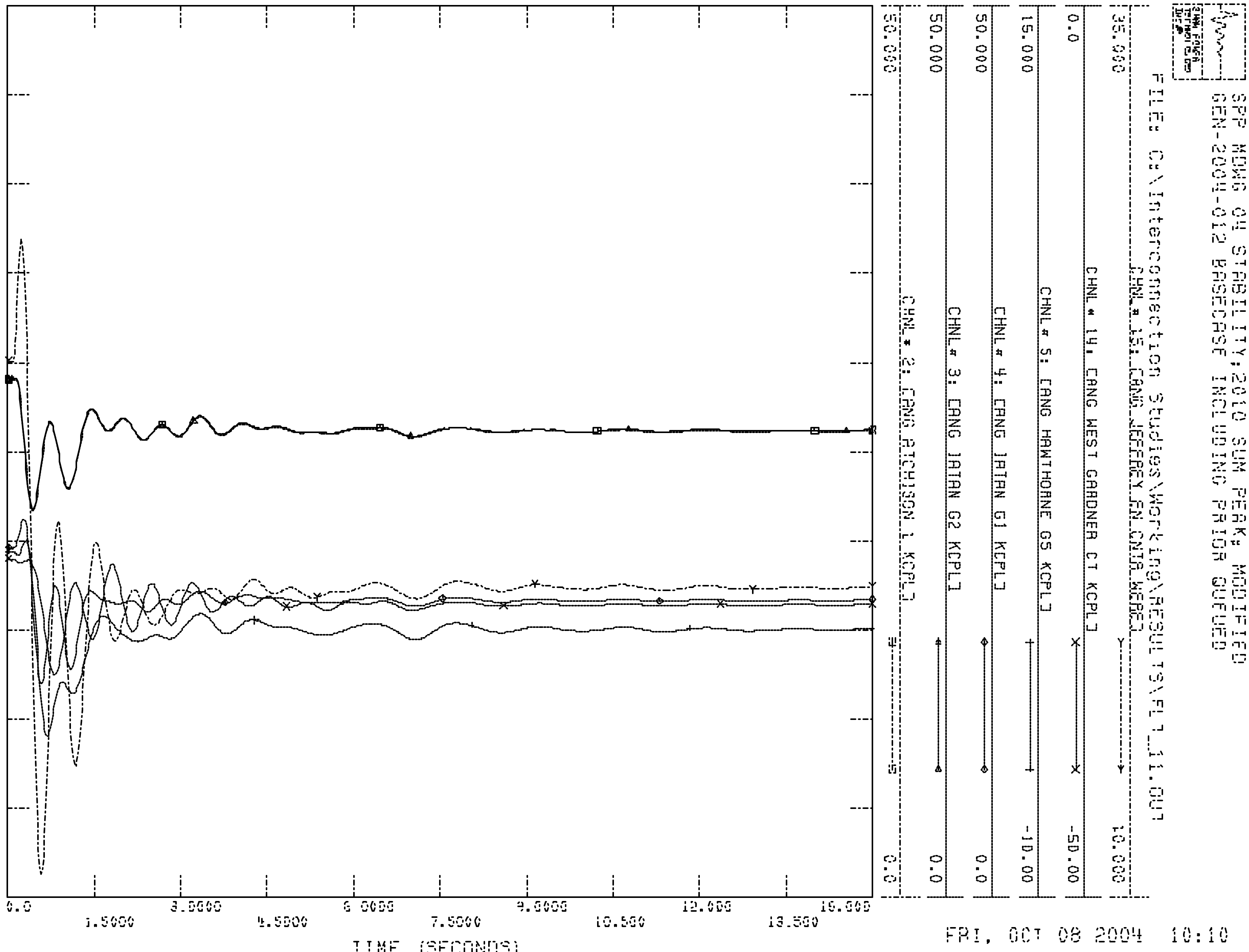


FRI, OCT 08 2004 10:10

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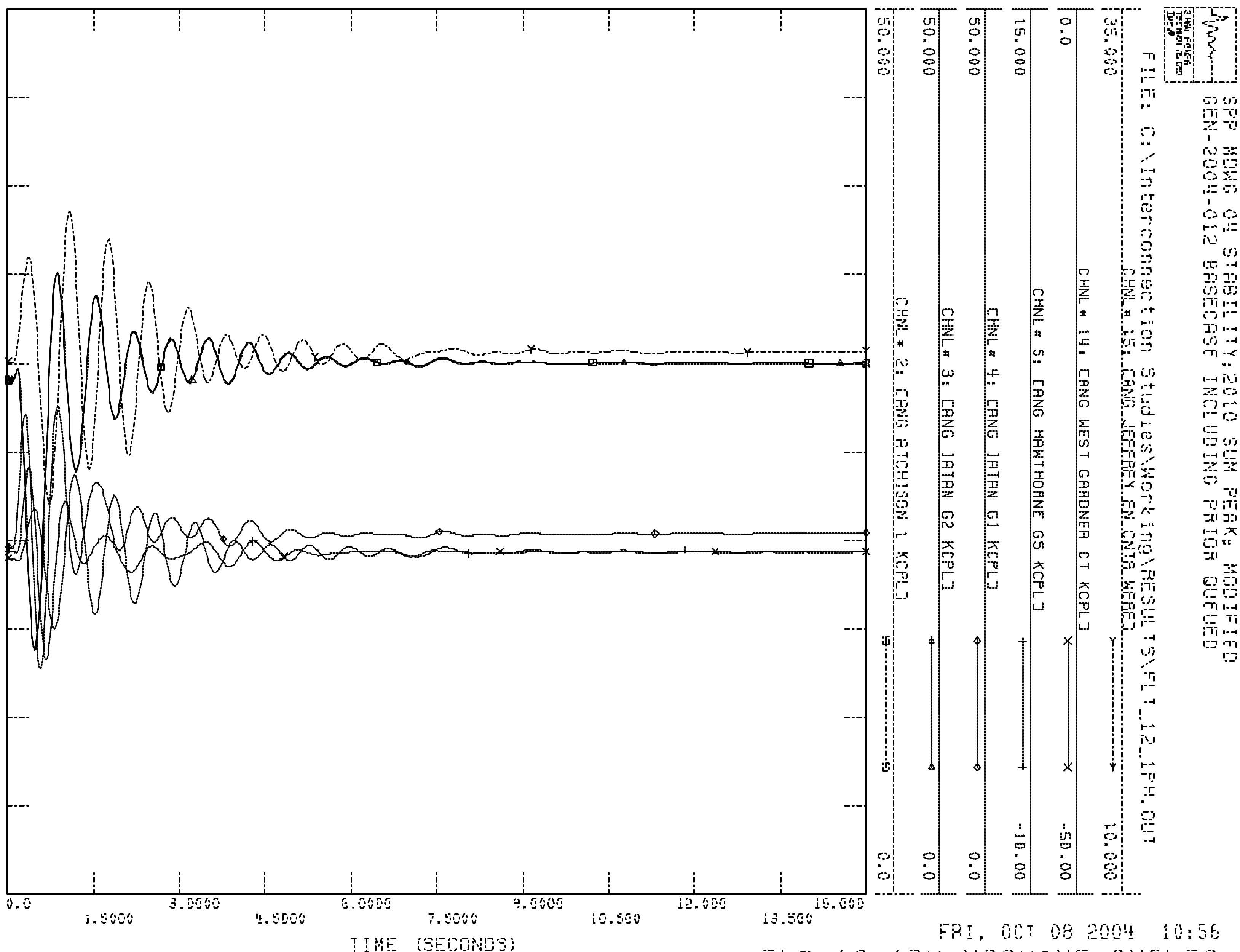


FRI, OCT 08 2004 10:56

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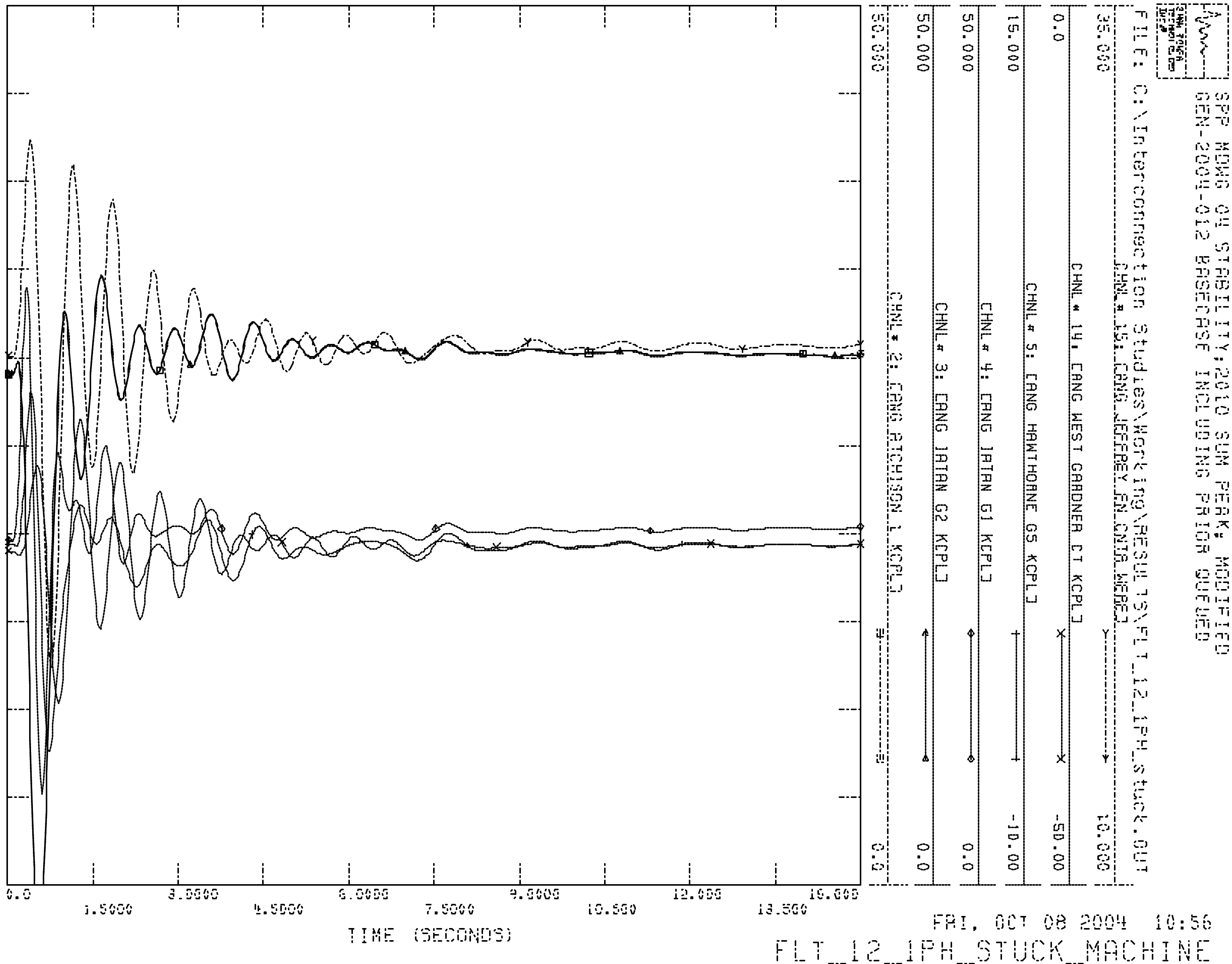
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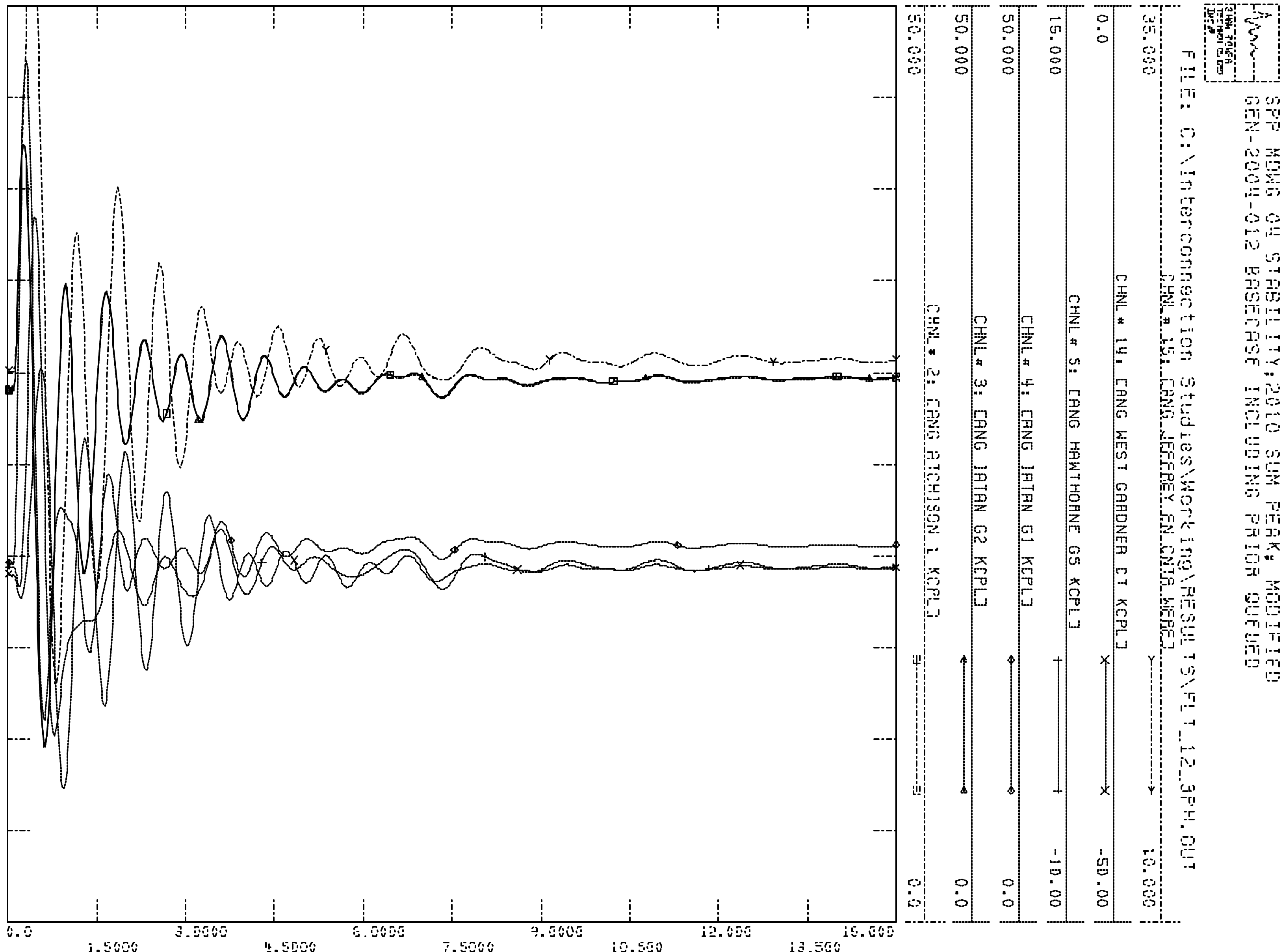
10.000
CHNL # 14: [ANG WEST GARDNER CT KCPL]
0.0
-50.00
CHNL # 5: [ANG HAWTHORNE G5 KCPL]
15.000
-10.00
CHNL # 4: [ANG IATAN G1 KCPL]
50.000
0.0
CHNL # 3: [ANG IATAN G2 KCPL]
50.000
0.0
CHNL # 2: [ANG ATCHISON 1 KCPL]
50.000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
FRI, OCT 08 2004 10:56
FLT_12_1PH_STUCK_MACHINE

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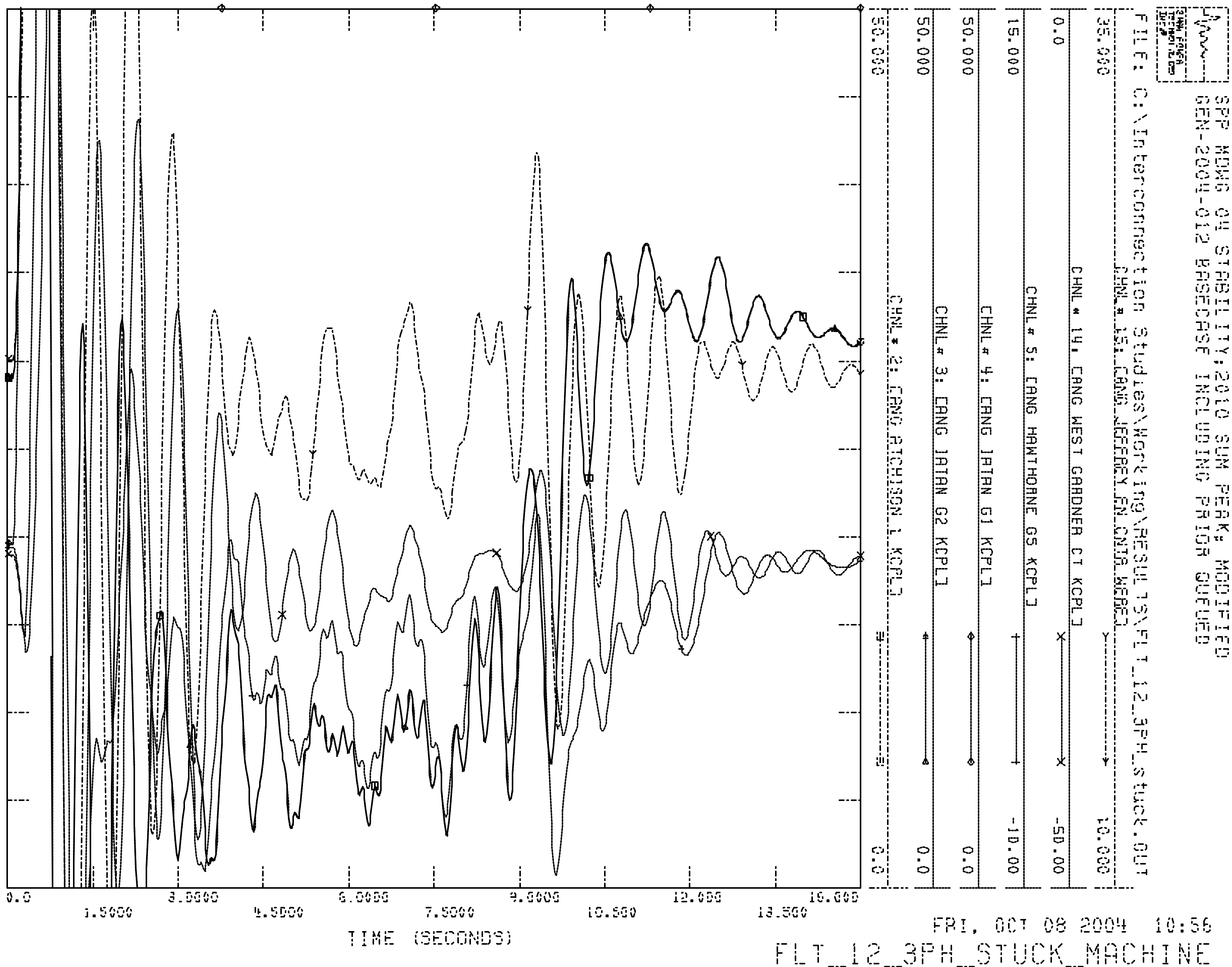

SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
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0.0 CHNL # 14: CANG WEST GARDNER CT KCPL] -50.00
15.000 CHNL # 5: CANG HAWTHORNE G5 KCPL] -10.00
50.000 CHNL # 4: CANG IATAN G1 KCPL] 0.0
50.000 CHNL # 3: CANG IATAN G2 KCPL] 0.0
50.000 CHNL # 2: CANG ATCHISON 1 KCPL] 0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
FRI, OCT 08 2004 10:56
FLT_12_3PH_STUCK_MACHINE

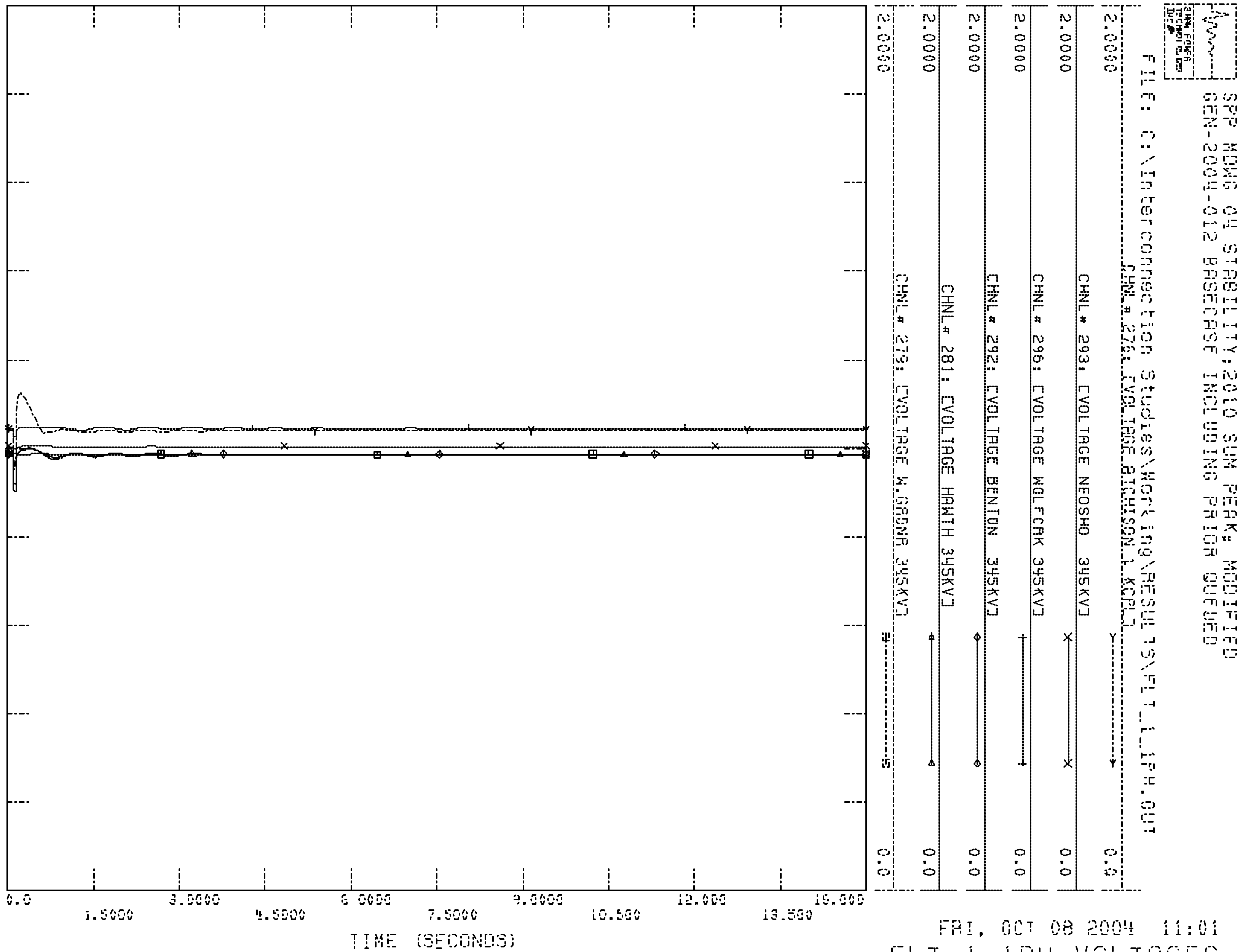
# Appendix B-2

# Plots of Fault Simulations

**Plots of selected bus voltage response during faults**

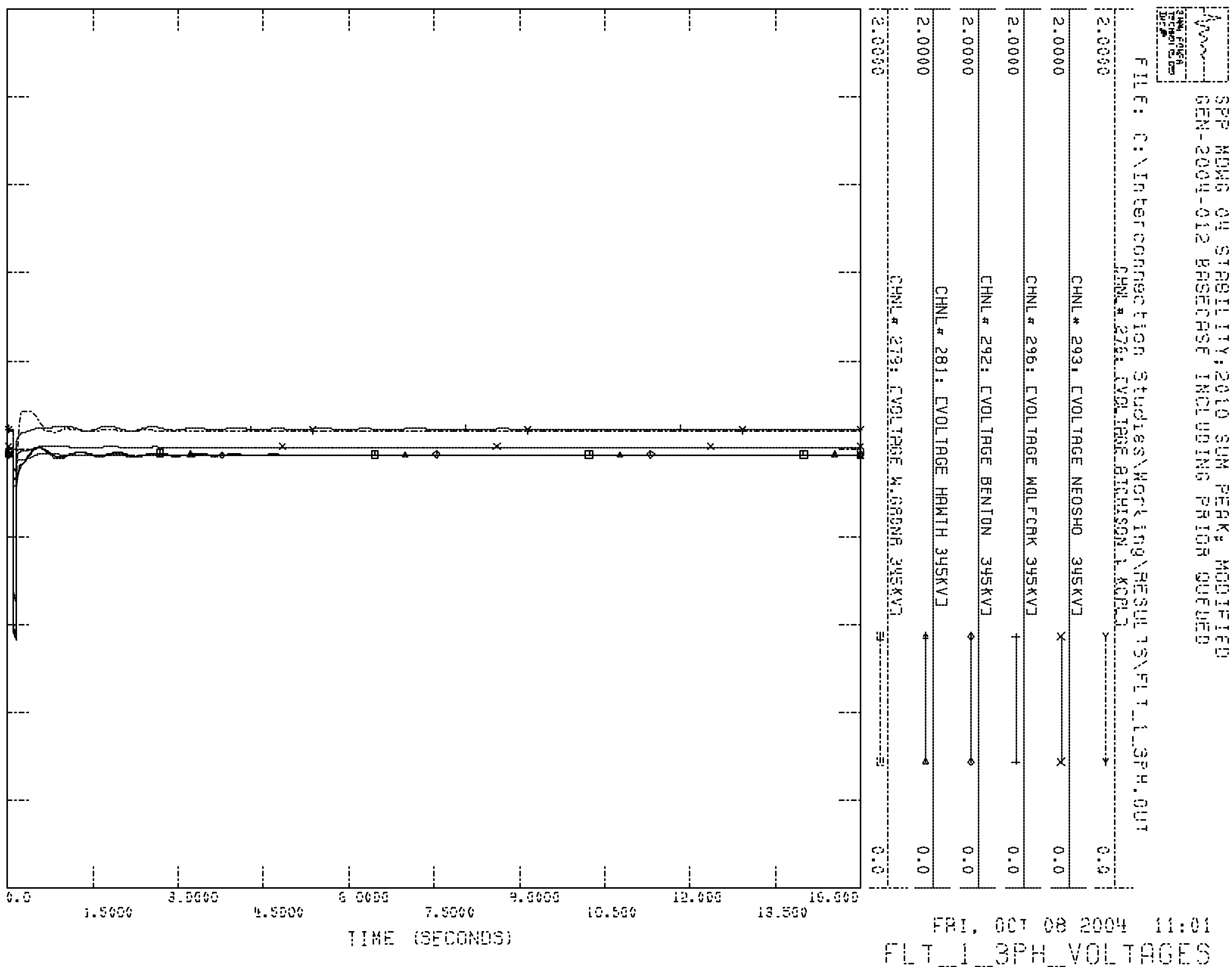
**Scenario:**
**2010 Summer Peak**

**[Customer plant at 900MW]**




FRI, OCT 08 2004 11:01

FLT_1_1PH_VOLTAGES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GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
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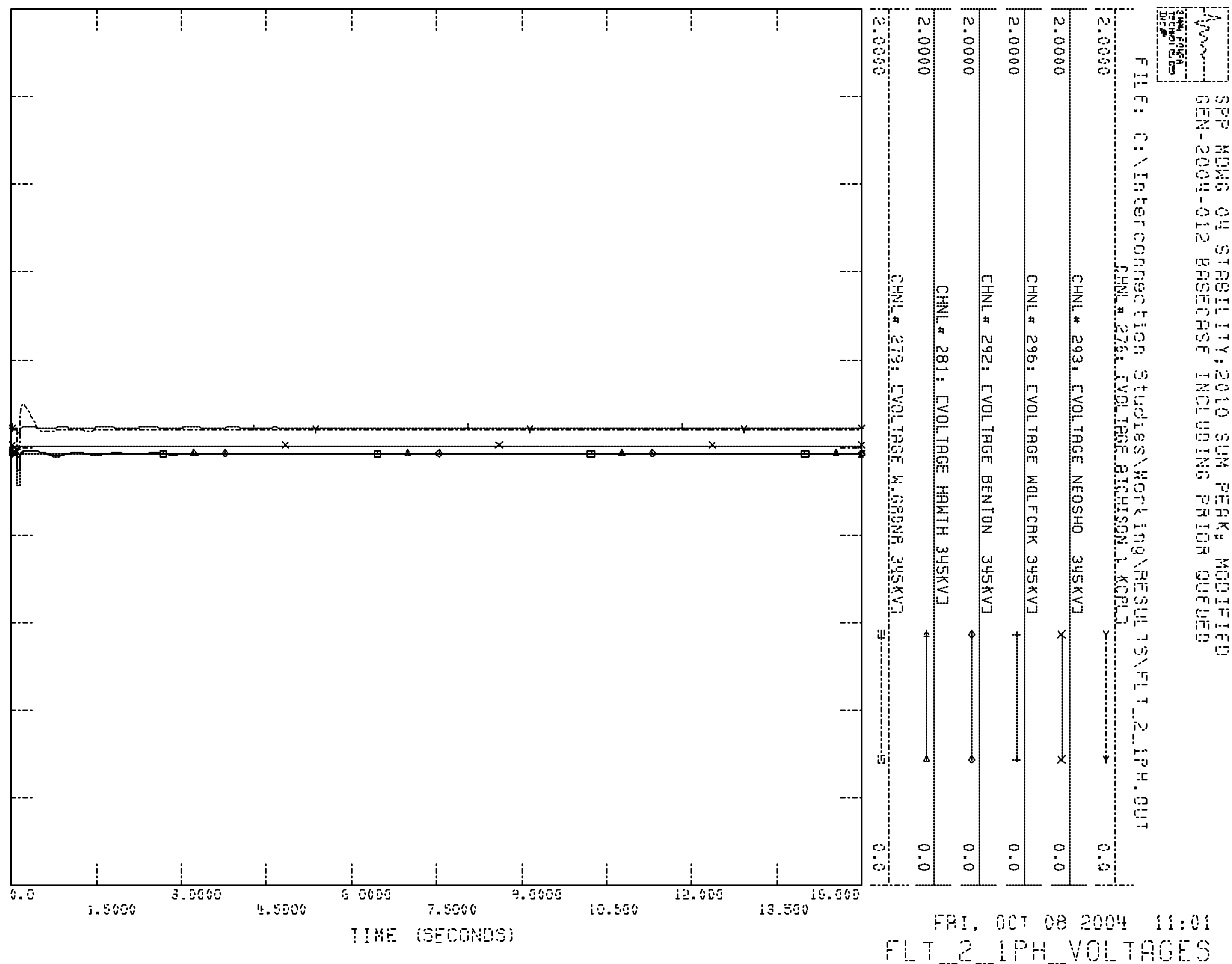
2.0000 0.0
CHNL# 293: [VOLTAGE NEOSHO 345KV]
2.0000 0.0
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000 0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000 0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000 0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000 0.0
0.0 1.5000 3.0000 4.5000 6.0000 7.5000 9.0000 10.500 12.000 13.500 15.000
TIME (SECONDS)
FRI, OCT 08 2004 11:01
FLT_1_3PH_VOLTAGES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0.0
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2.0000
0.0
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.000
0.0
0.0
1.5000
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7.5000
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12.000
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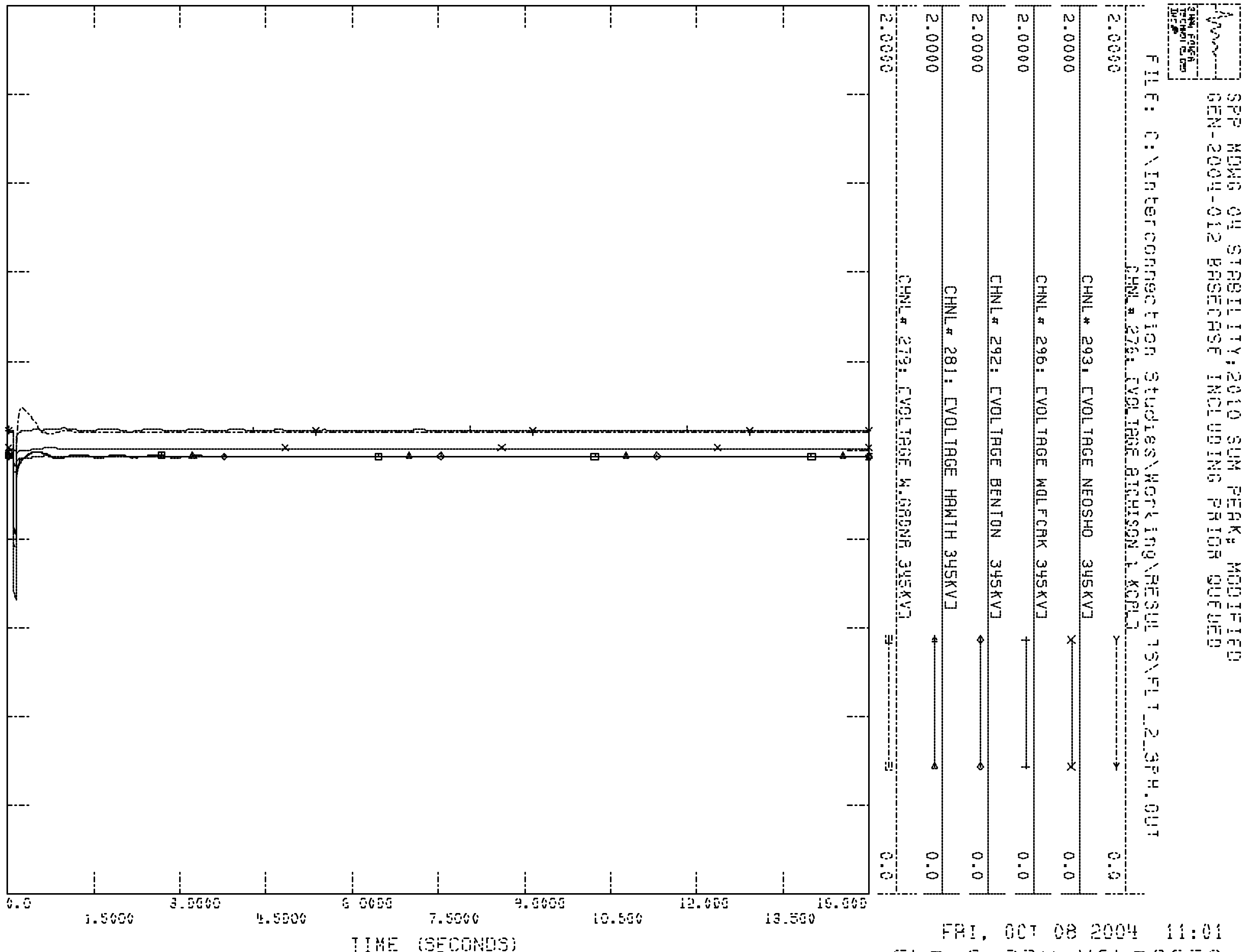
TIME (SECONDS)
FRI, OCT 08 2004 11:01
FLT_2_1PH_VOLTAGES




FRI, OCT 08 2004 11:01

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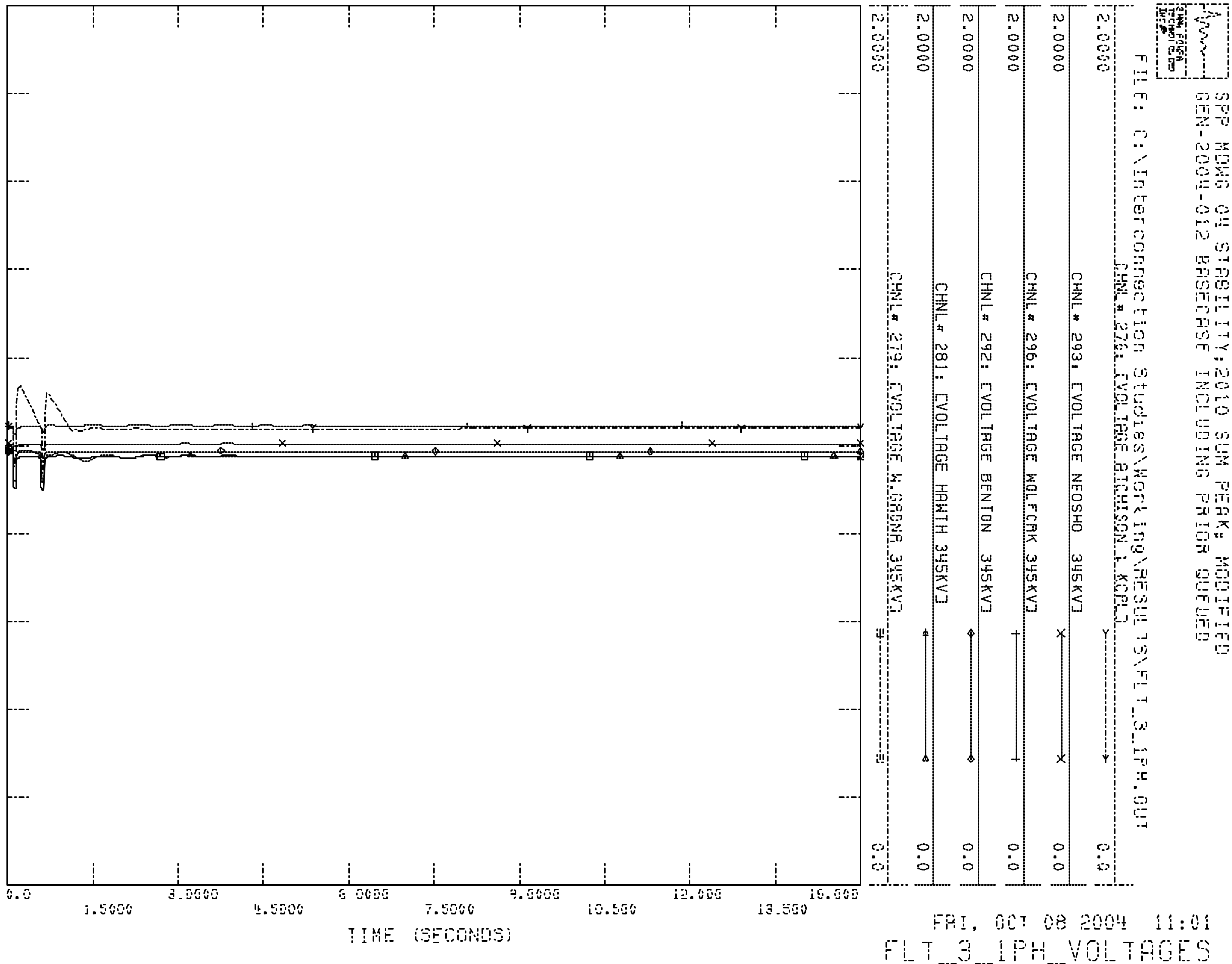

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0.0
CHNL# 293: [VOLTAGE NEOSHO 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
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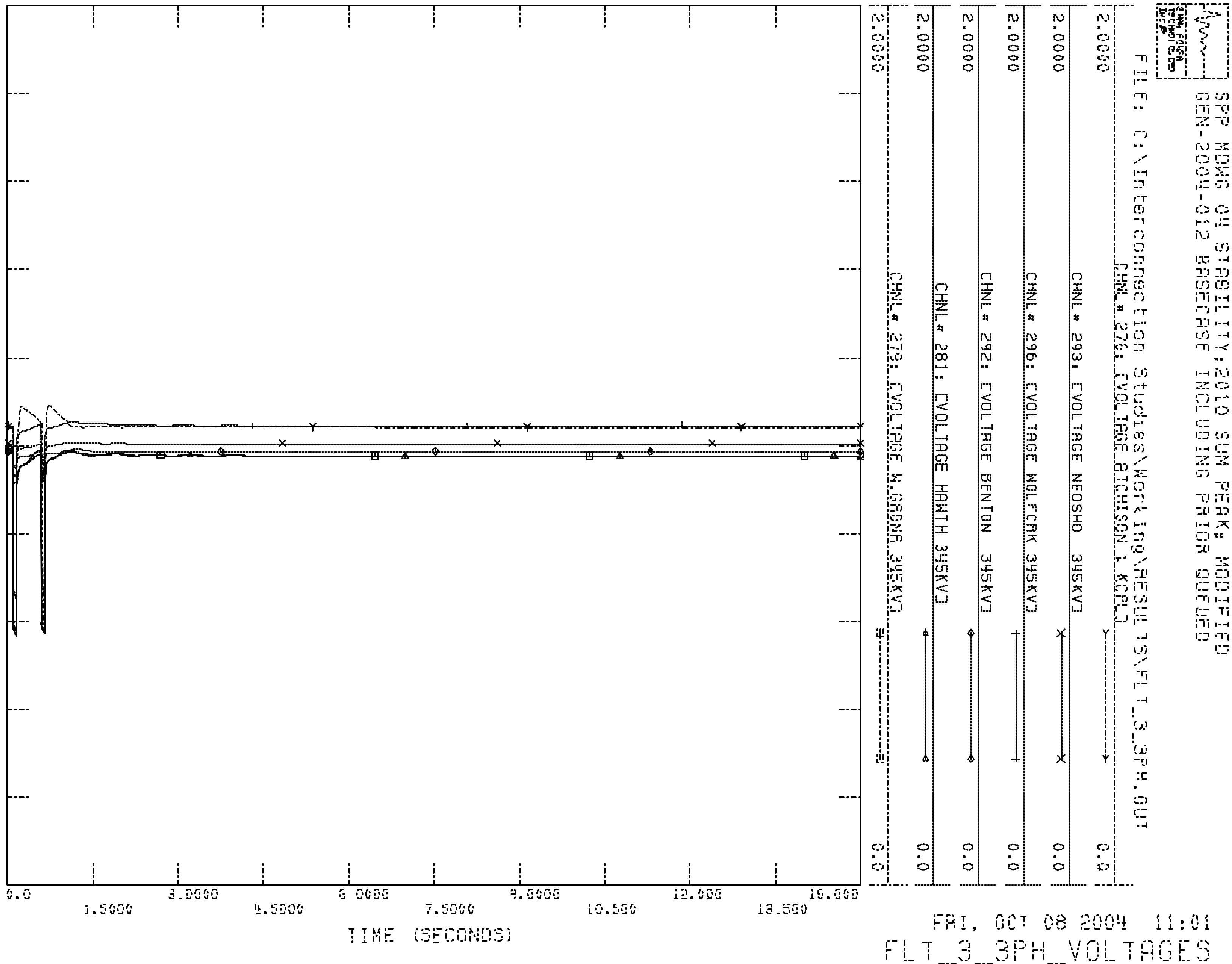
TIME (SECONDS)
FRI, OCT 08 2004 11:01
FLT_3_1PH_VOLTAGES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CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
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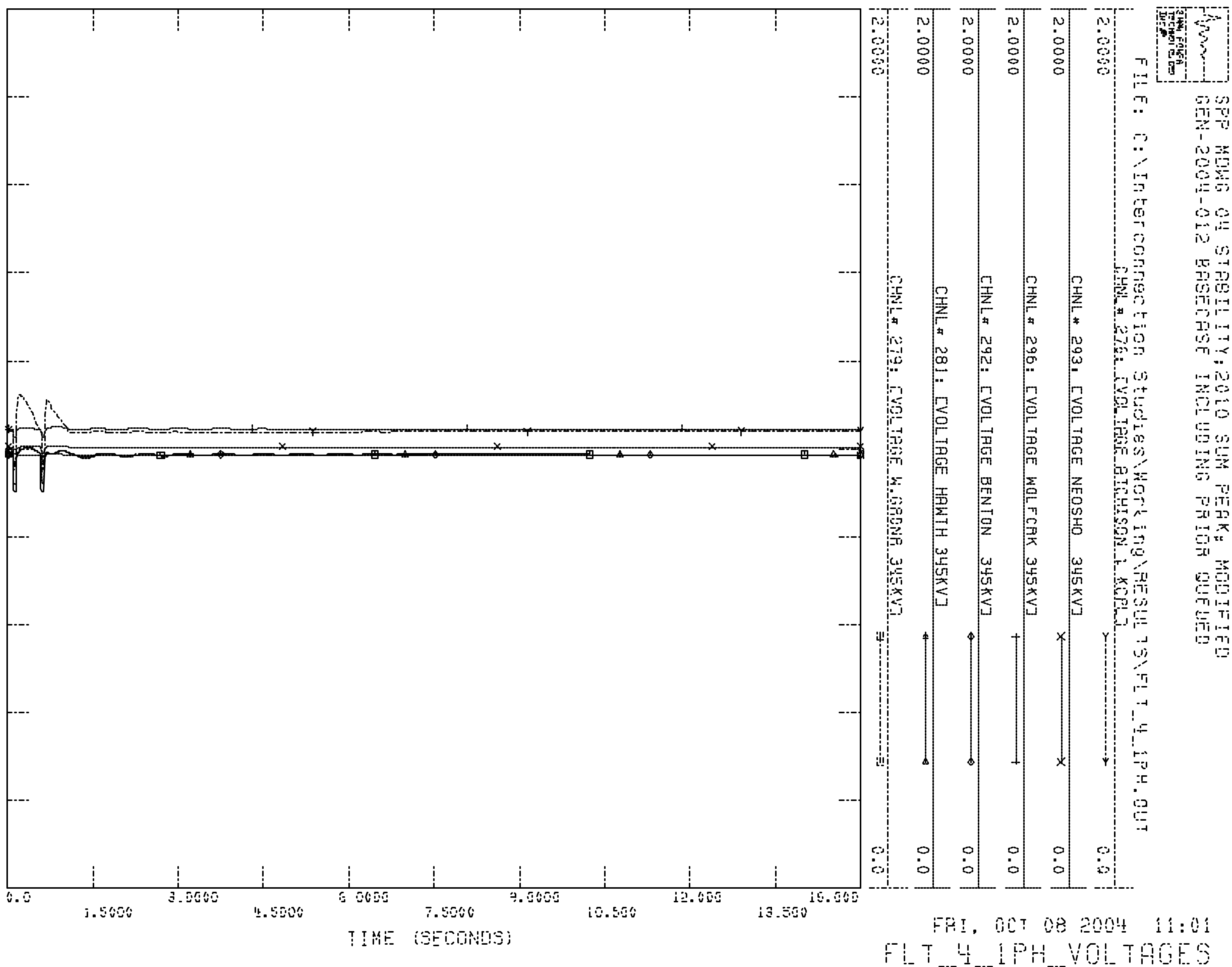
TIME (SECONDS)
FRI, OCT 08 2004 11:01
FLT_3_3PH_VOLTAGES



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CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
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FRI, OCT 08 2004 11:01
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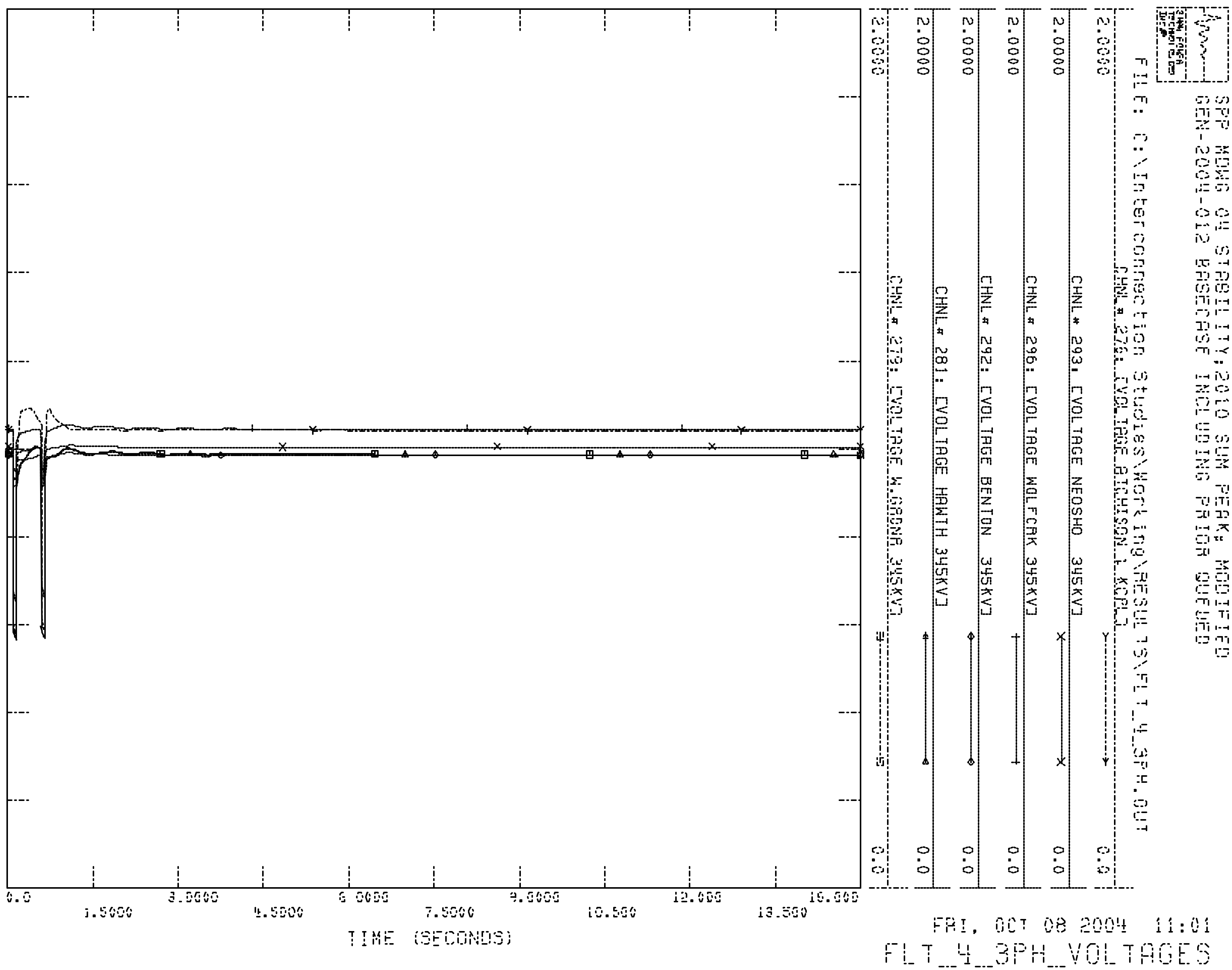
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CHNL # 279: [VOLTAGE W.GRDNR 345KV]
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FRI, OCT 08 2004 11:01
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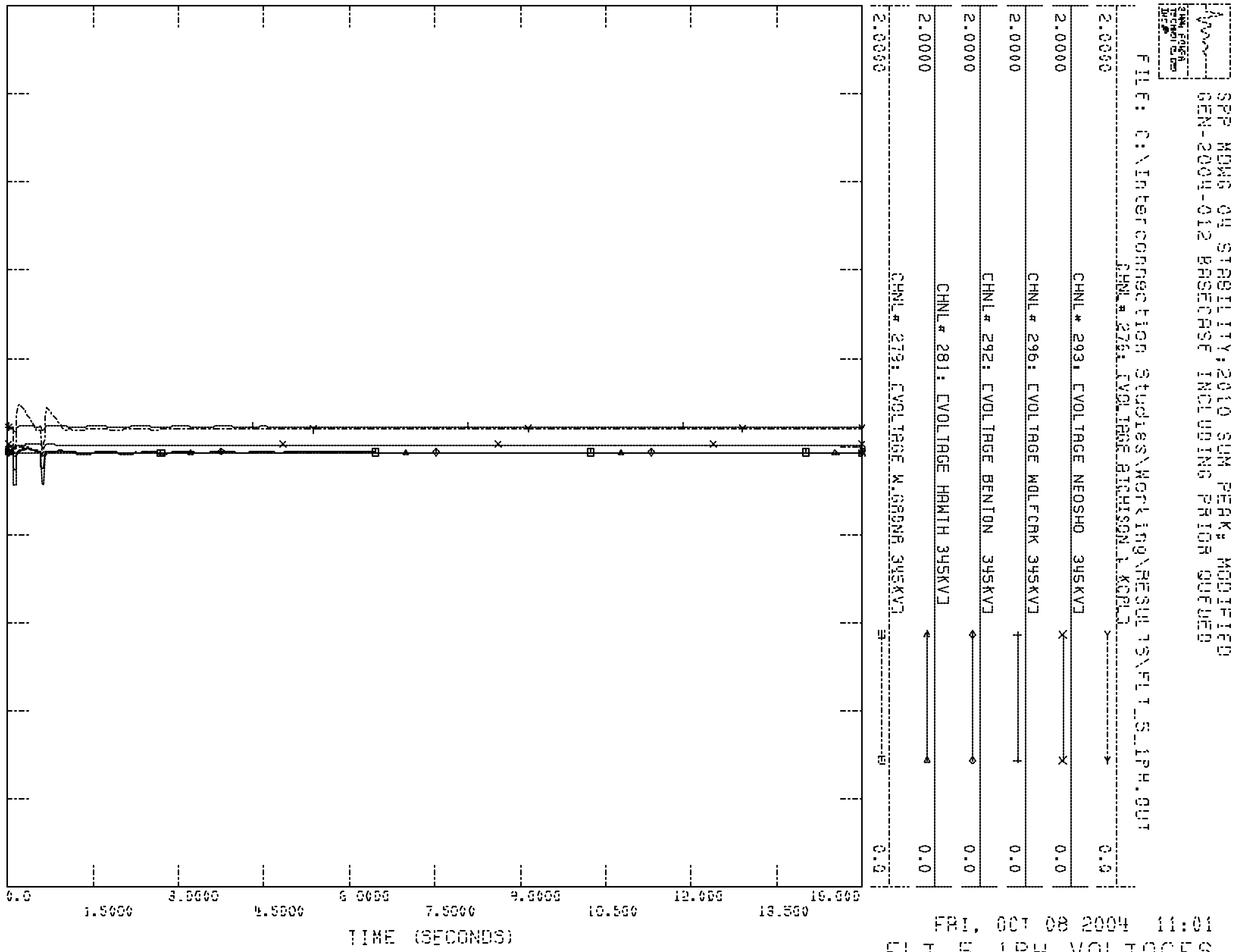


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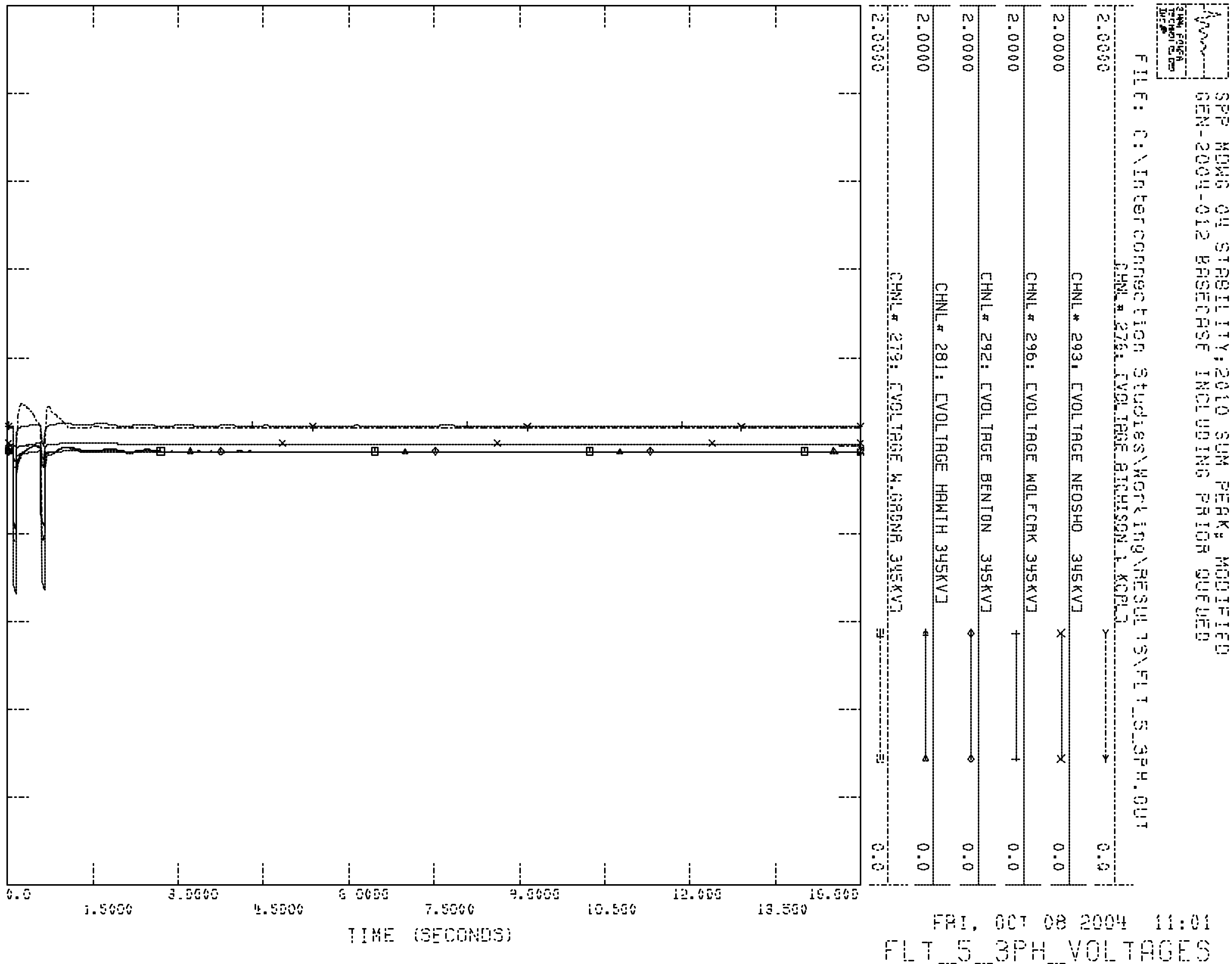
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CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
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FRI, OCT 08 2004 11:01
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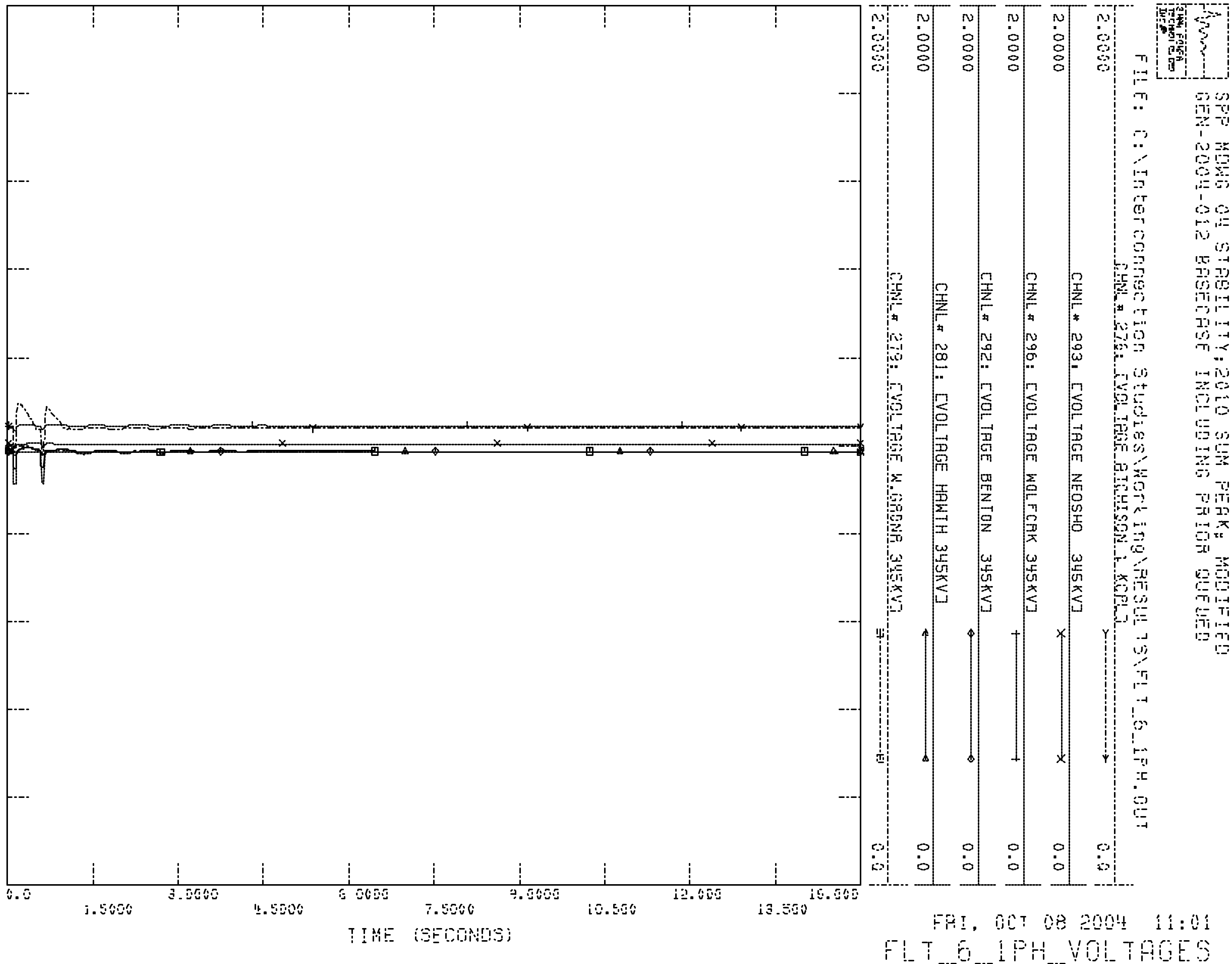
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CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
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FRI, OCT 08 2004 11:01
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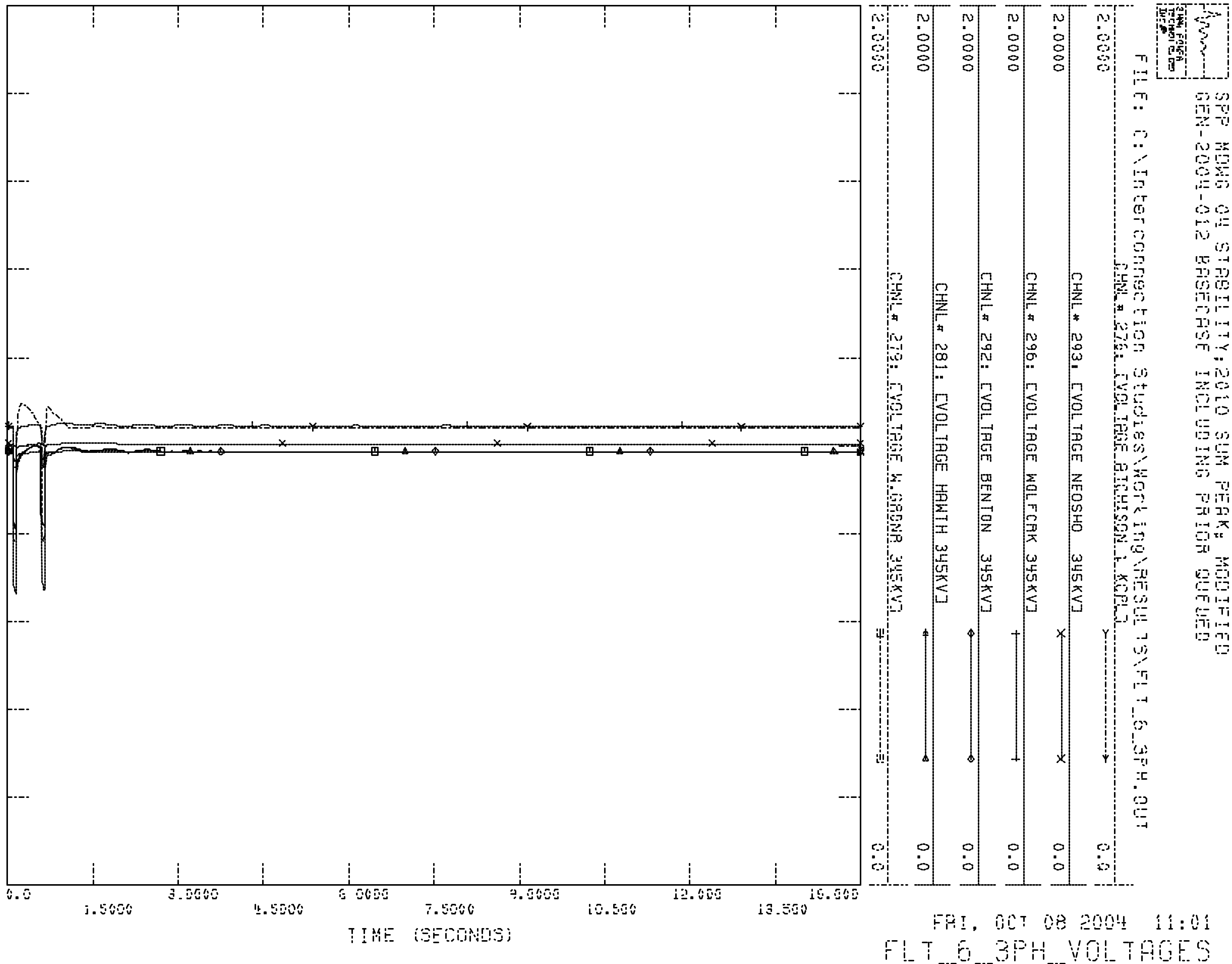
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2.0000
0.0
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0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
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FRI, OCT 08 2004 11:01
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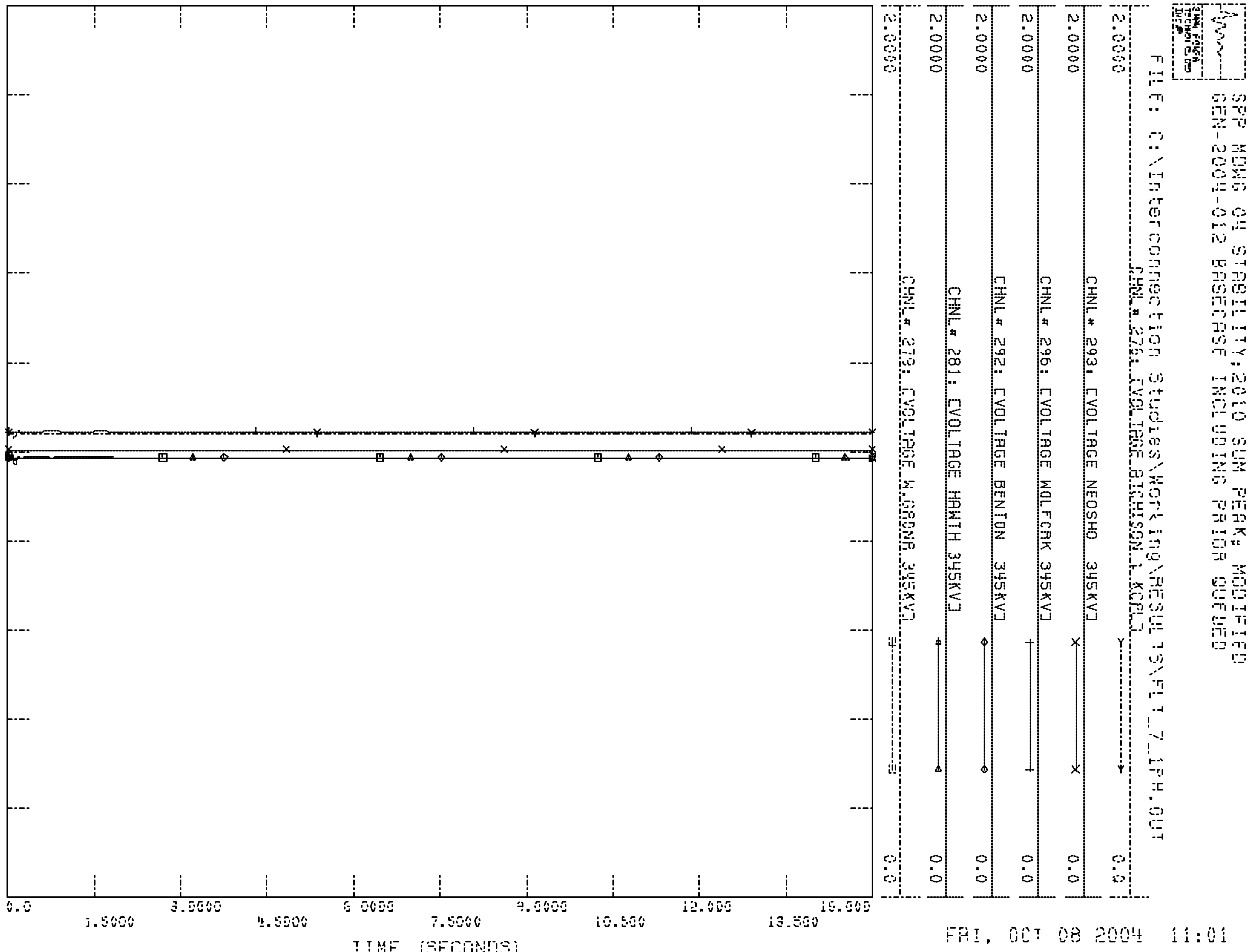


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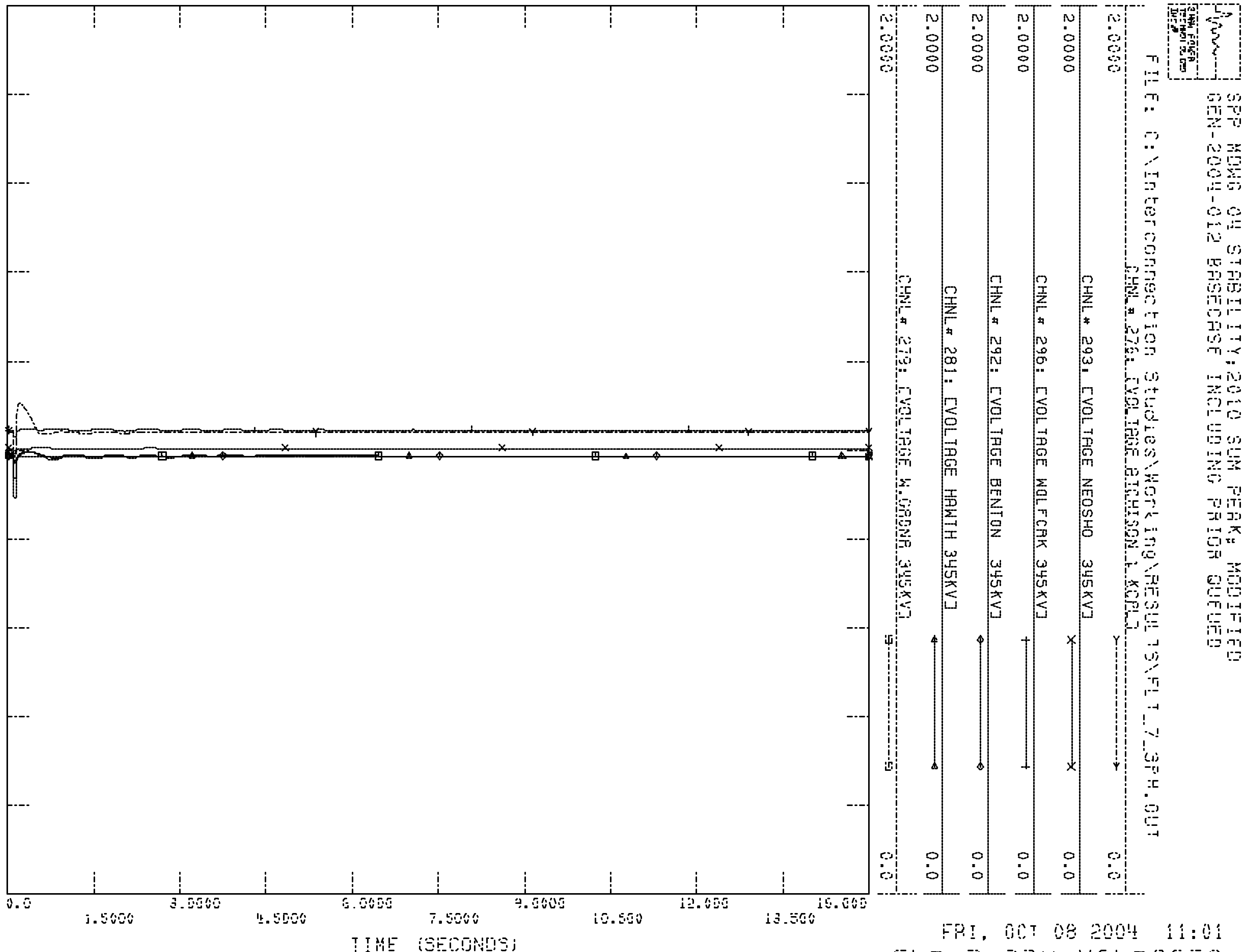


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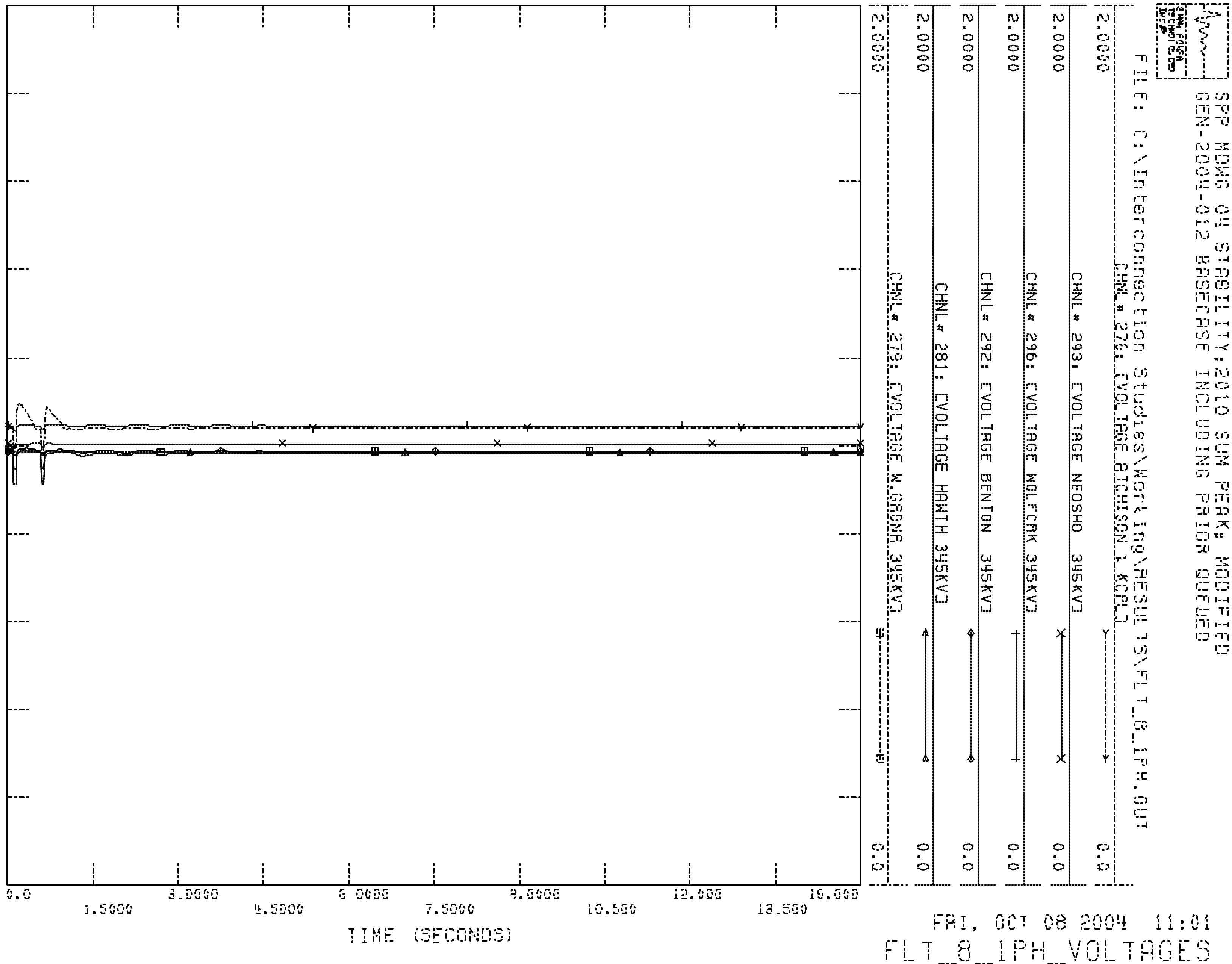

SPP MDWG 04 STABILITY, 2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
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CHNL# 293: [VOLTAGE NEOSHO 345KV]
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
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TIME (SECONDS)
FRI, OCT 08 2004 11:01
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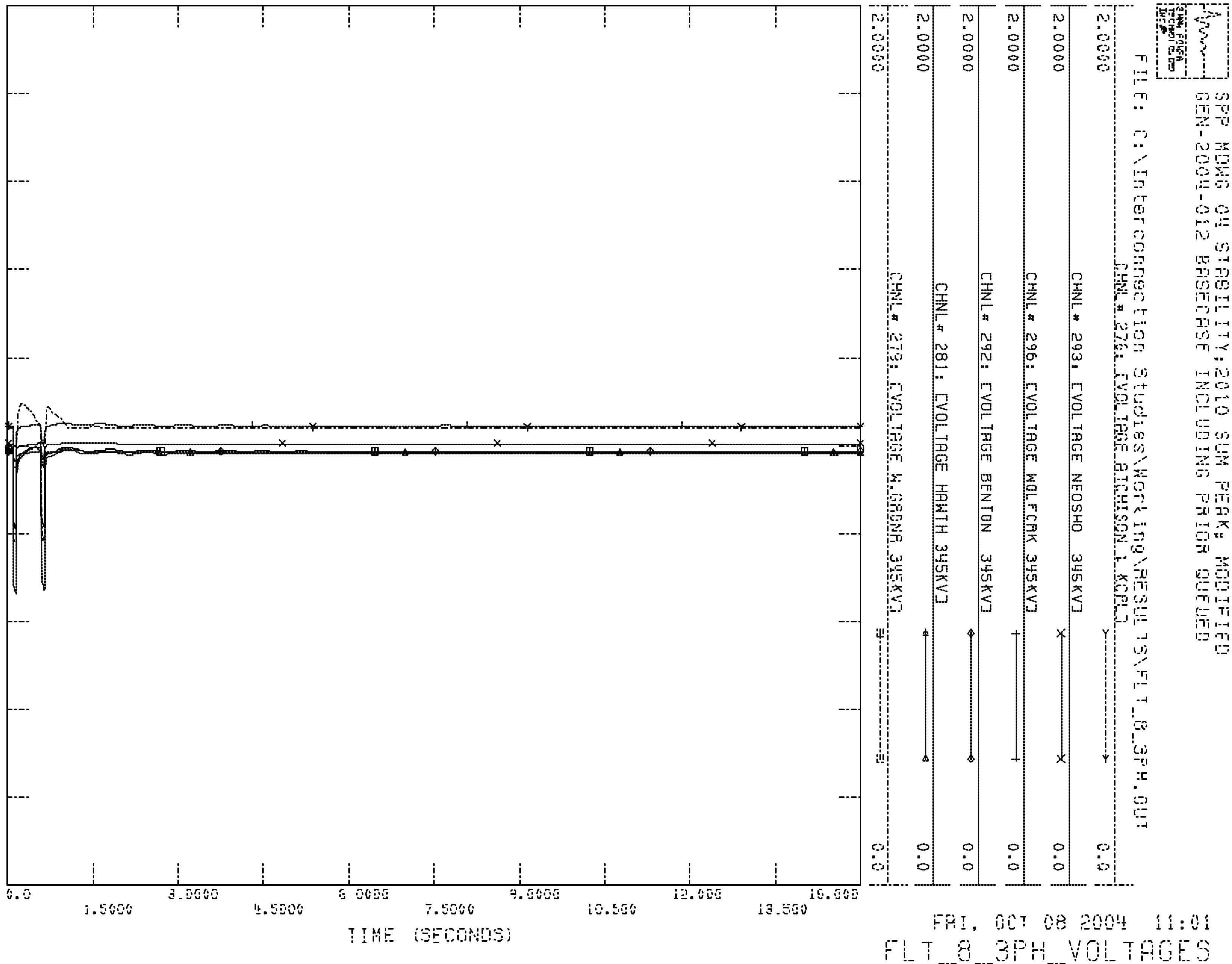
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GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
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CHNL# 292: [VOLTAGE BENTON 345KV]
CHNL# 281: [VOLTAGE HAWTH 345KV]
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
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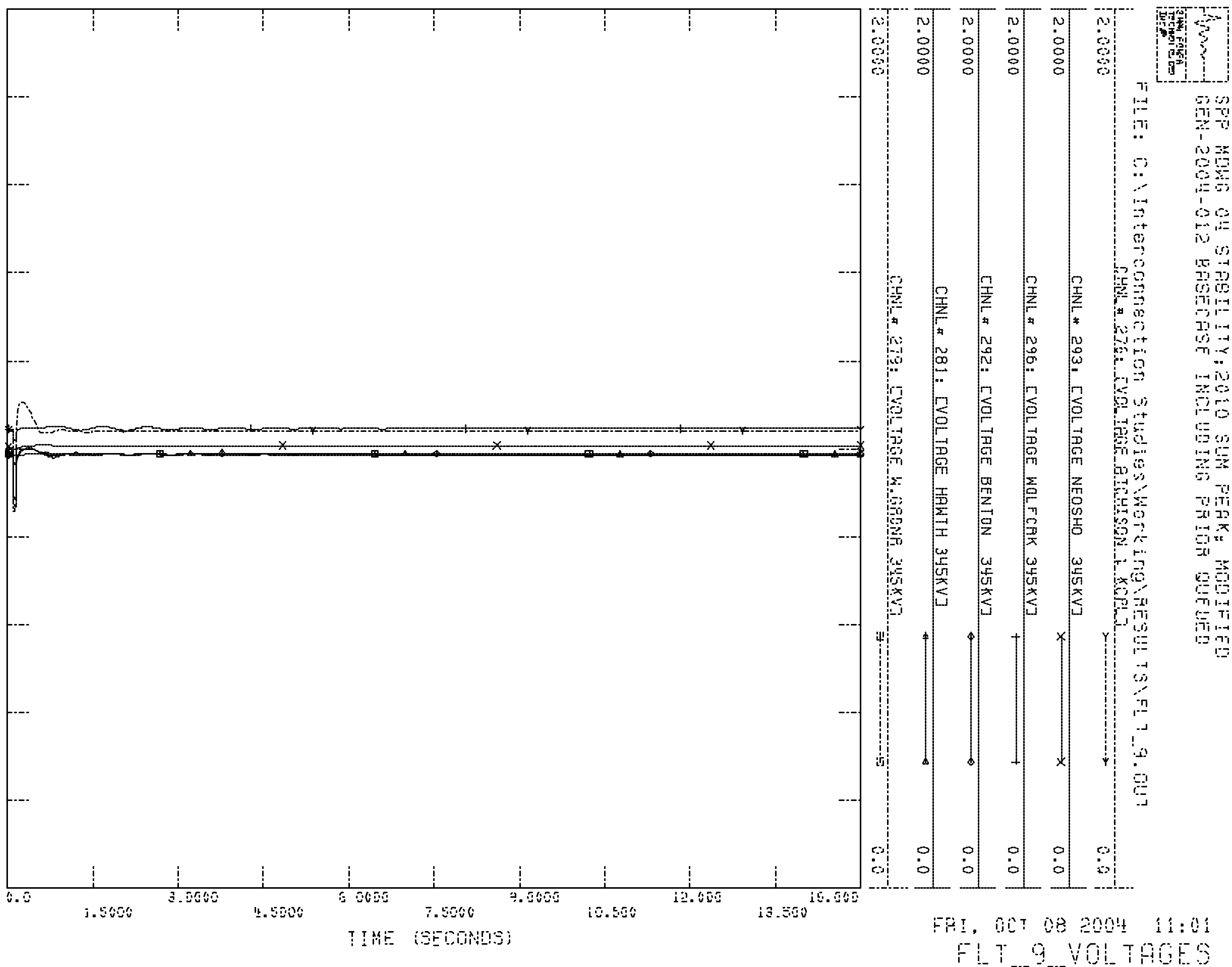
TIME (SECONDS)
FRI, OCT 08 2004 11:01
FLT_8_3PH_VOLTAGES



SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
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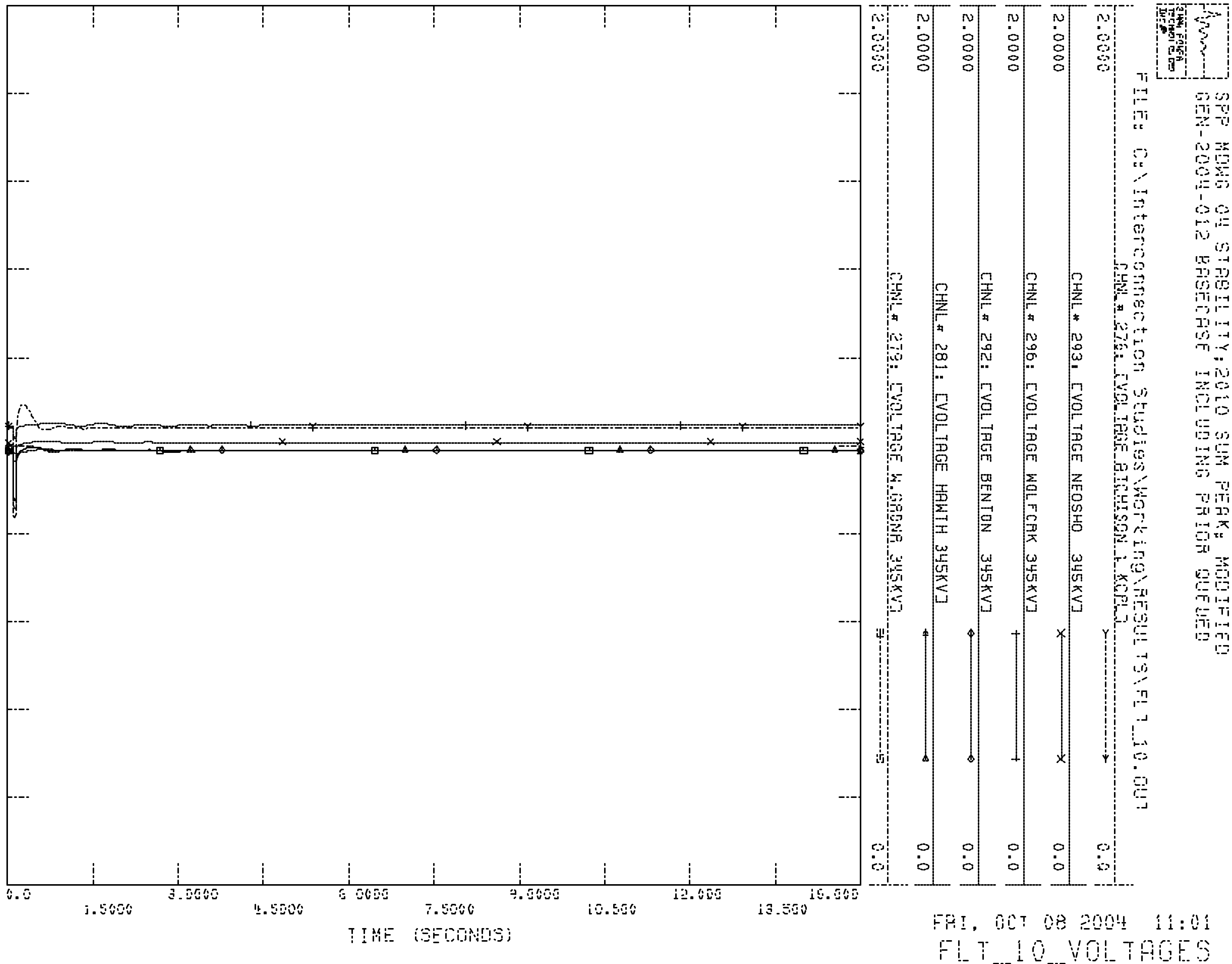
CHNL # 293: [VOLTAGE NEOSHO 345KV] 2.0000 0.0
CHNL # 296: [VOLTAGE WOLFCRK 345KV] 2.0000 0.0
CHNL # 292: [VOLTAGE BENTON 345KV] 2.0000 0.0
CHNL # 281: [VOLTAGE HAWTH 345KV] 2.0000 0.0
CHNL # 279: [VOLTAGE W.GRDNR 345KV] 2.0000 0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
FRI, OCT 08 2004 11:01
FLT_9_VOLTAGES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\RESULTS\FLT_10.OUT
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0.0
CHNL# 293: [VOLTAGE NEOSHO 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
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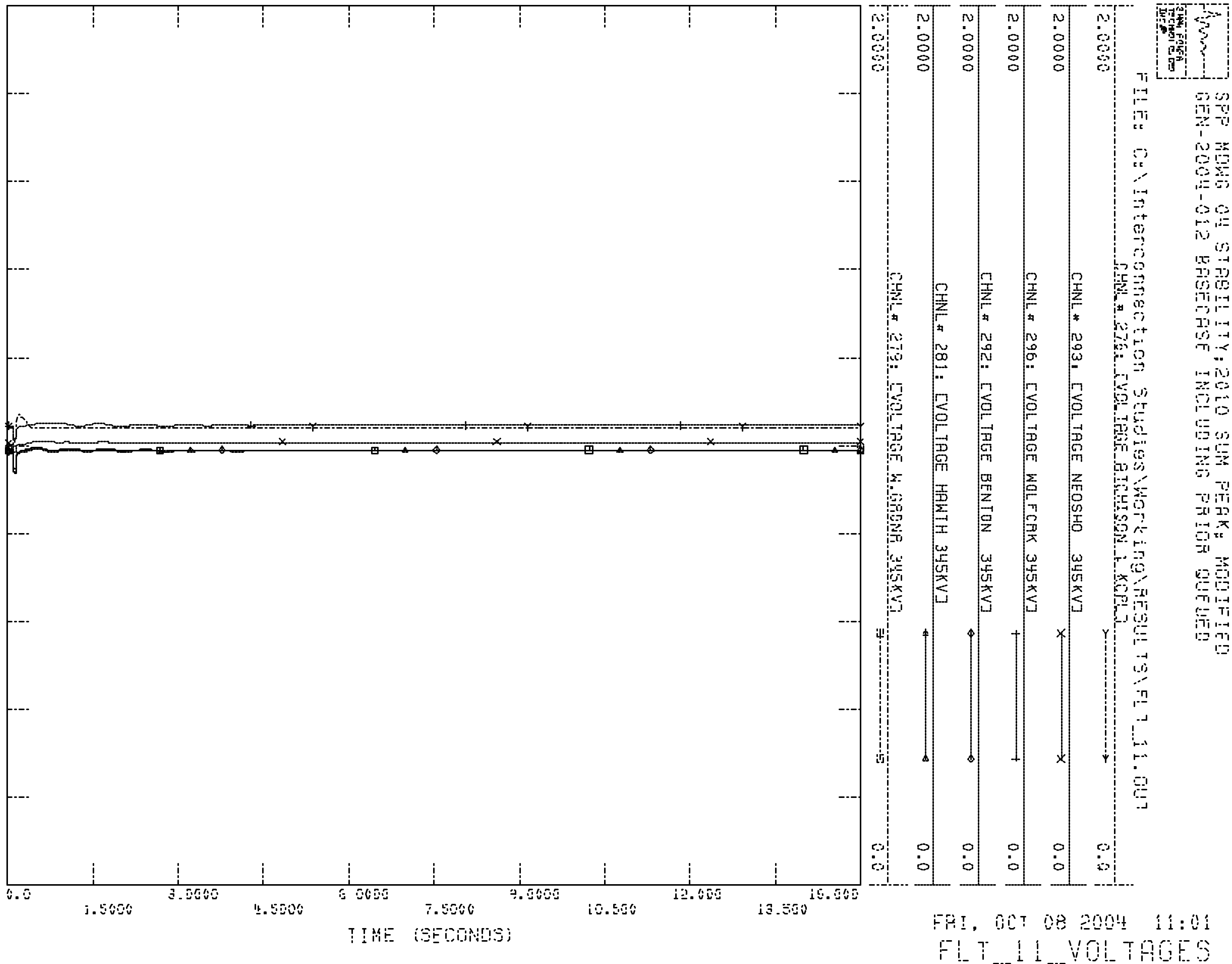
TIME (SECONDS)
FRI, OCT 08 2004 11:01
FLT_10_VOLTAGES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
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CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000 0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
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CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000 0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000 0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
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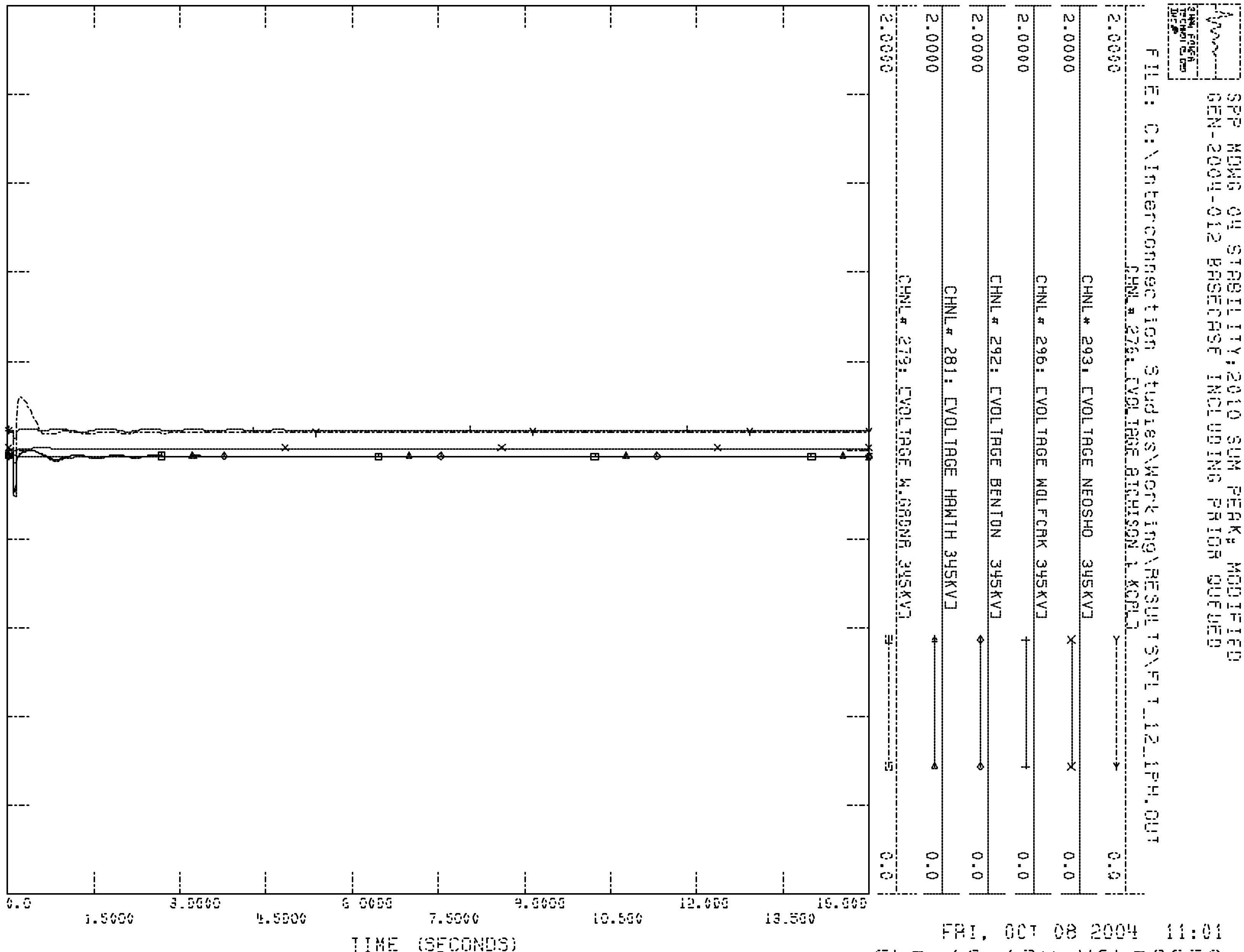
TIME (SECONDS)
FRI, OCT 08 2004 11:01
FLT_11_VOLTAGES

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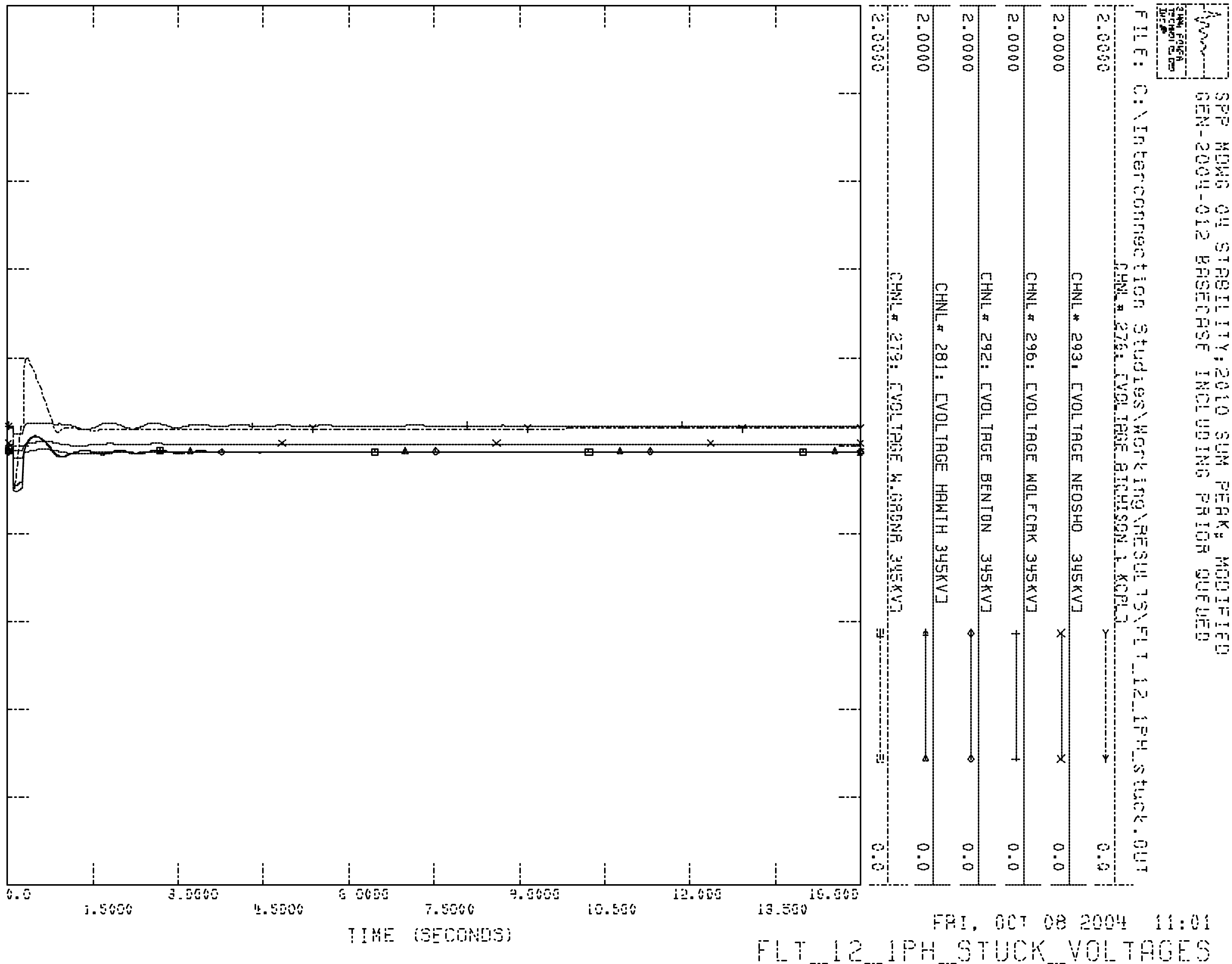
FLT_12_1PH_VOLTAGES



SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
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0.0
CHNL# 296: [VOLTAGE WOLFCRK 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE BENTON 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE W.GRDNR 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
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TIME (SECONDS)
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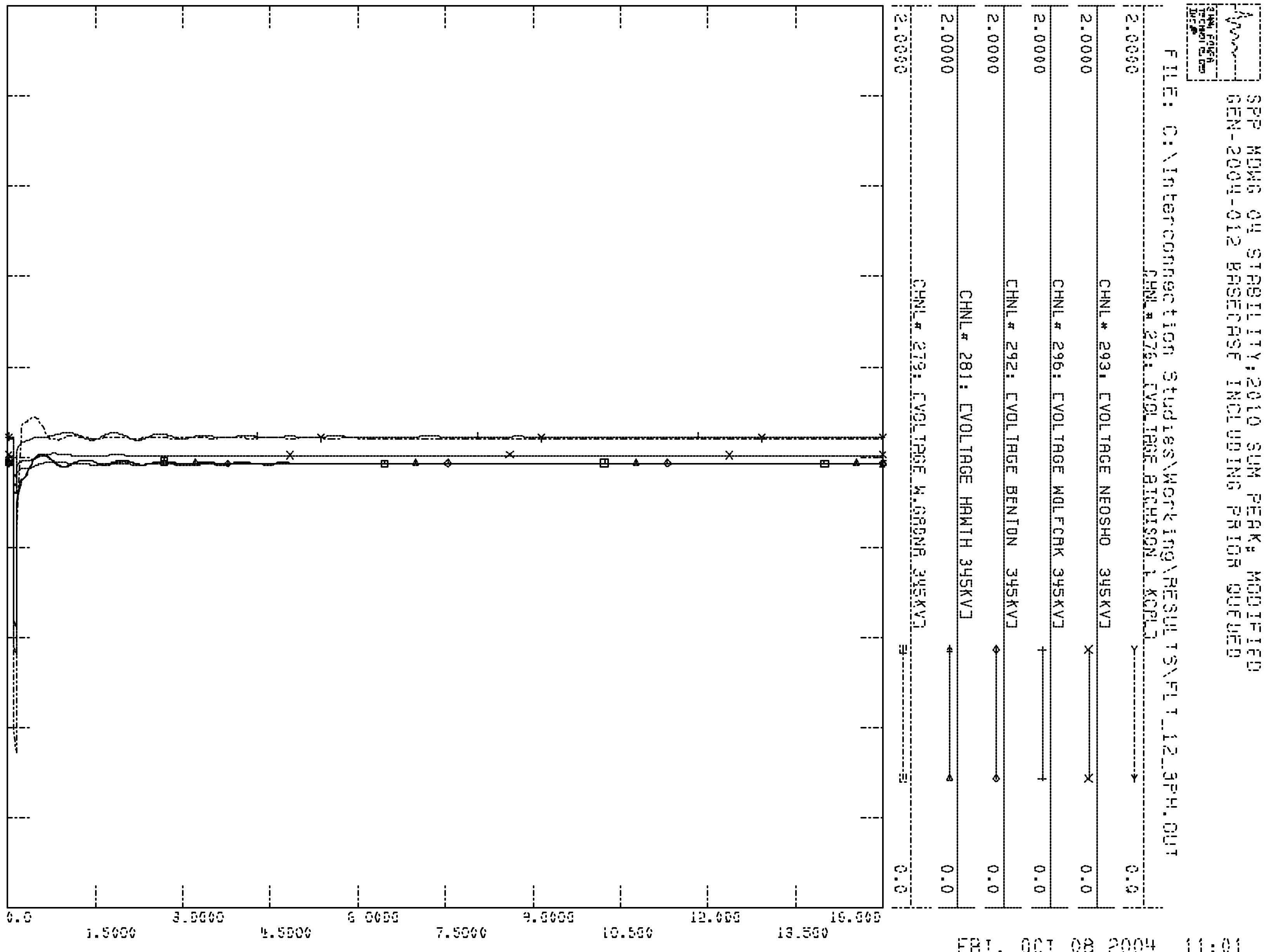
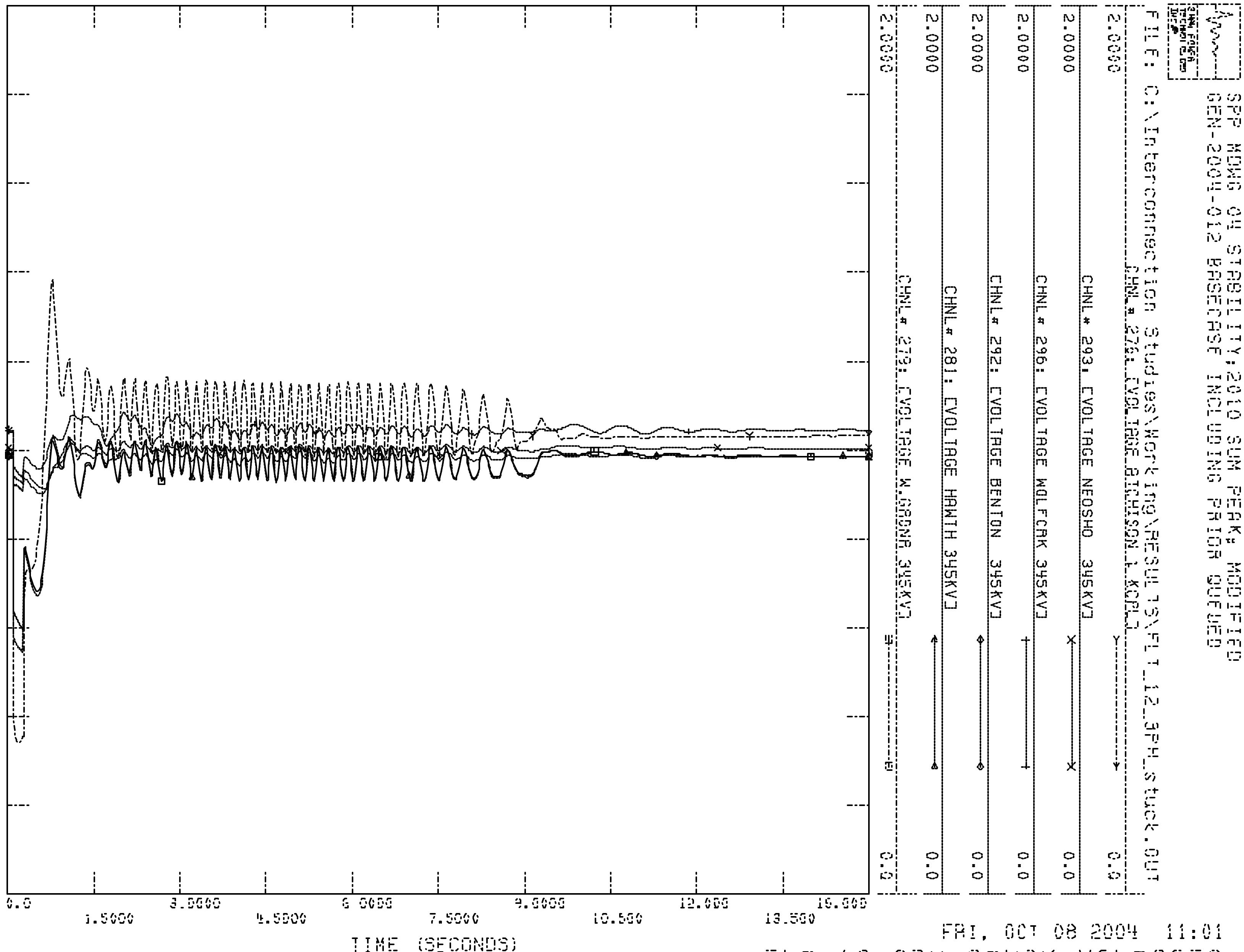
FLT_12_1PH_STUCK_VOLTAGES




FLT_12_3PH_VOLTAGES

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FLT_12_3PH_STUCK_VOLTAGES