SPP Southwest Power Pool

Expedited System Impact Study for Generation Interconnection Request

GEN-2004-012

SPP Tariff Studies

(#GEN-2004-012)

September 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 northern Platte County, MO. 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.

The network upgrade requirements include expansion of the Iatan 345kV bus and installation of six (6) new 345kV circuit breakers. This expansion would provide terminals for the unit and start/standby transformers and a line terminal position for a new Iatan-Nashua 345kV circuit necessary for the generation interconnection. The ratings of the new Iatan-Nashua 345kV circuit will be at least 1099MVA normal and 1251MVA emergency.

The network upgrades outside of the Iatan 345kV substation are required to alleviate the contingency overloading on the 345kV and 161kV transmission system that results from the additional generation. A new Iatan-Nashua 345kV circuit eliminates the contingency overloading of the Iatan-St. Joe 345kV circuit and Iatan-Stranger Creek 345kV circuit along with several surrounding 161kV overloads due to contingency events.

The total estimated cost of the required network upgrades for interconnection are $25,318,000 including work at both Iatan and Nashua substations and the Iatan to Nashua 345kV line.

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 are unstable if the proposed Iatan-Nashua 345kV line is not built. If the Iatan-Nashua 345kV line is in service, the units remain stable for a stuck breaker condition at Iatan. 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 northern Platte County, MO. The requested generation addition is for a 900MW coal-fired unit at the customer's site adjacent to the existing KCPL Iatan 345kV substation. The requested in-service date is June 1, 2009.

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 plants output is not studied. The plants 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 overloading occurs 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, no overloading occurs as a result of outages of transmission facilities in the 2007 Summer Peak case.

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, no overloading occurs as a result of outages of transmission facilities in the 2007 Winter Peak case.

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 KCPL facilities impacted by the addition of the generation after the proposed network upgrades are added.

Facility Name	SIS Rate B	Base Case Loading	Transfer Case Loading	%TDF	Outage Contingency	Solution	Cost
BLUE VALLEY -- WINCHESTER JCT SOUTH 161 KV	224	90.2	104.7	3.6	STRANGER CREEK -- CRAIG 345kV	Replace Wavetrap at Blue Valley	$6,000
SOUTHTOWN -- WINCHESTER JCT SOUTH 161 KV	224	90.8	104.8	3.5	STRANGER CREEK -- CRAIG 345kV	Replace Wavetrap at Southtown	$6,000
						Total Estimated Cost	$12,000

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 KCPL facilities impacted by the addition of the generation after the proposed network upgrades are added.

Facility Name	SIS Rate B	Base Case Loading	Transfer Case Loading	%TDF	Outage Contingency	Solution	Cost
BUCYRUS - STILWELL 161KV	245	91.8	103.7	3.2	WEST GARDNER – S. RICHLAND 161KV	Wavetrap at Stilwell for Bucyrus line terminal must be replaced.	$6,000
						Total Estimated Cost	$6,000

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. Six (6) 345kV circuit breakers will be added to accommodate the new unit and additional 345kV line terminal for the proposed Iatan-Nashua line. The new Iatan-Nashua line is necessary to relieve the contingency overloads on the existing circuits at the point of the interconnection due to the increased generation. The estimated cost of the interconnection substation work is $5,300,000.

3.2 Iatan-Nashua 345kV line

The combined output of 1570MW from the Customer and the Iatan #1 plants will be injected into the grid at the Iatan substation. Presently, the Iatan-St. Joe 345kV line and the Iatan-Stranger Creek 345kV line exit the Iatan substation. The Iatan-St. Joe circuit is rated at 956MVA and the Iatan-Stranger Creek 345kV line is rated at 1099MVA. Loss of either line results in overloading of the remaining circuit. The Iatan-St. Joe line is particularly susceptible to overloading by a number of contingencies because of the limited capability. A third 345kV circuit exiting the Iatan substation is required to inject the proposed plant's output into the grid and will be included as part of the direct-assignment interconnection facilities. The new circuit would carry a significant portion of the combined plant output under normal conditions and would alleviate the overloading of the Iatan-St. Joe line and the Iatan-Stranger Creek line during contingency events. The estimated cost of the Iatan-Nashua 345kV circuit is $15,000,000.

3.3 Nashua 345kV Substation

Analysis indicates that the third circuit from Iatan should be tied into the Hawthorn-St. Joe 345kV line at Nashua. This substation construction will be included as part of the network upgrades. The estimated cost of the Nashua substation is estimated at $5,000,000.

3.4 161kV Upgrades

After the installation of the proposed Network Upgrades mentioned above, three 161kV facilities still show overloading due to contingency analysis. The 161kV line from Blue Valley to Winchester Junction South and the line from Winchester Junction South to Southtown both show an overload after outage of the Stranger Creek to Craig 345kV line in the 2010 Summer Peak model. Upgrade of these facilities will include replacement of wave traps at both Blue Valley and Southtown. This will increase the emergency summer rating from 224MVA to 335MVA. The estimated cost of these upgrades is $12,000. Also, the Bucyrus to Stillwell 161kV circuit shows overloading due to outage of the West Gardner to South Richland 161kV line. Mitigation of this overload involves rebuilding the Bucyrus line terminal at Stillwell to remove a wavetrap limitation on the rating of the circuit. This upgrade will result in an increase in the emergency rating of this facility from 245MVA to 335MVA. The estimated cost of this upgrade is $6,000. The total estimated 161kV costs are $18,000.

The preliminary cost estimates for the network upgrade facilities are listed in Table 1 below. An estimated project schedule will be included in the Facility Study.

Table 1 – Summary of Network Upgrade Costs for Interconnection

Stand Alone Network Upgrades	
Description	Cost
Iatan 345kV substation facilities and equipment to facilitate interconnection	$5,300,000
Total Stand Alone Network Upgrades	***$5,300,000***

Other Required Network Upgrades	
Description	Cost
New Iatan-Nashua line (27.5 mi.)	$15,000,000
Nashua substation construction	$5,000,000
Southtown -- Winchester Junction South 161kV	$6,000
Blue Valley -- Winchester Junction South 161kV	$6,000
Bucyrus – Stillwell 161kV	$6,000
Total Other Required Network Upgrades	***$20,018,000***
Total Required Network Upgrades	***$25,318,000***

Other facilities may be required depending on the results of the Transmission Service study performed separately and attached to this study. The facilities mentioned above are required only for interconnection of the generation facility.

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 the 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 three scenarios: A basecase without the Customer plant or the Iatan-Nashua 345kV line in service, a case with the Customer plant online at 900MW and no Iatan-Nashua line, and a case with the Customer plant online at 900MW with the Iatan-Nashua line in service.

In the case without the Iatan-Nashua 345kV line, the study 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 Iatan and Customer units 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.

In the case with the new Iatan-Nashua 345kV line, the stuck breaker at Iatan does not cause instability.

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 in northern Platte County, MO. 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 capacity of the plant, and a new Iatan-Nashua 345kV line rated at 1099MVA is required for the plant interconnection to allow the transfer of power from the Iatan site under contingency conditions.

Network upgrades are required at the Iatan substation to accommodate the proposed plant. Expansion of the 345kV ring bus and installation of six (6) 345kV circuit breakers is necessary for the new unit terminal and proposed Iatan-Nashua 345kV circuit. 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 $25,318,000. An estimated project schedule will be determined during the Facility Study.

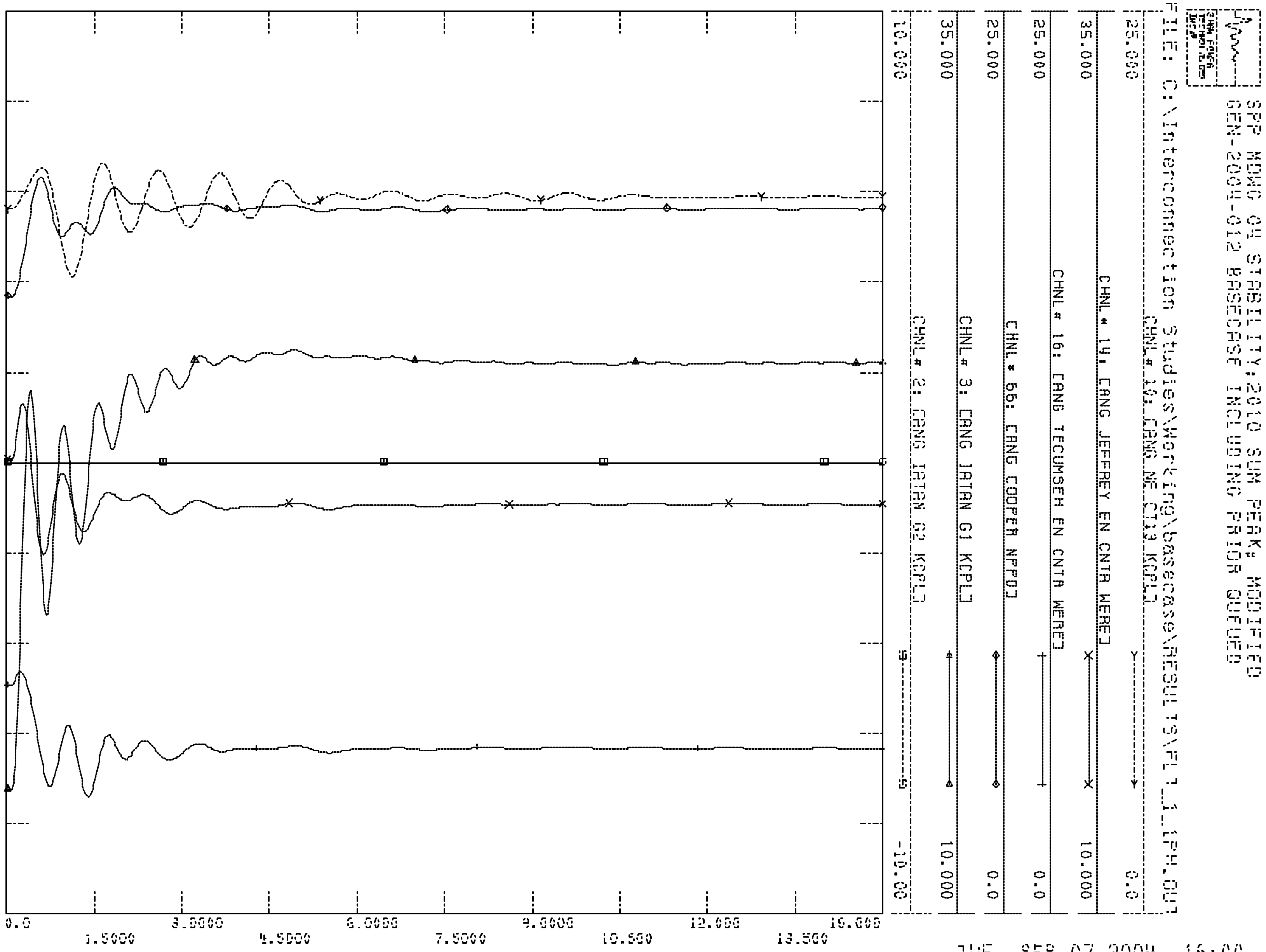
The costs do not include any costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies when the Customer requests transmission service through Southwest Power Pool’s OASIS.

Appendix A-1

Plots of Fault Simulations

Plots of selected machine angle response during faults

Scenario:
2010 Summer Peak
Basecase
[No Customer Plant – No Network Upgrades]



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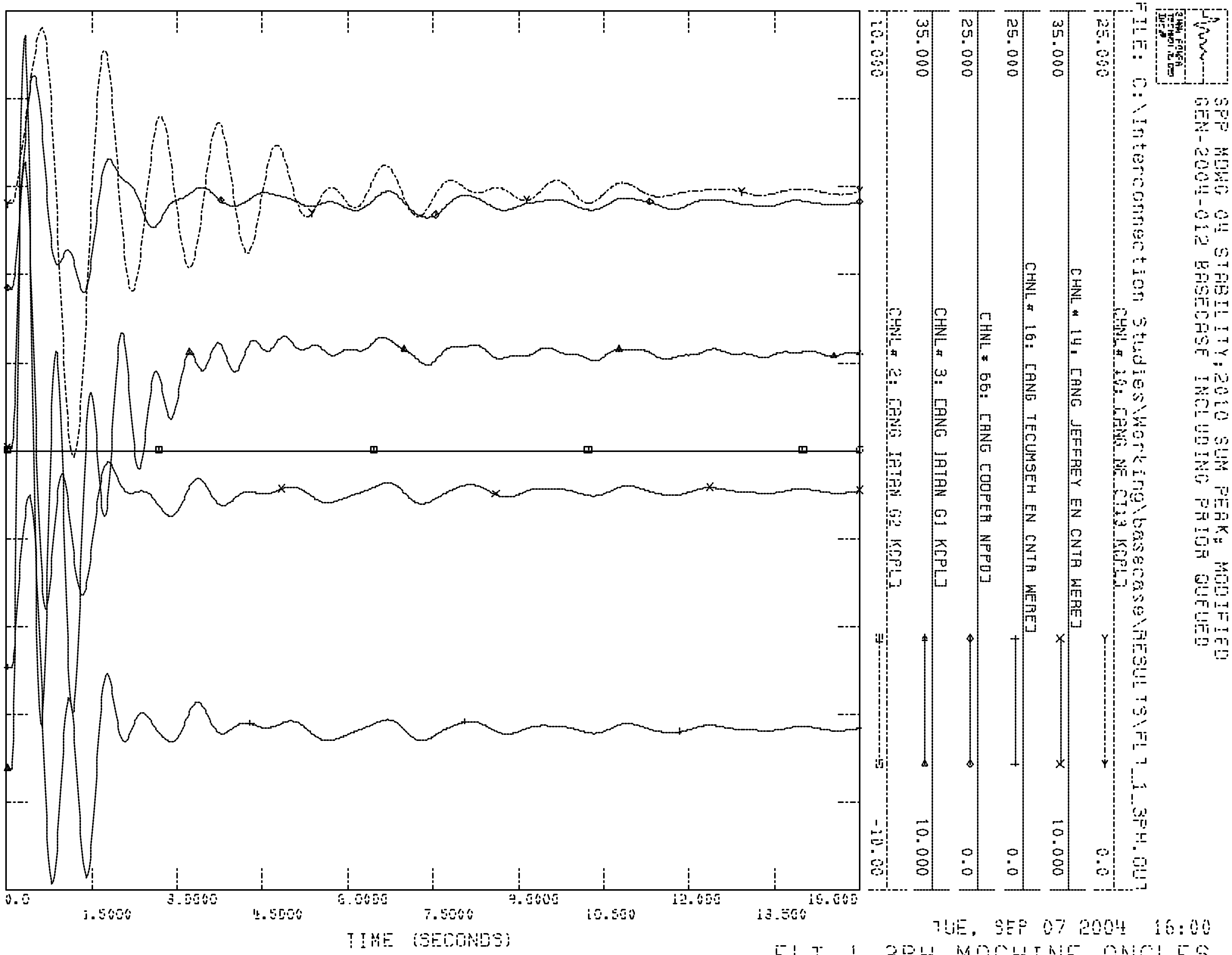

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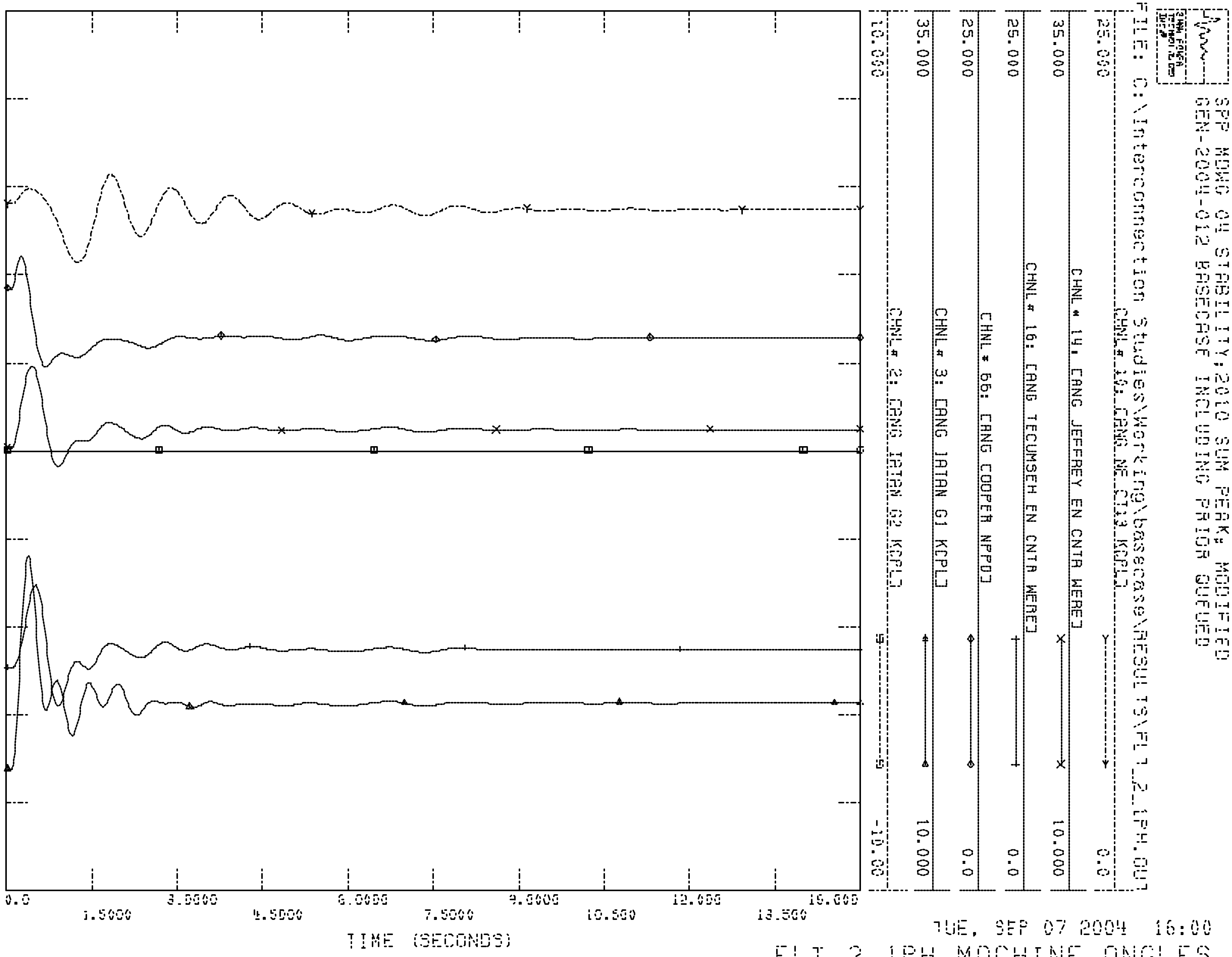

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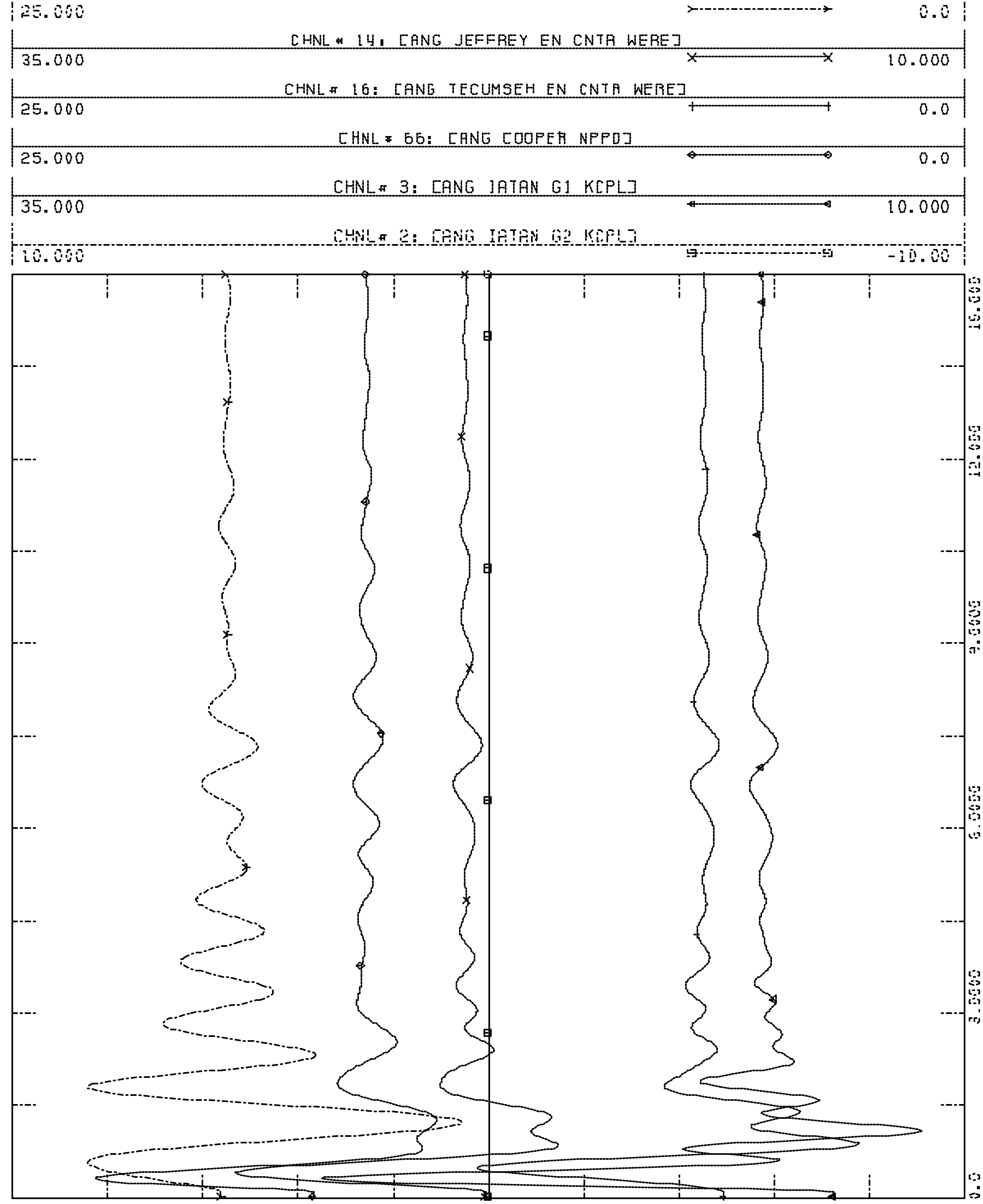

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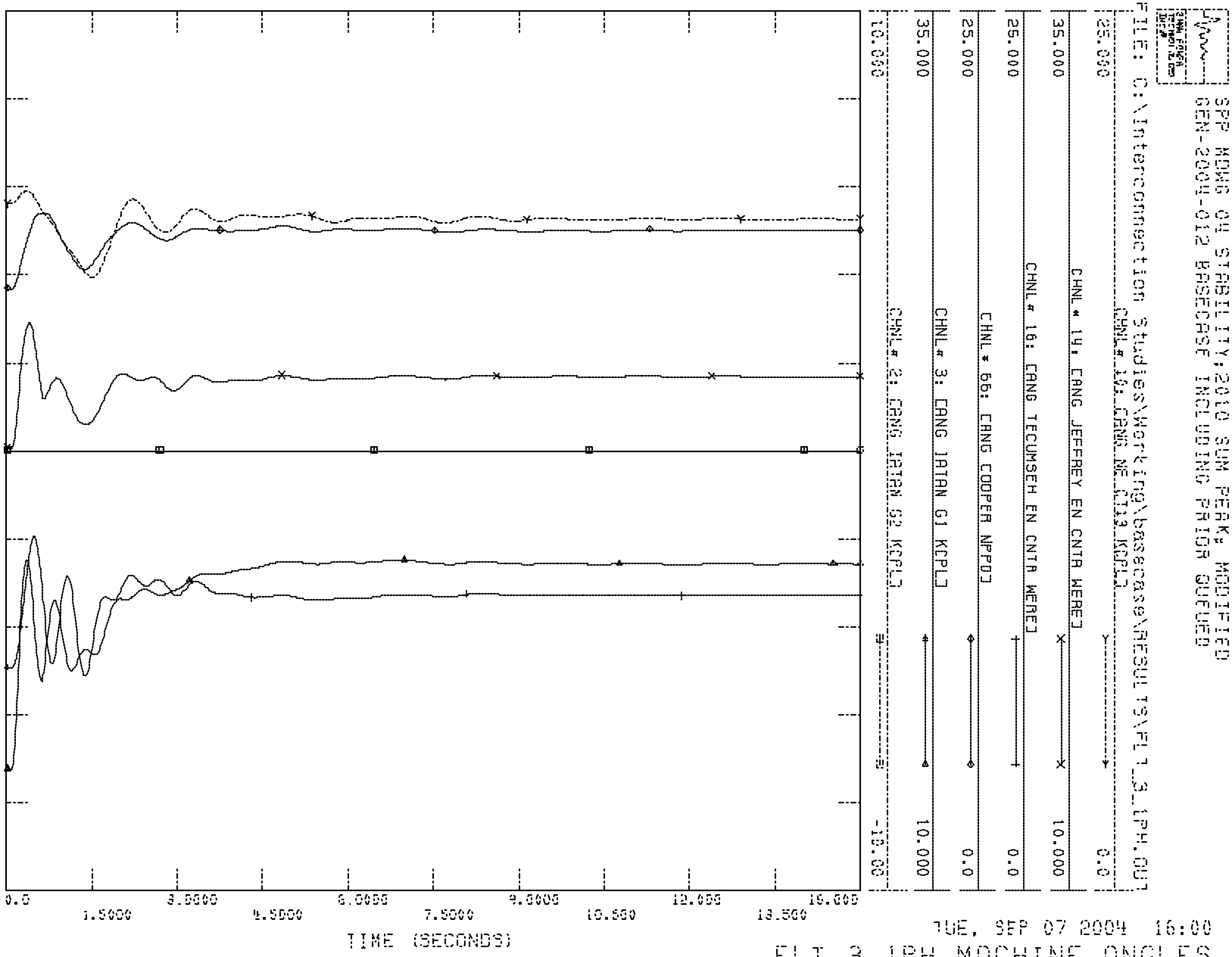

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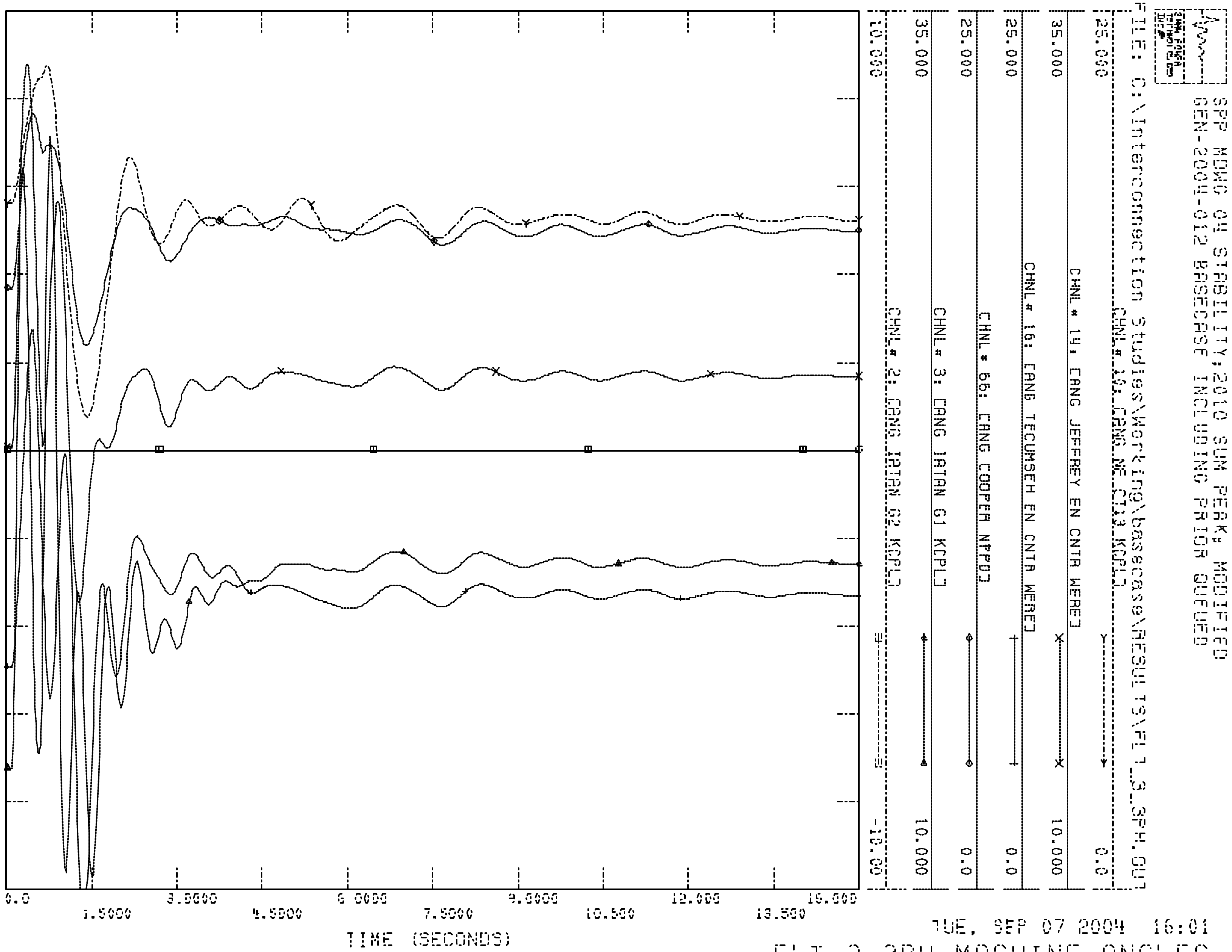

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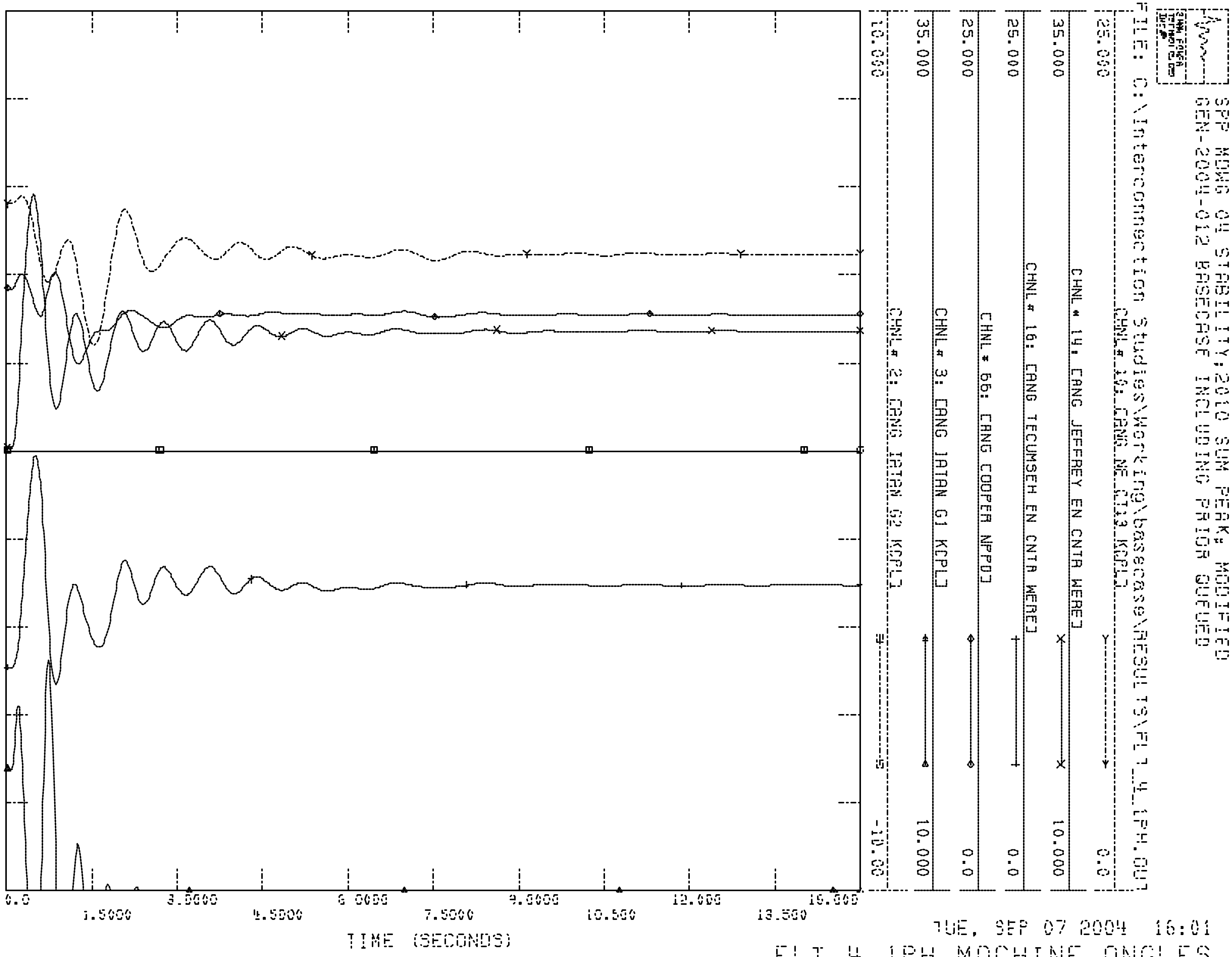

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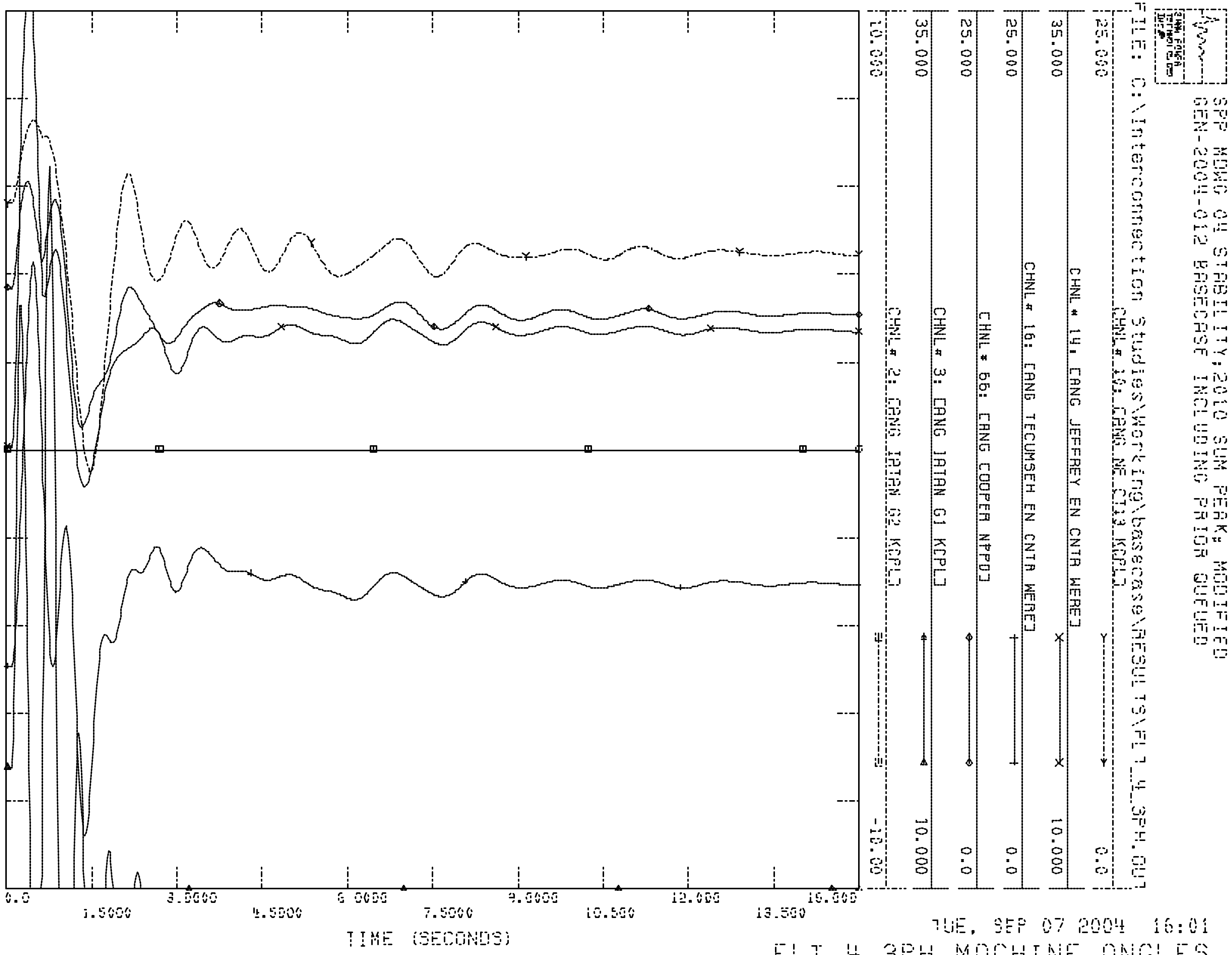

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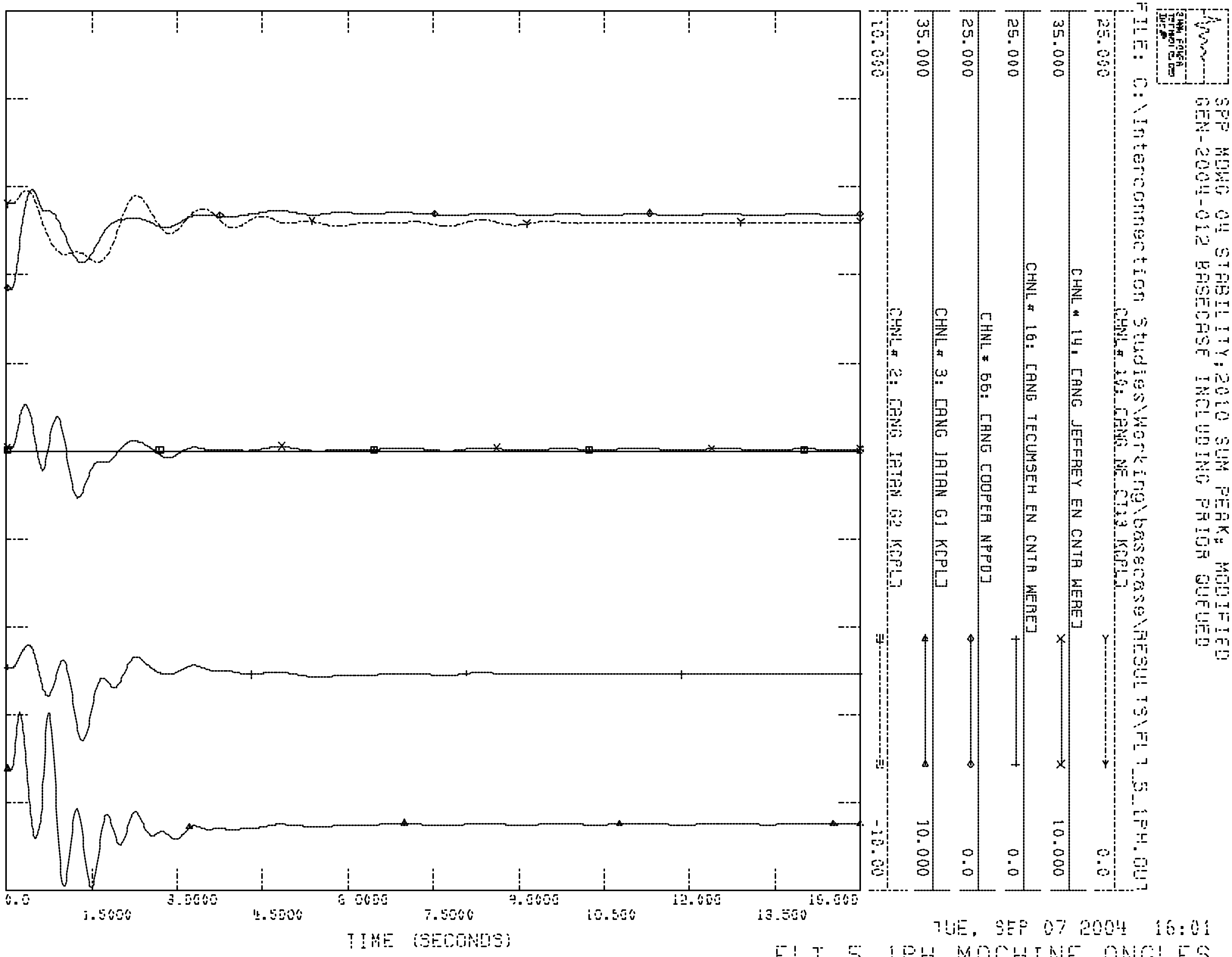

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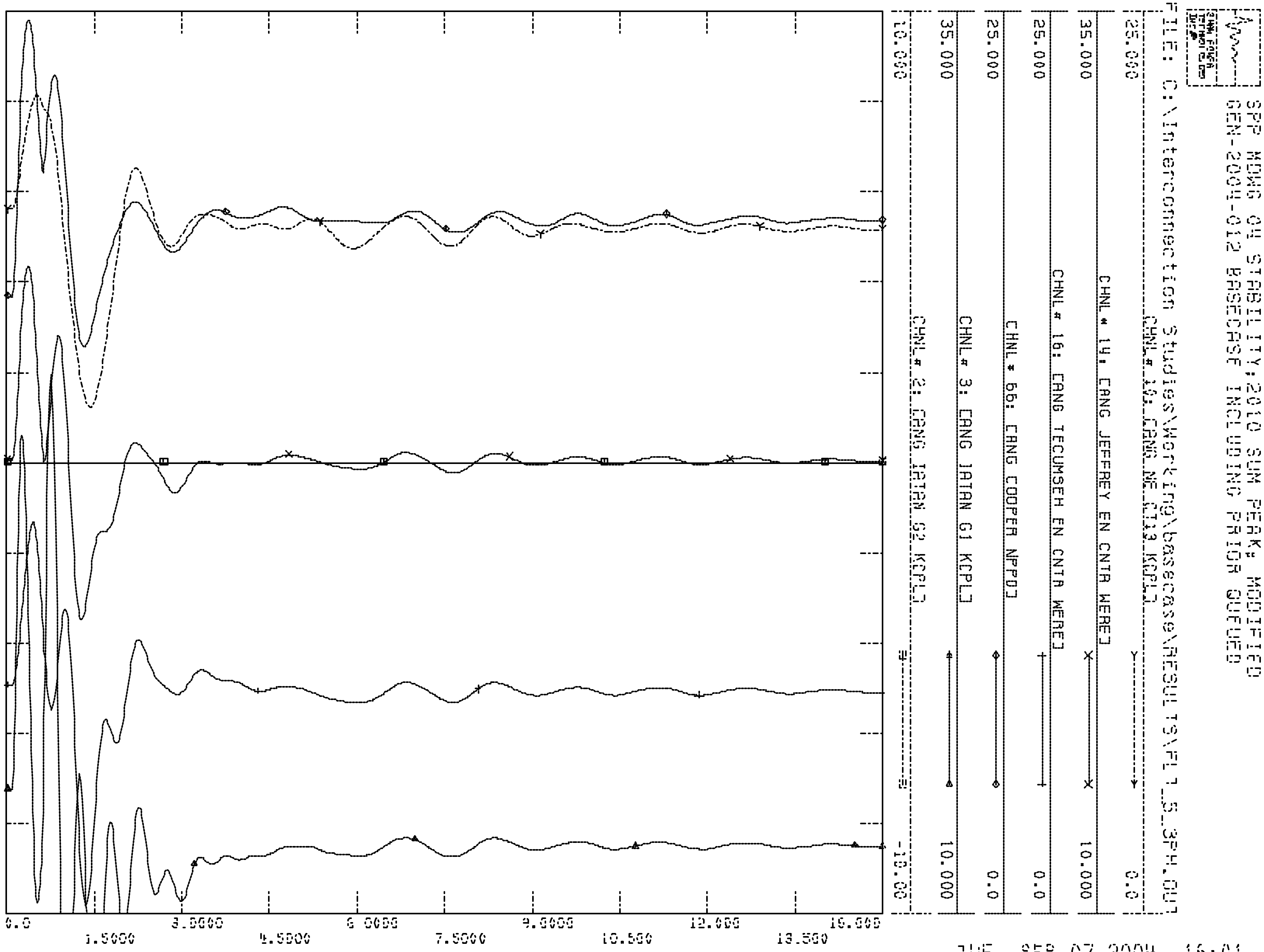

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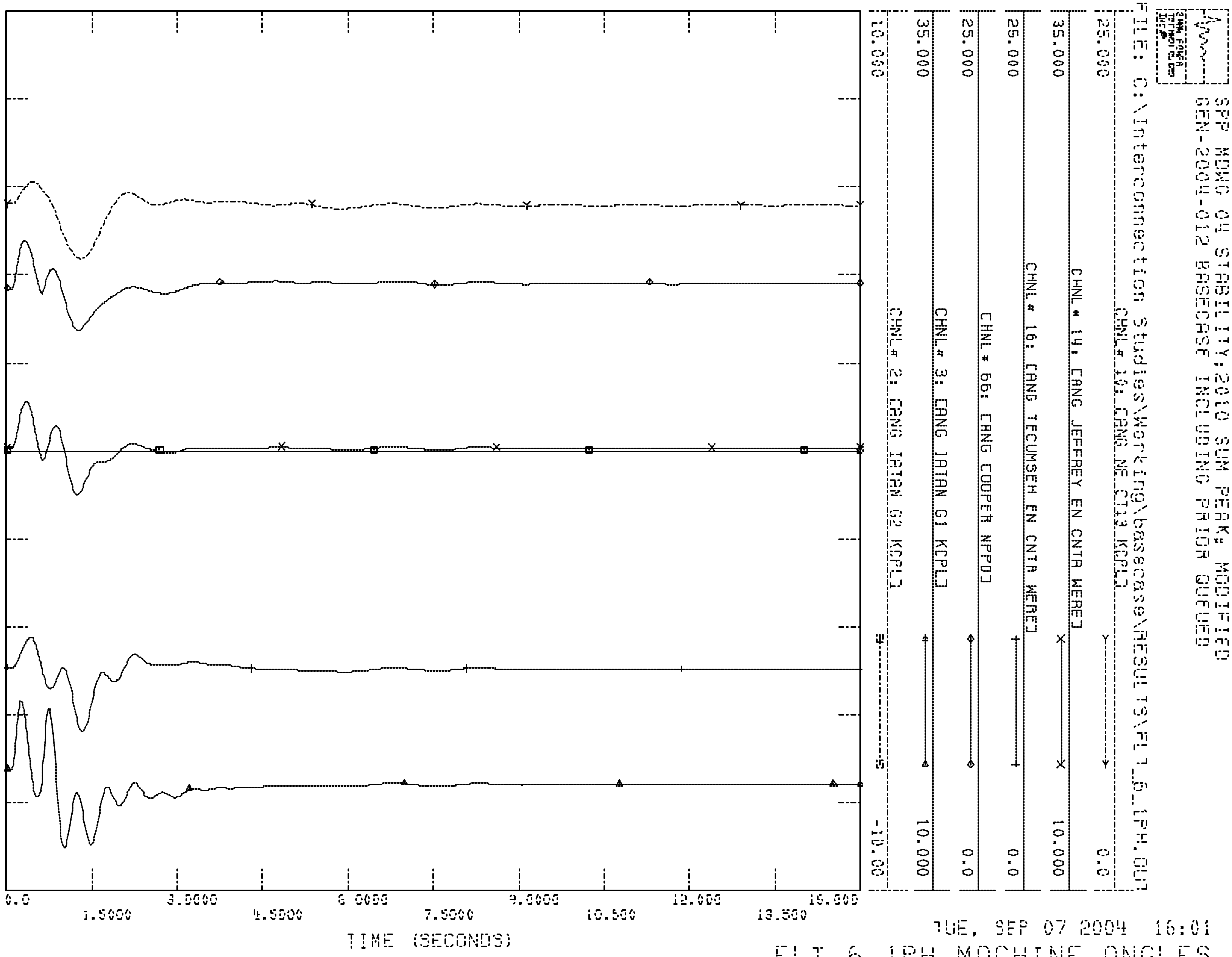

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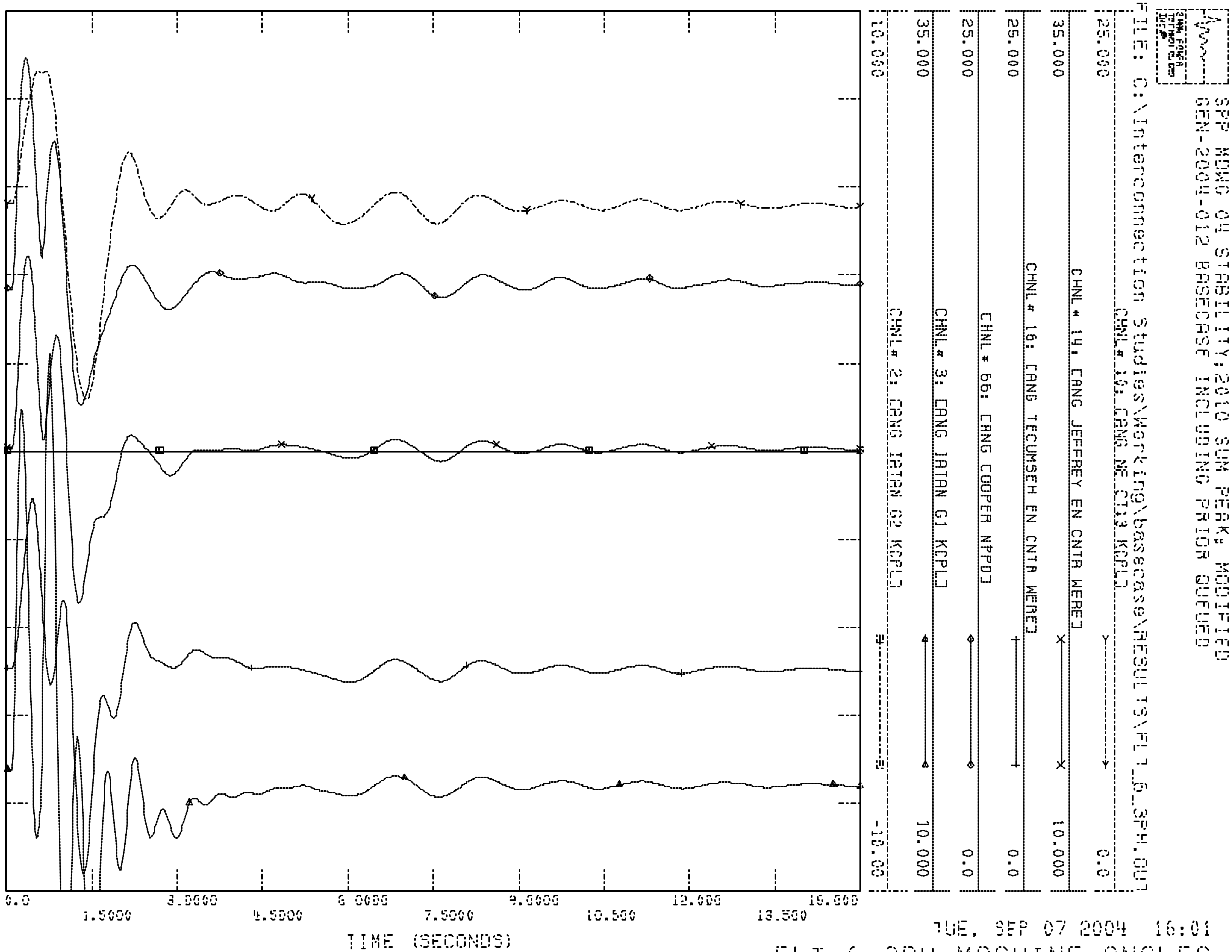

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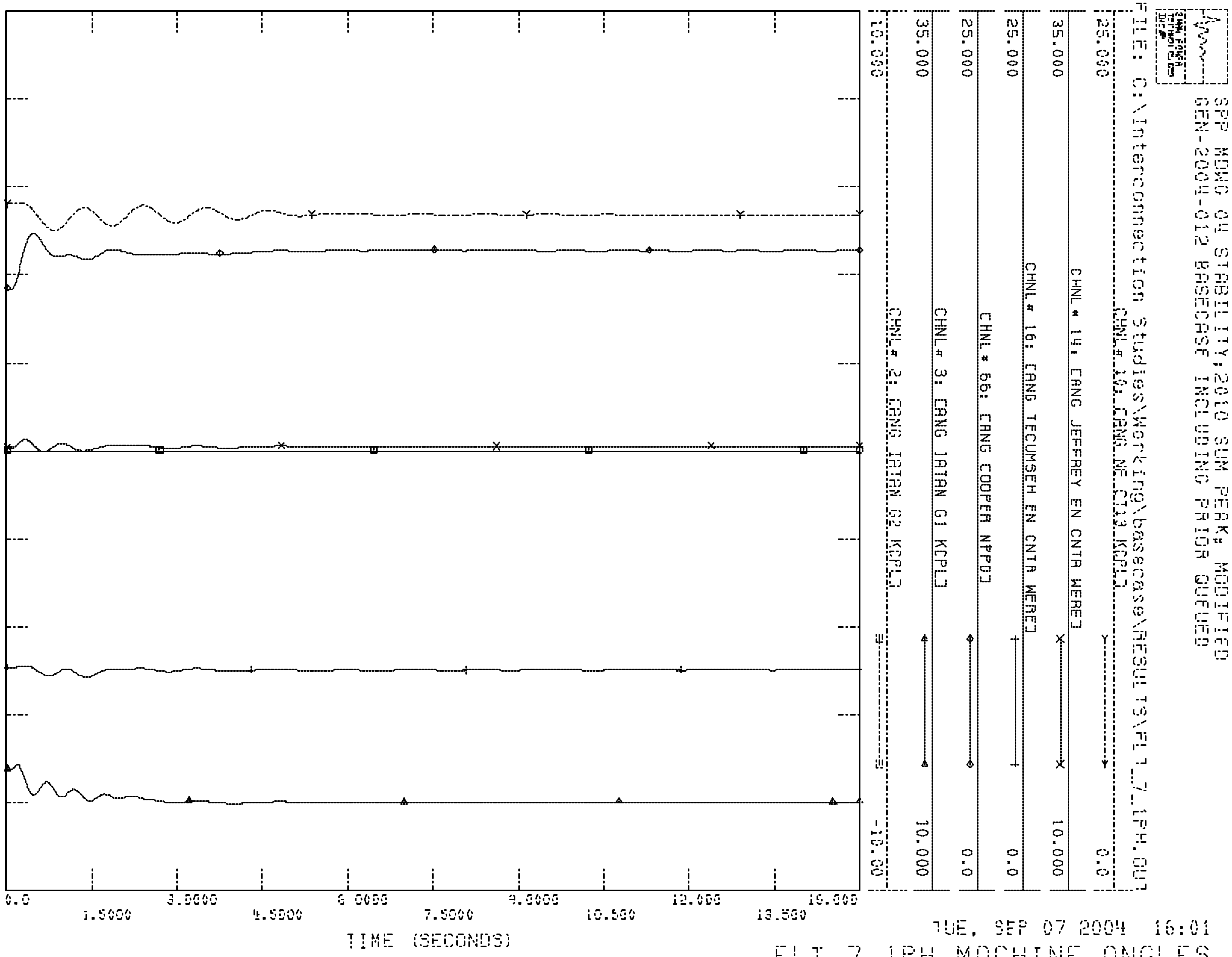

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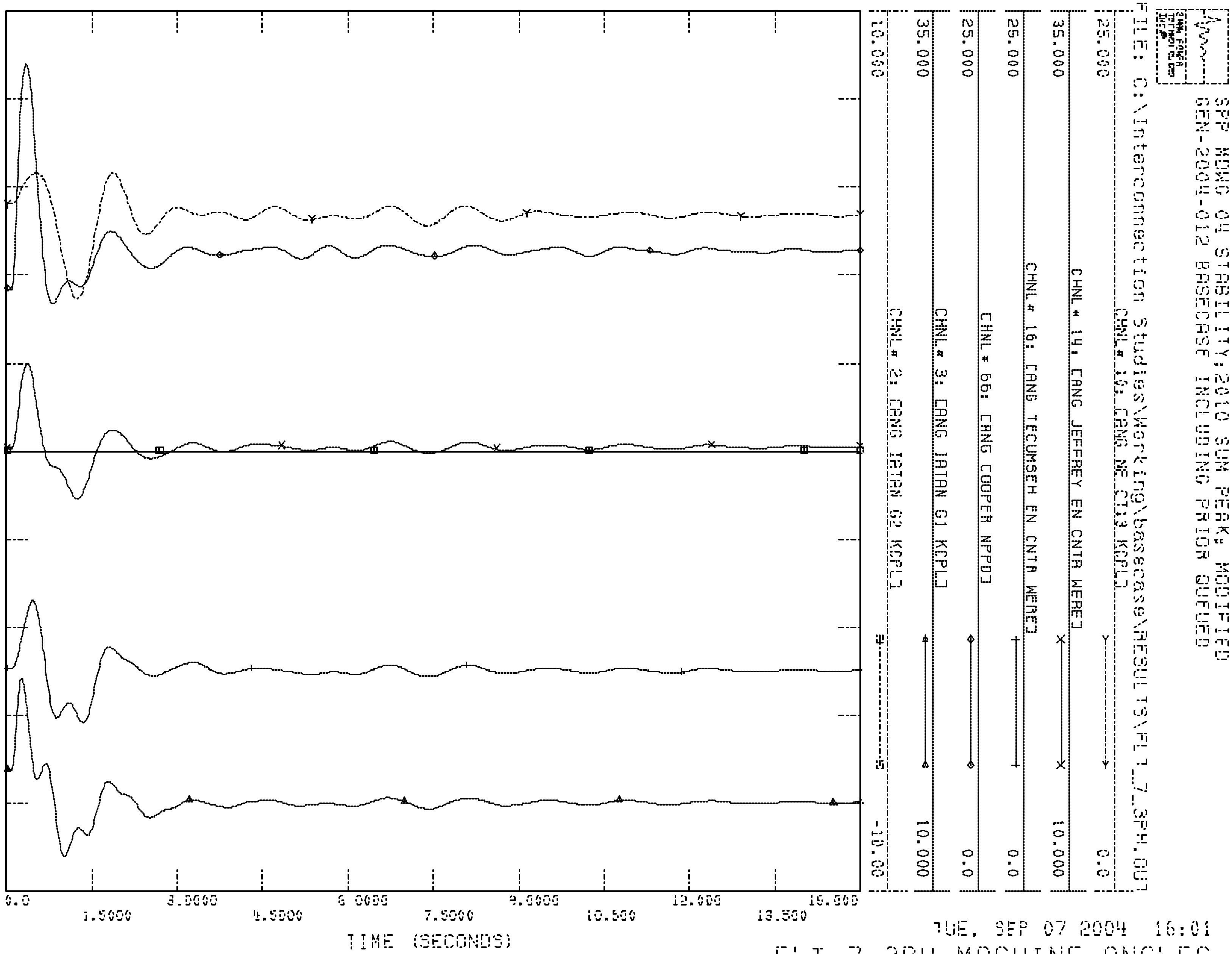

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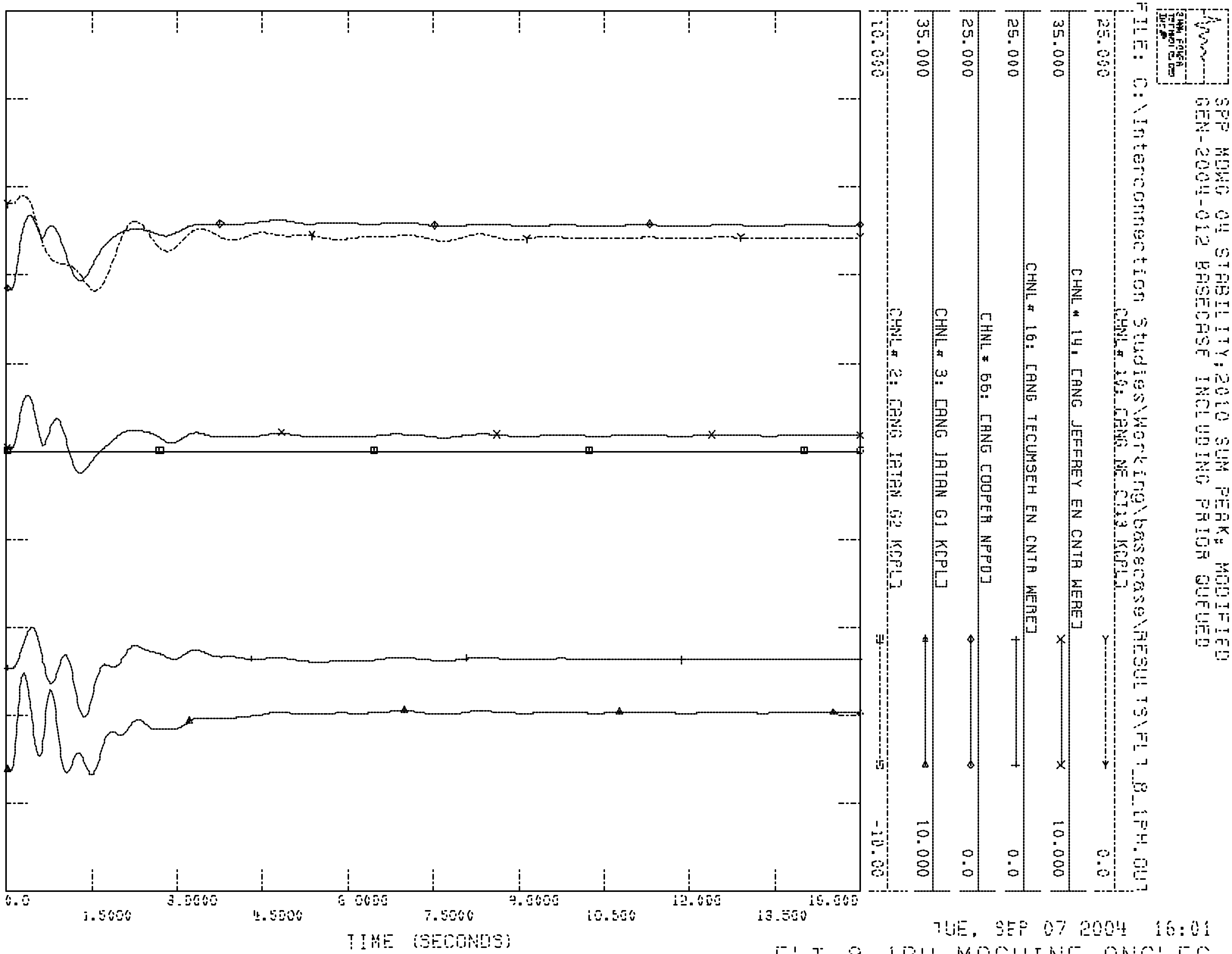

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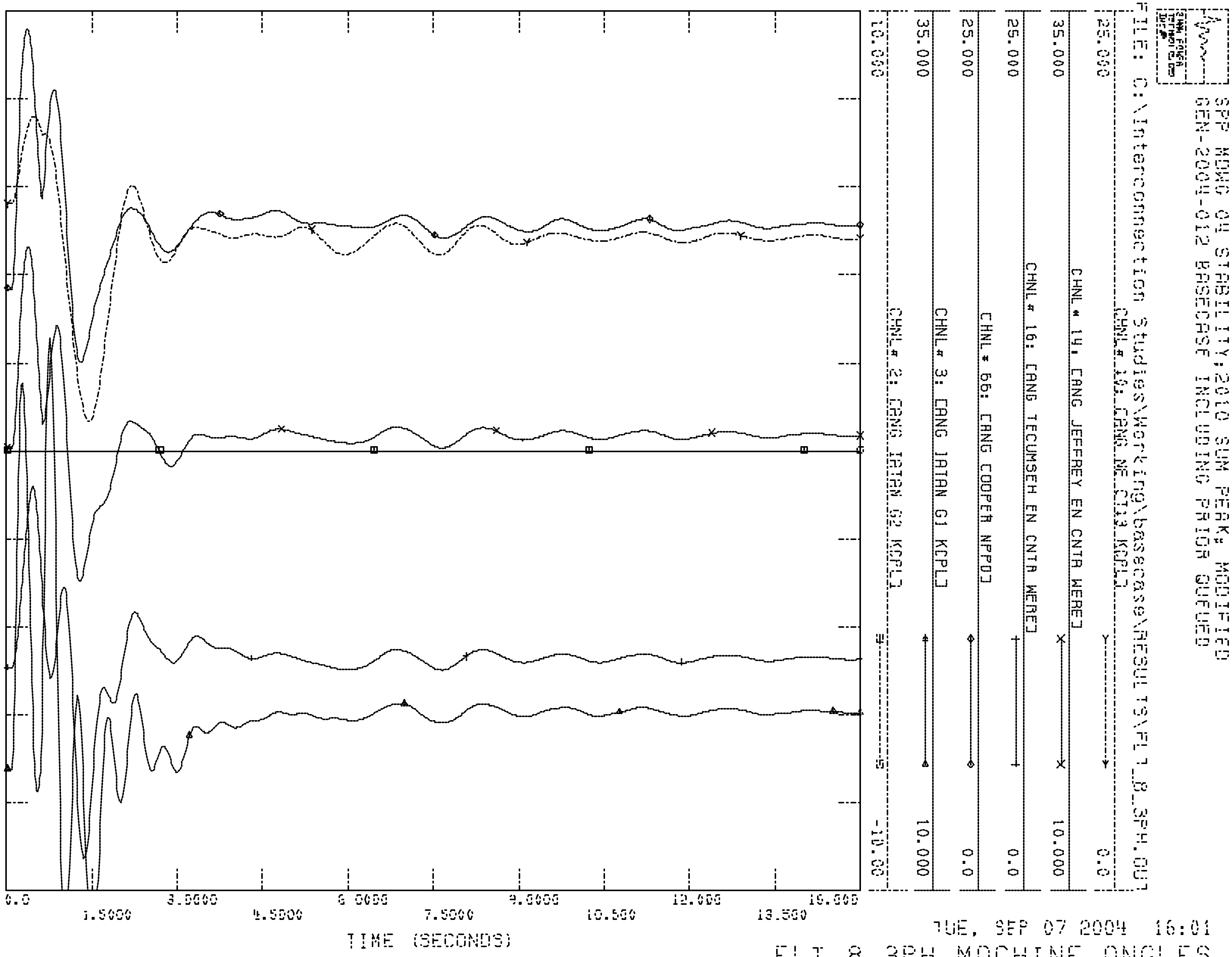

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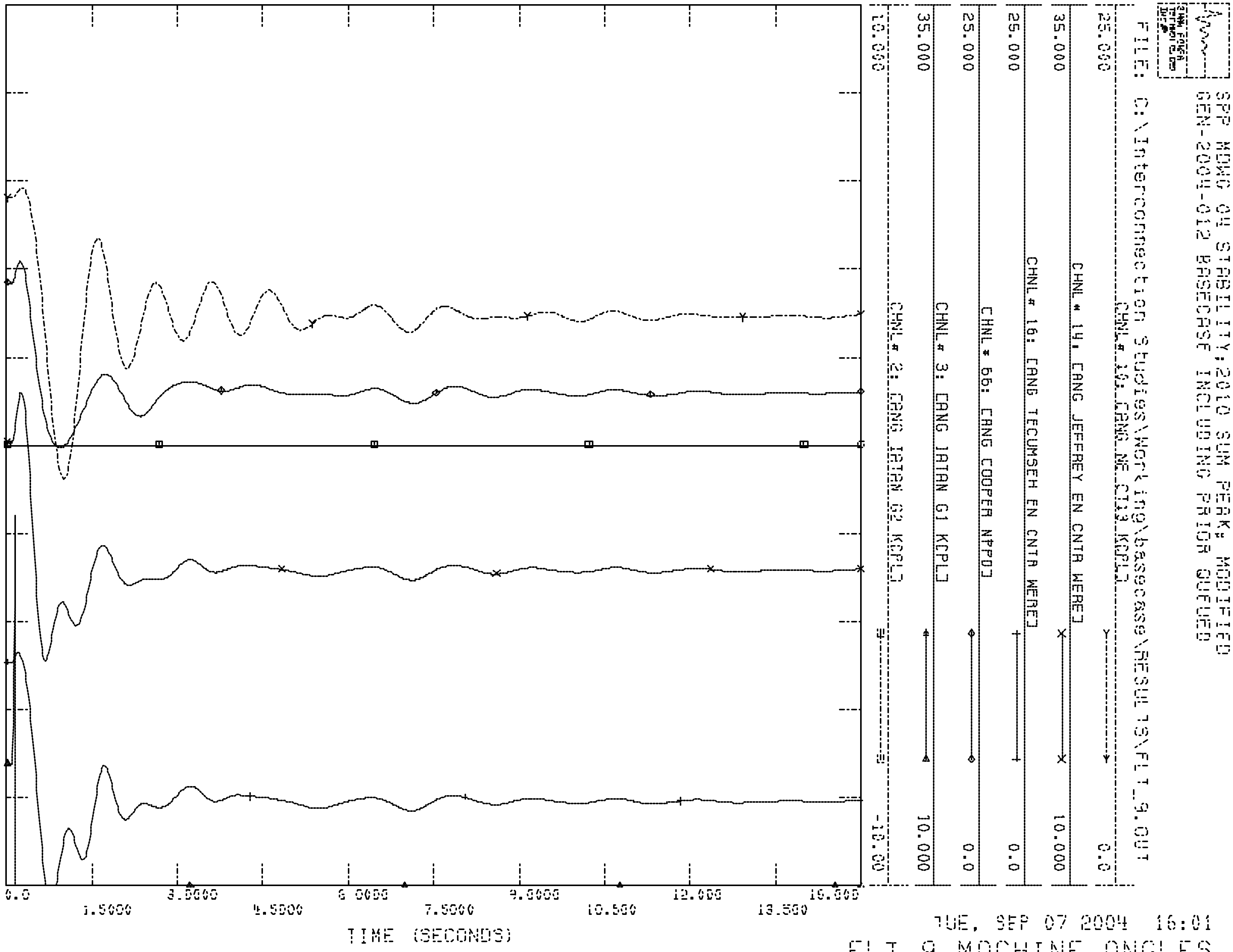

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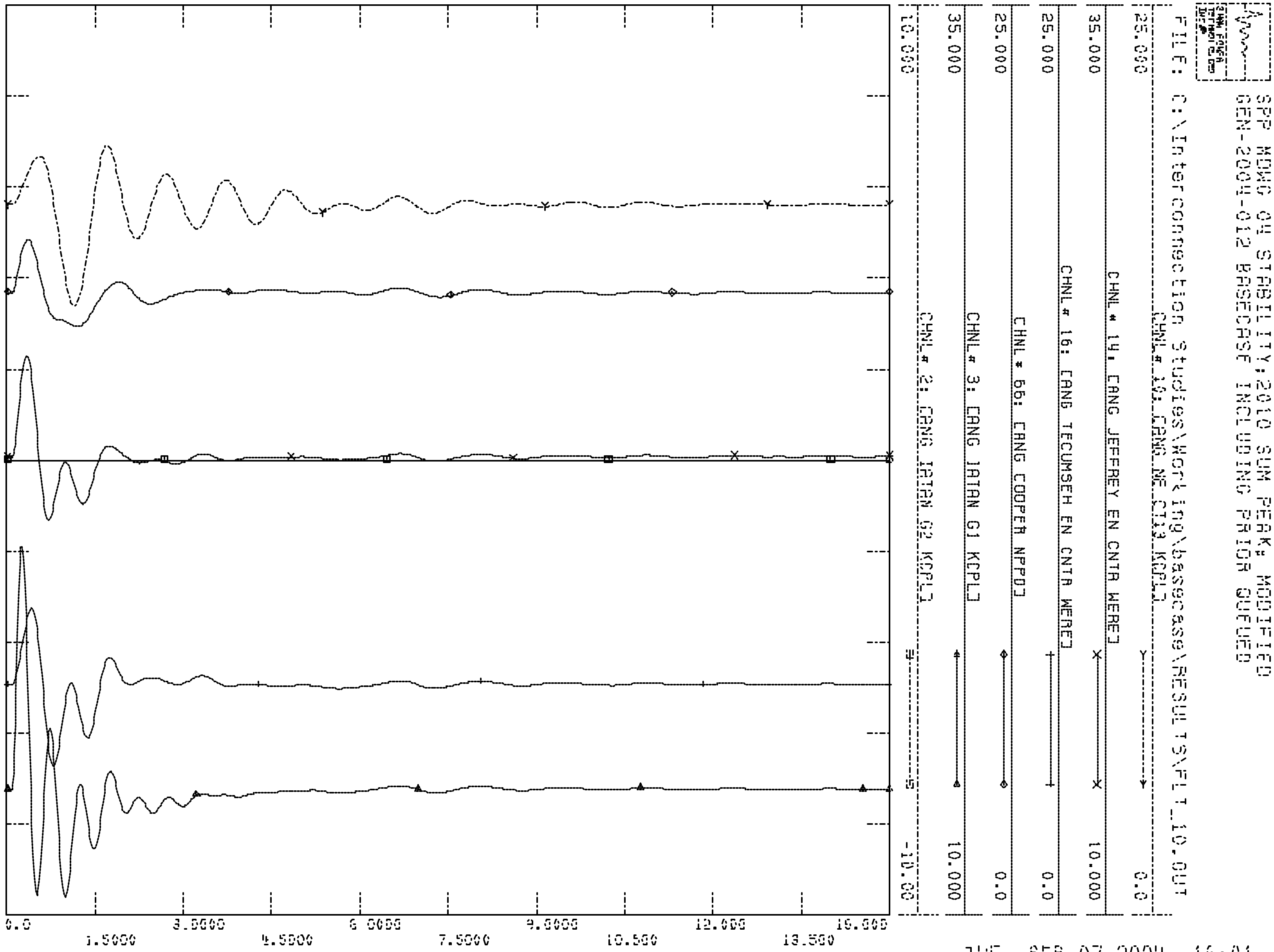

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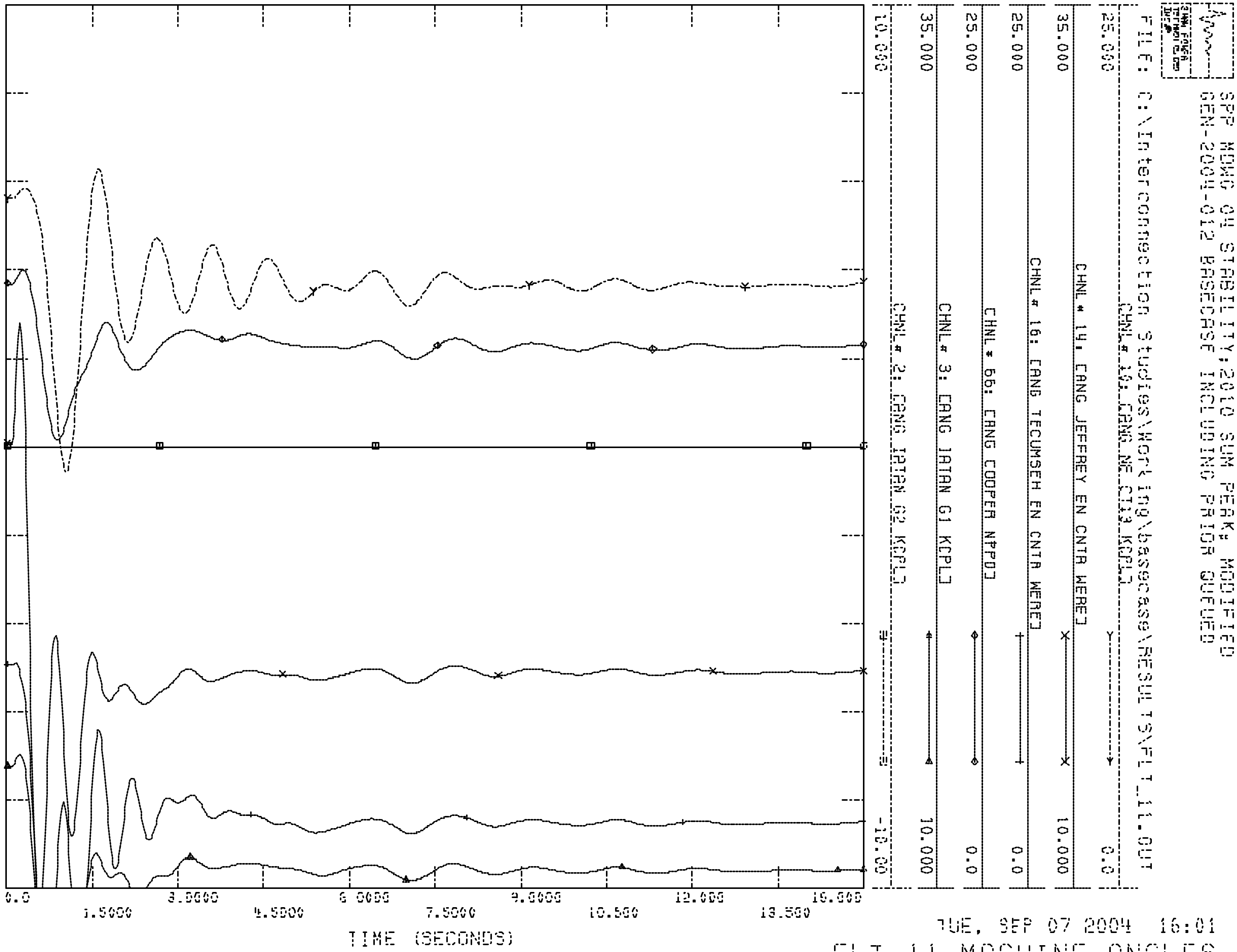

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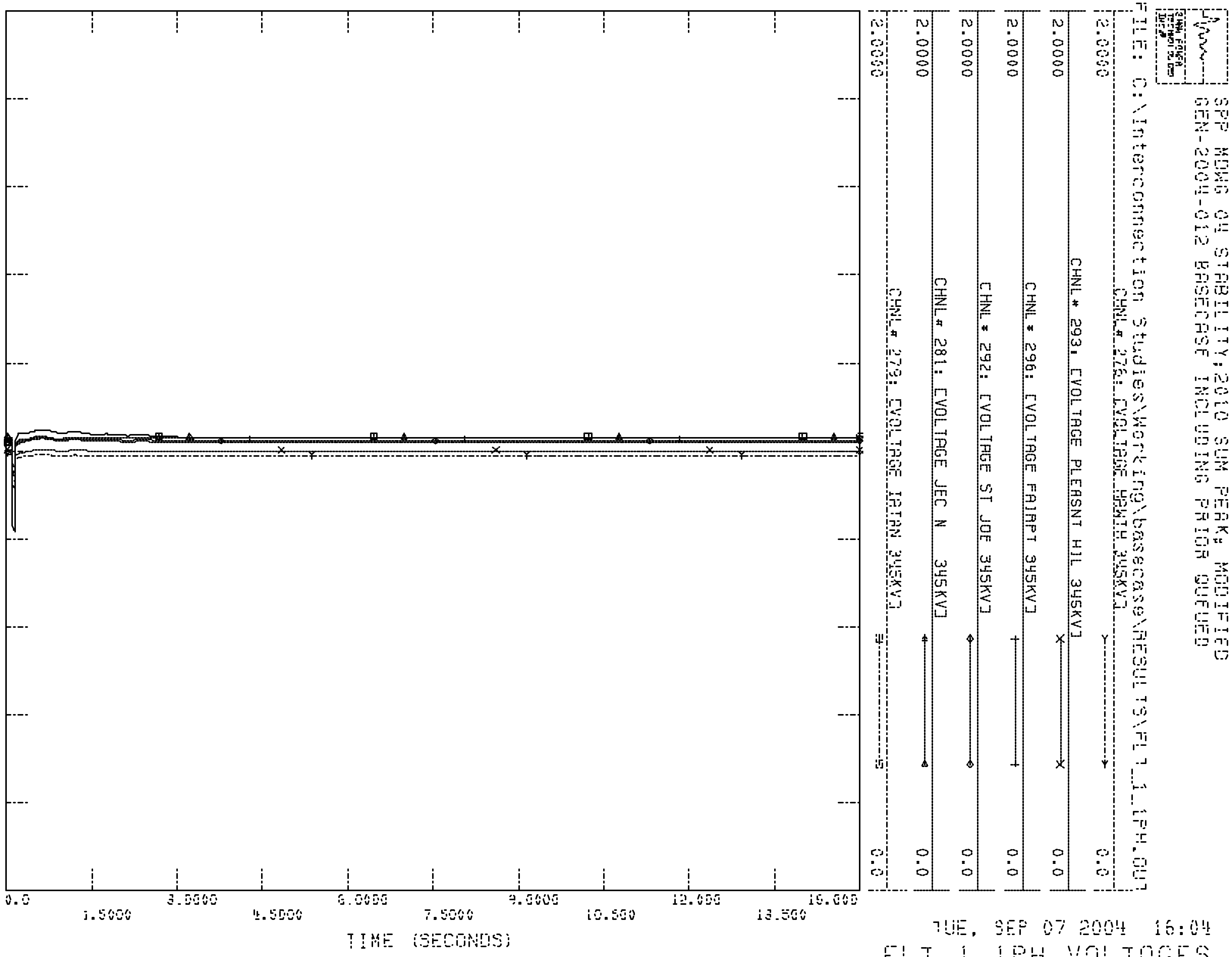
Appendix A-2

Plots of Fault Simulations

Plots of selected bus voltage response during faults

Scenario:
2010 Summer Peak
Basecase
[No Customer Plant – No Network Upgrades]



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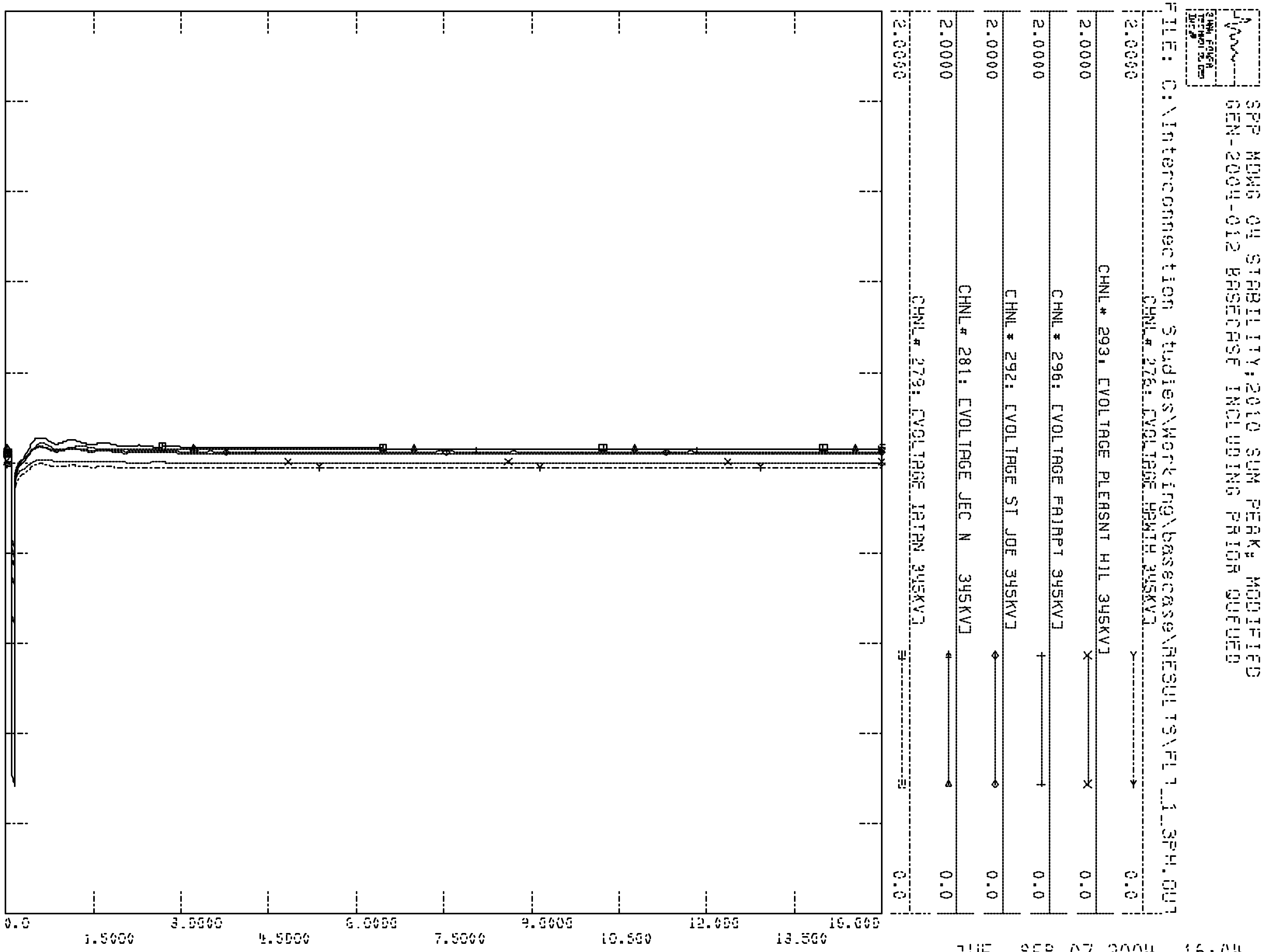

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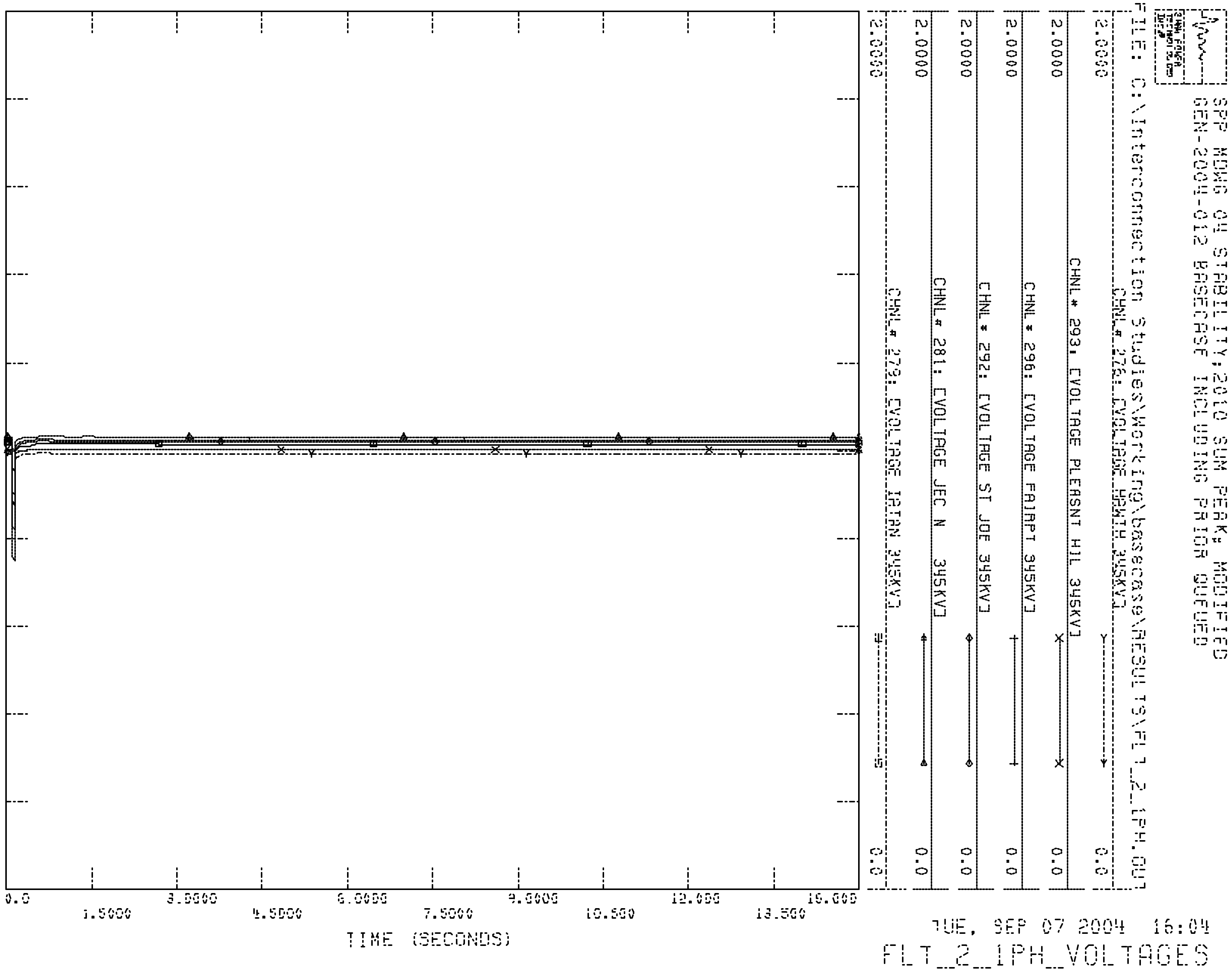

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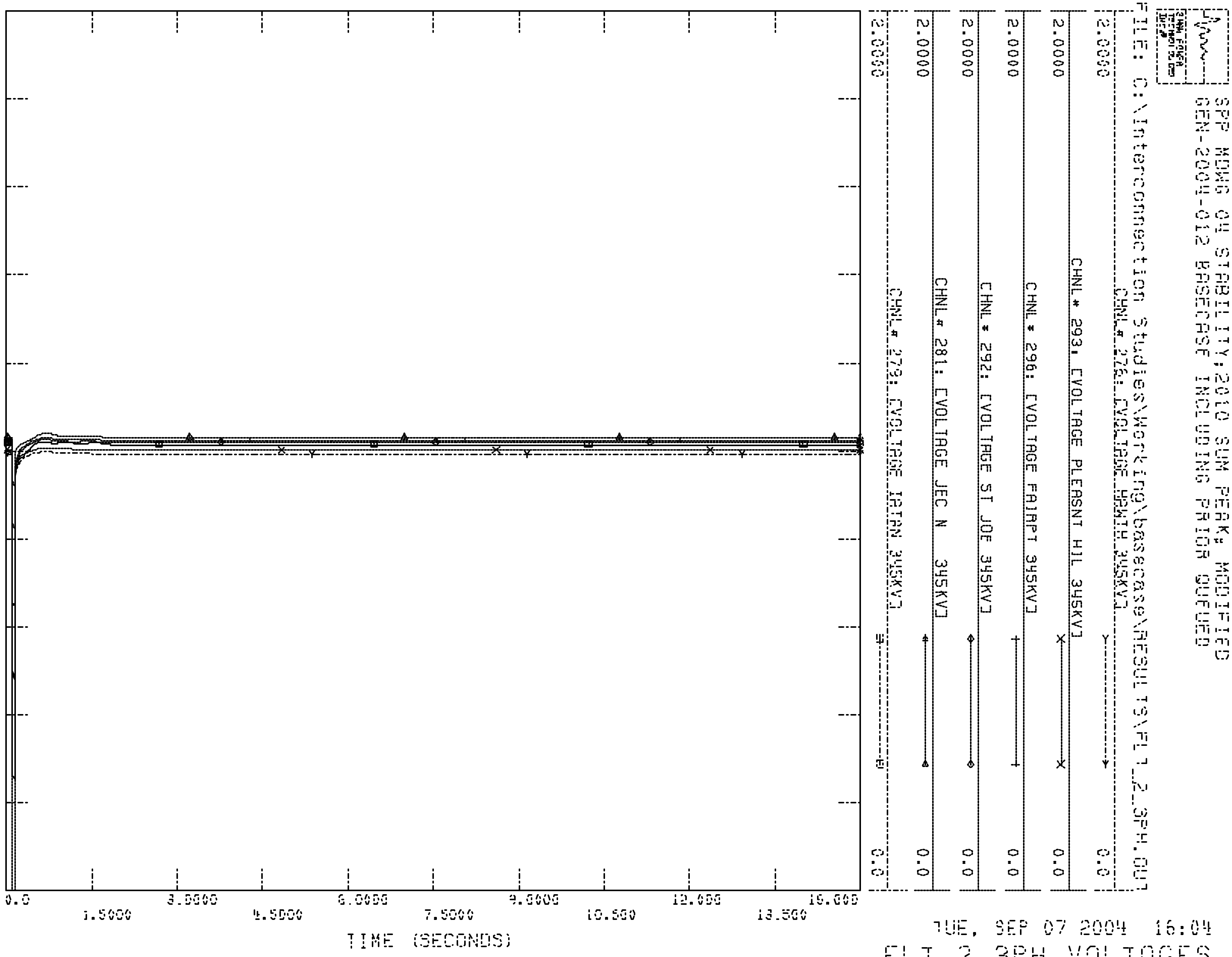

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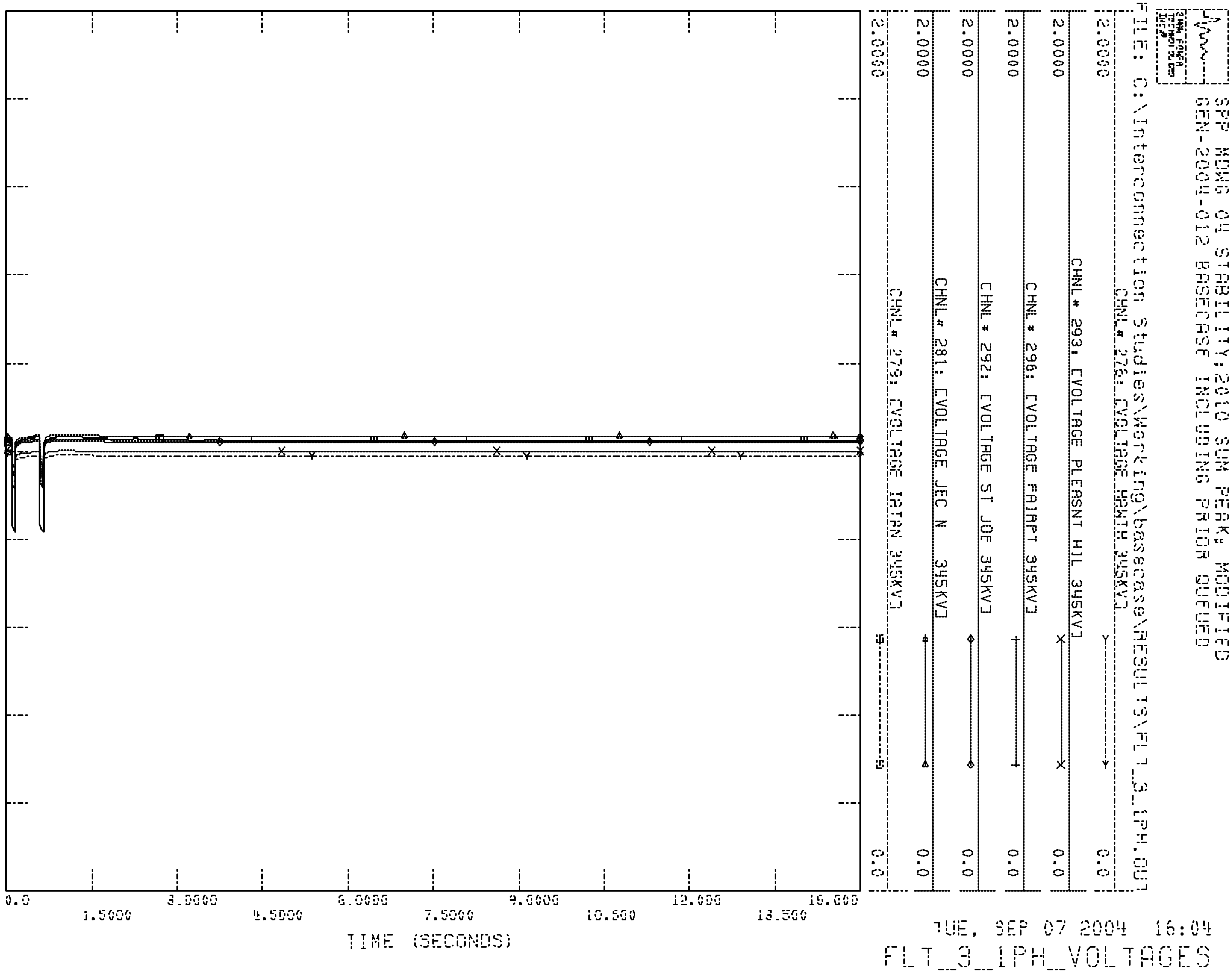
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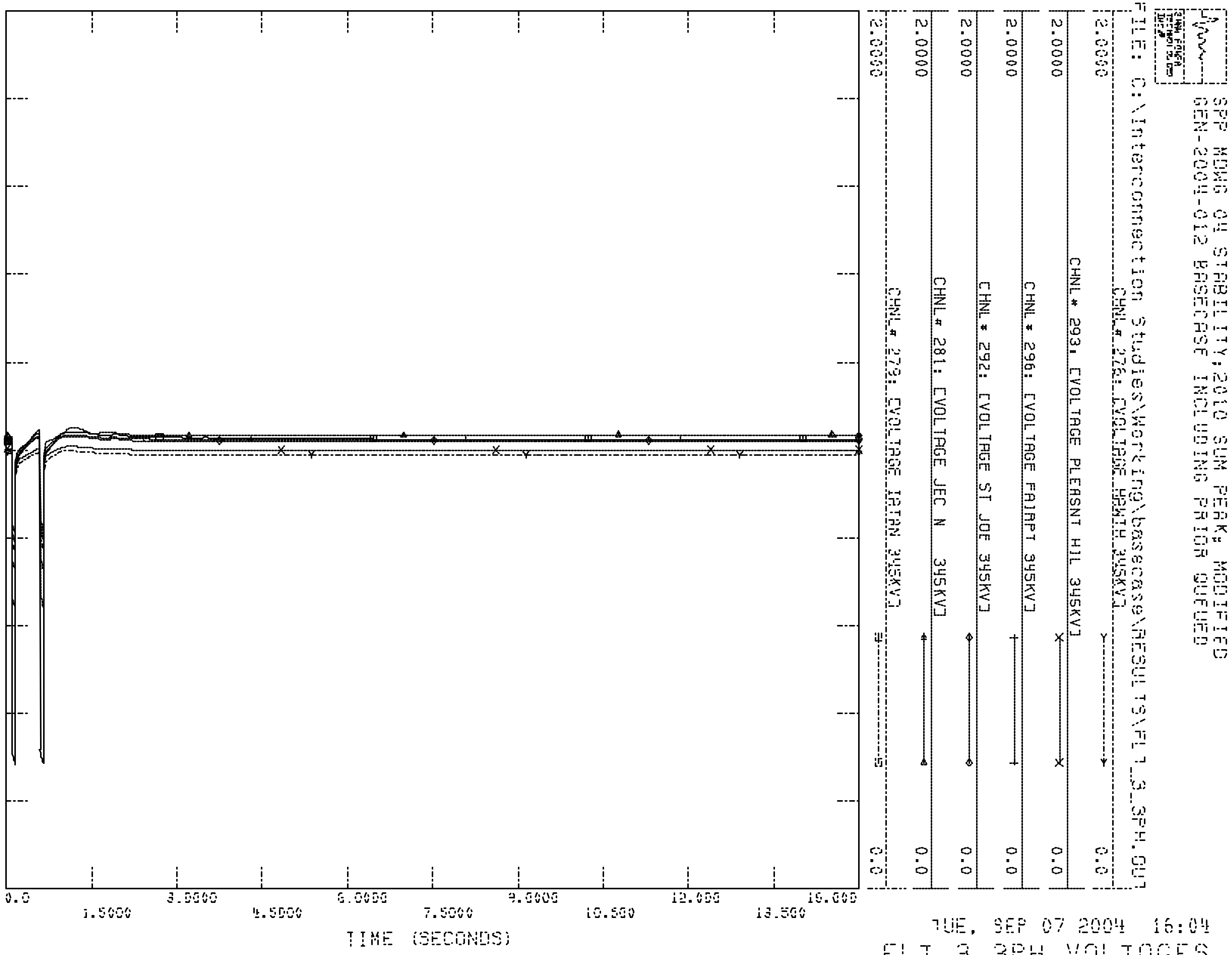

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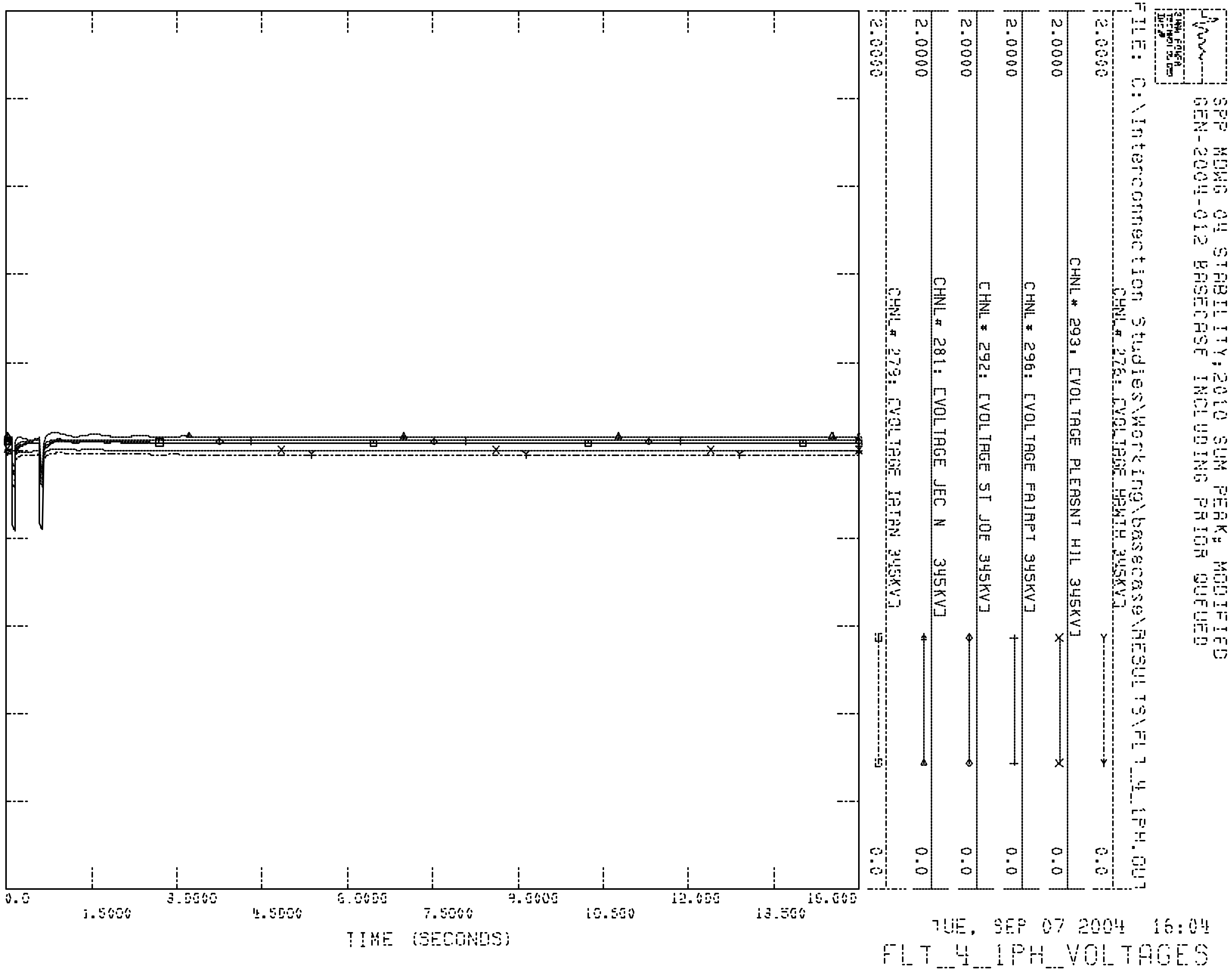
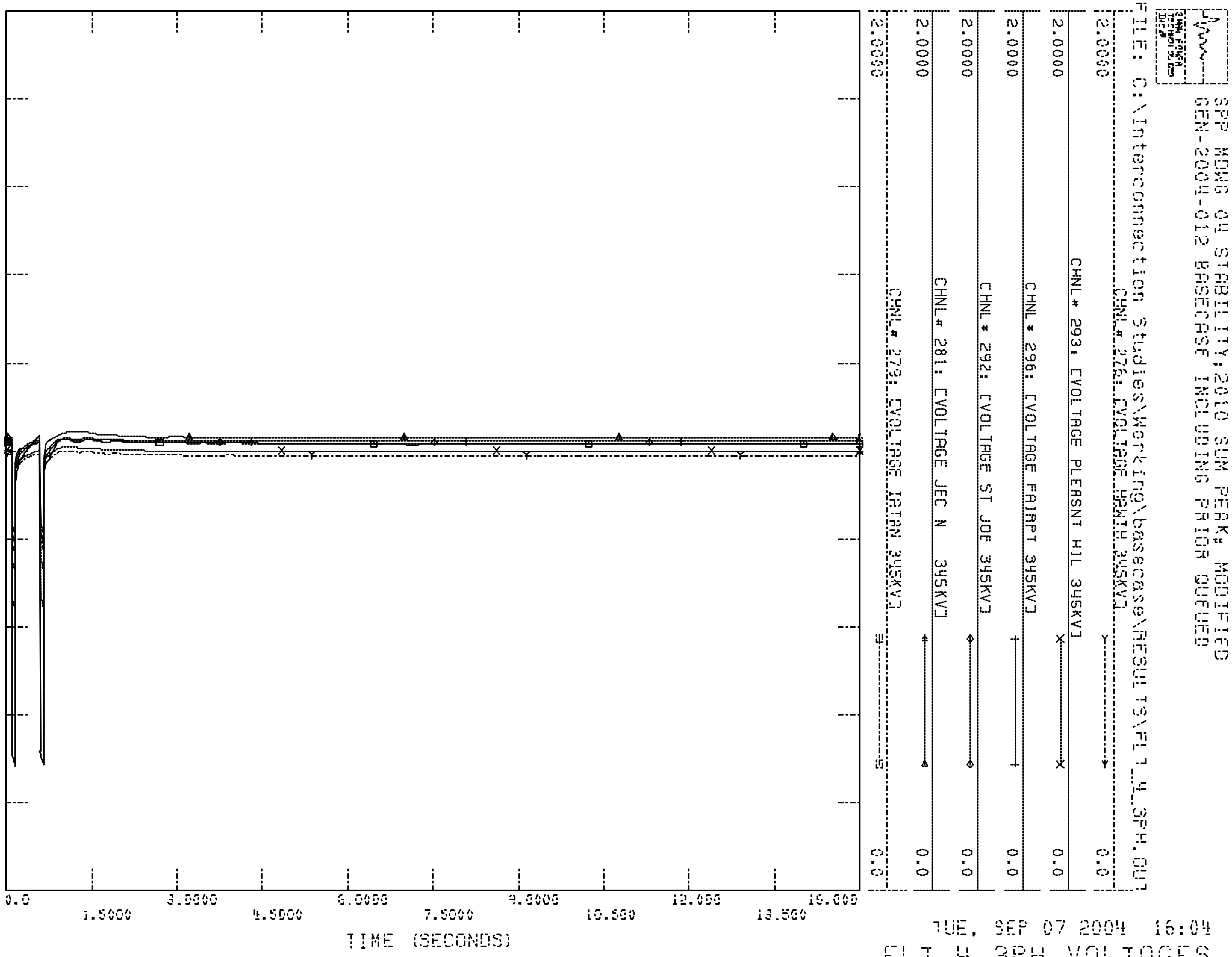
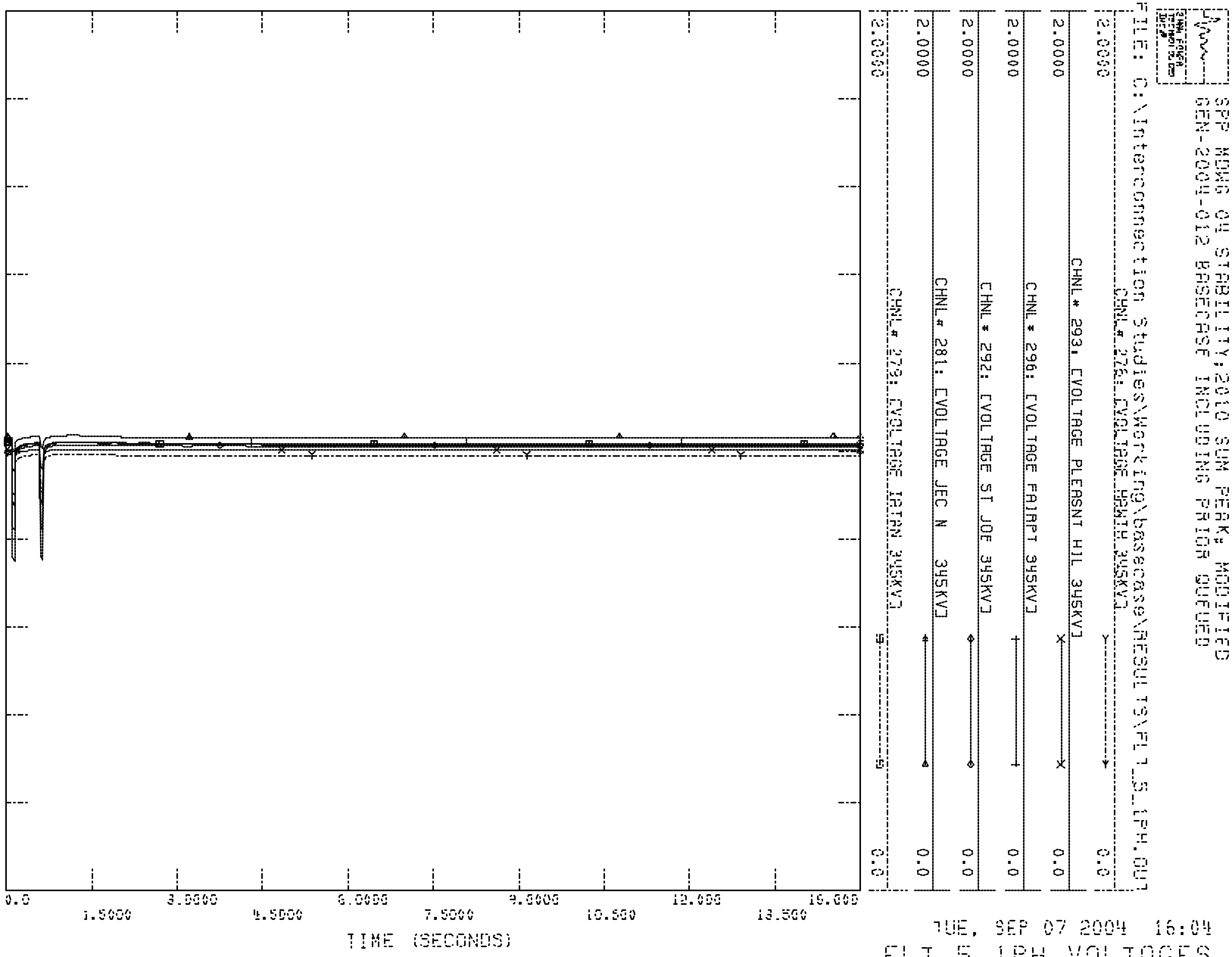
FLT_3_3PH_VOLTAGES


SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\basecase\RESULTS\FLT_4_1PH.OUT
CHNL# 276: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE IATAN 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, SEP 07 2004 16:04
FLT_4_1PH_VOLTAGES



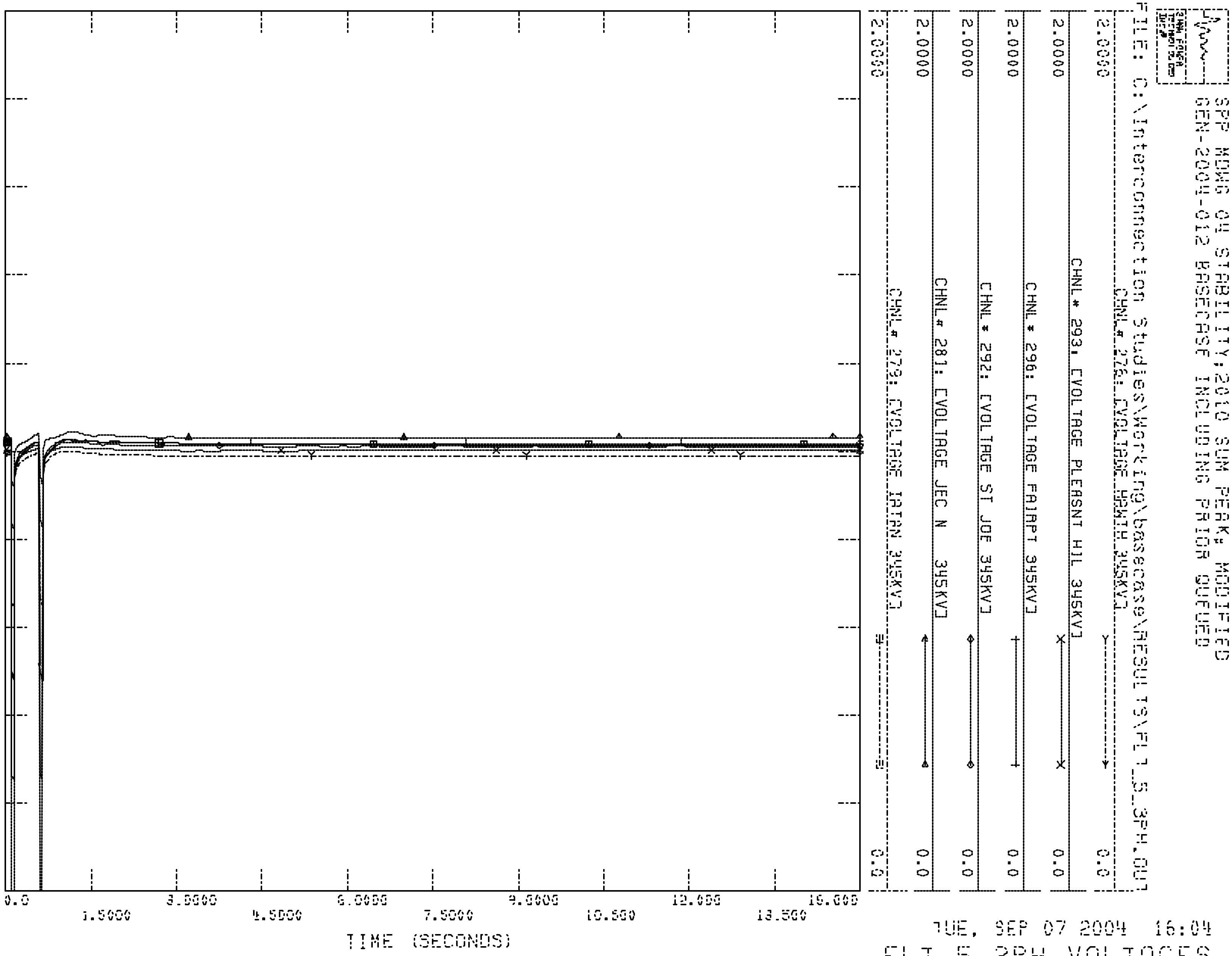
TUE, SEP 07 2004 16:04

FLT_4_3PH_VOLTAGES



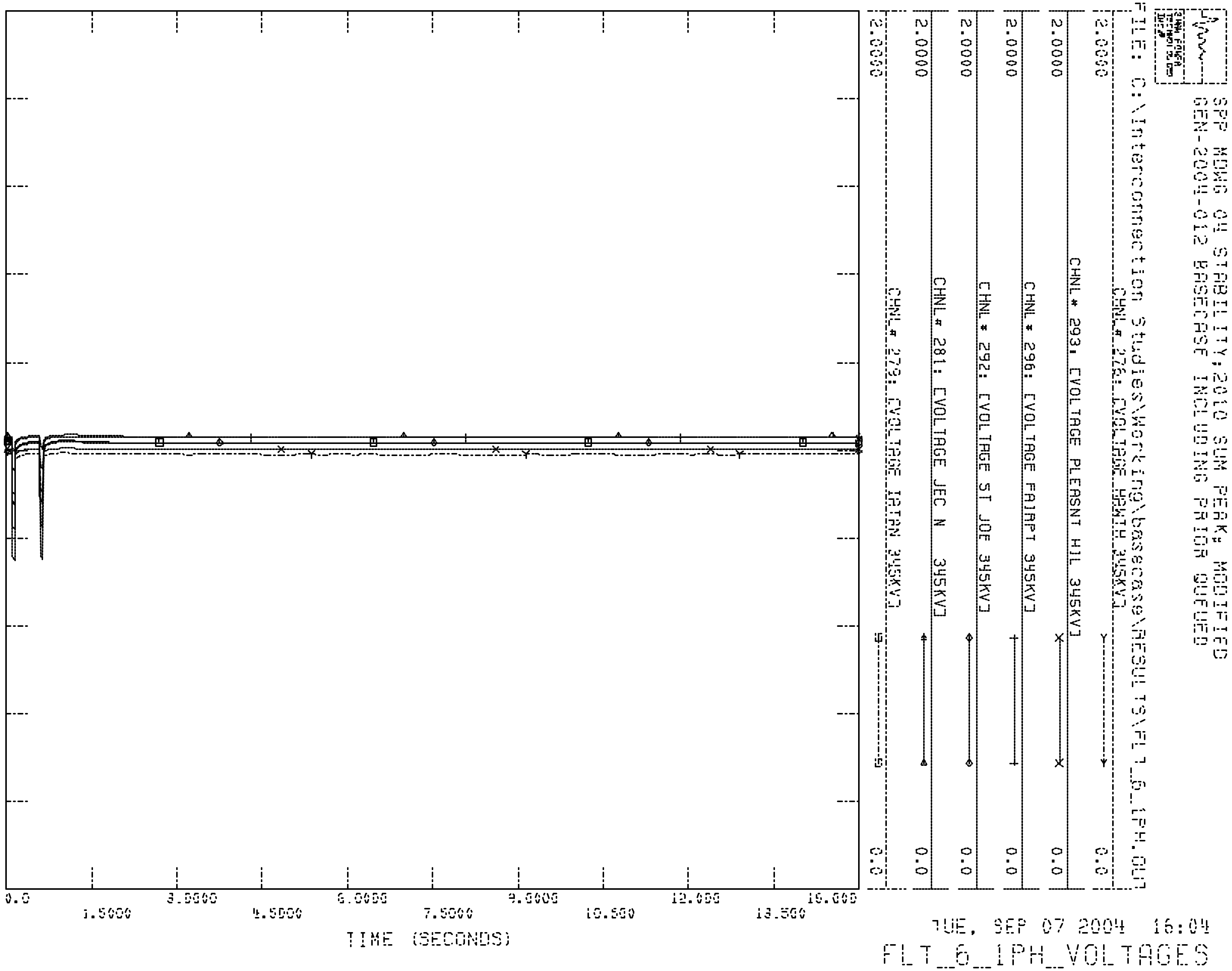
TUE, SEP 07 2004 16:04

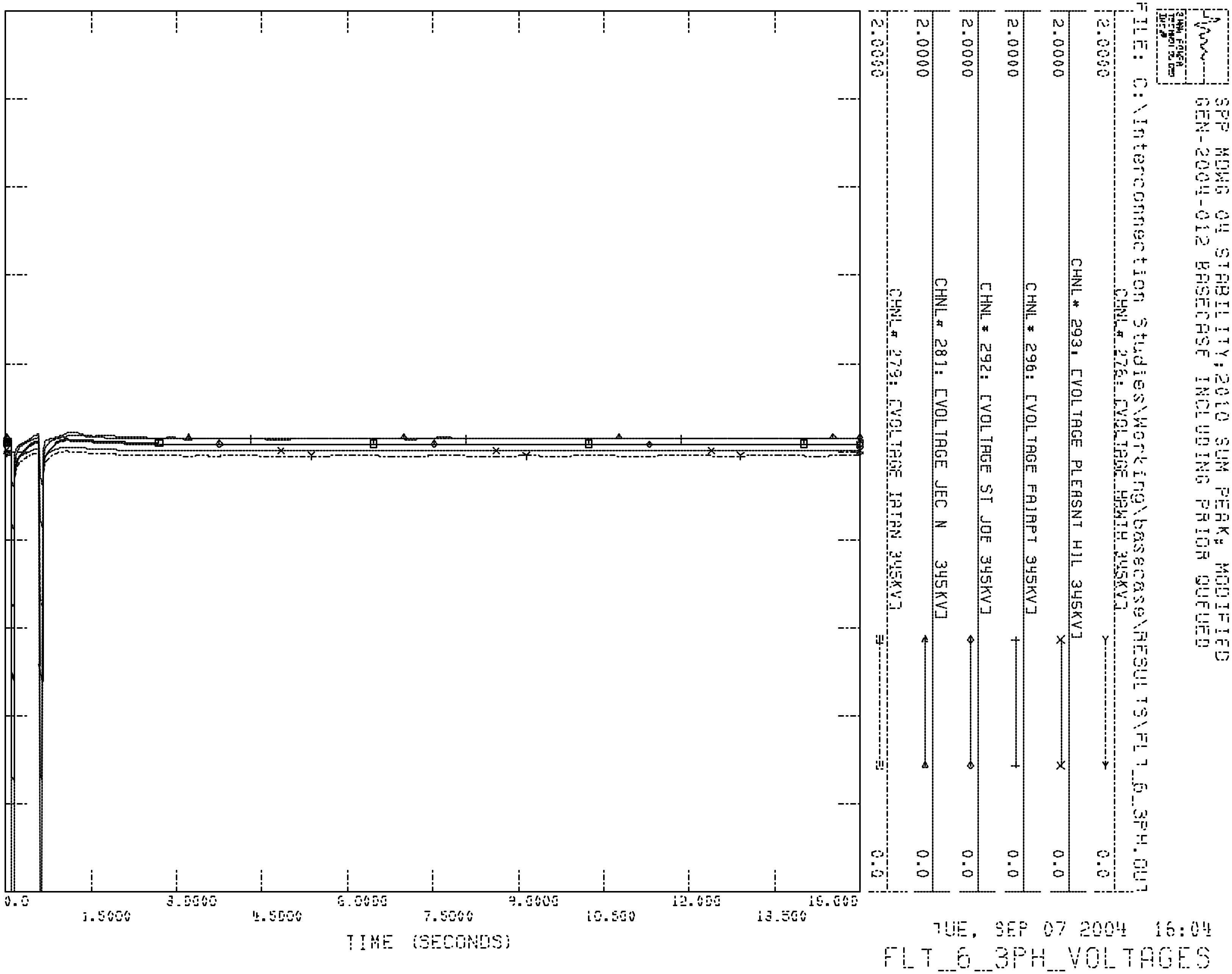
FLT_5_1PH_VOLTAGES

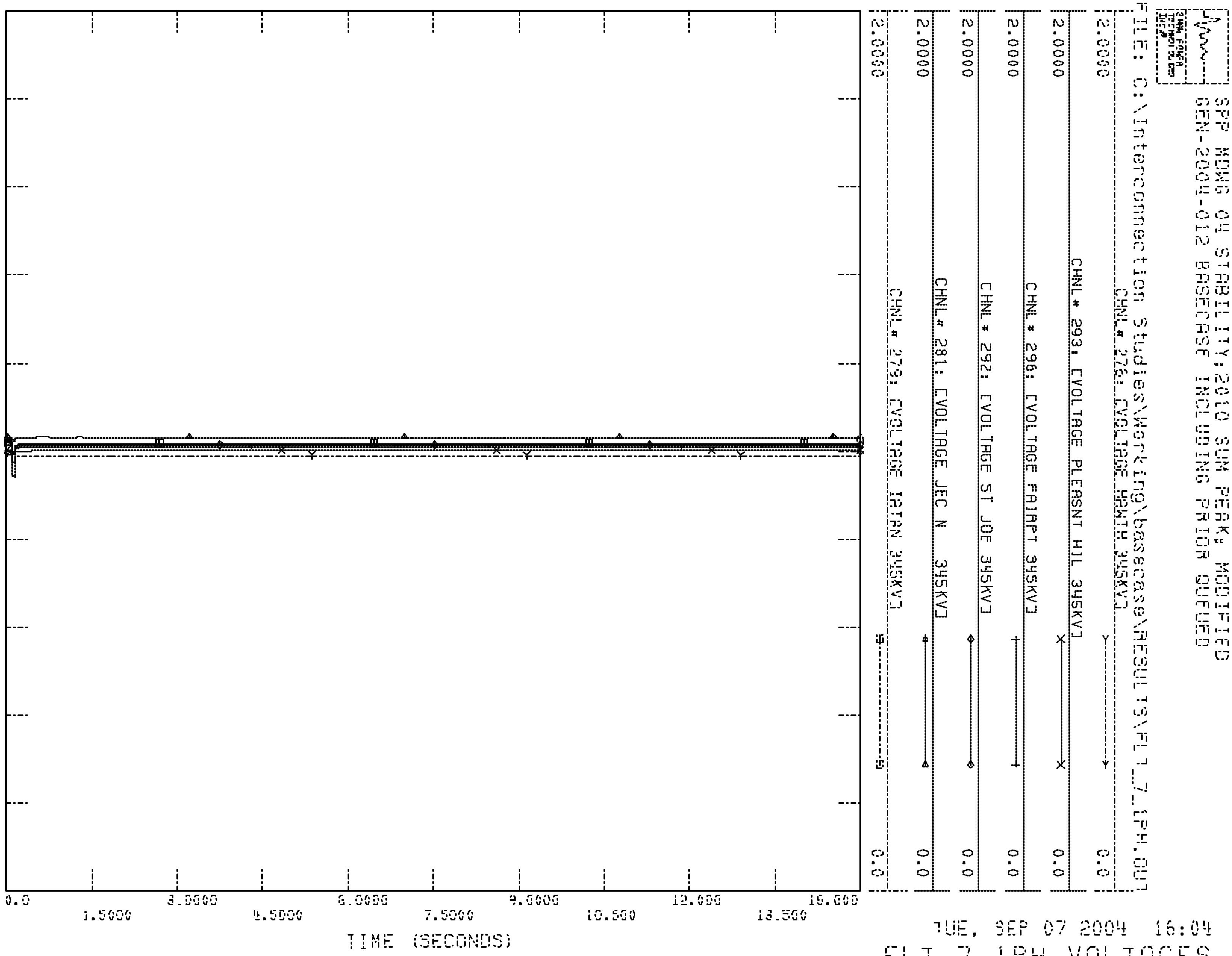


TUE, SEP 07 2004 16:04

FLT_5_3PH_VOLTAGES

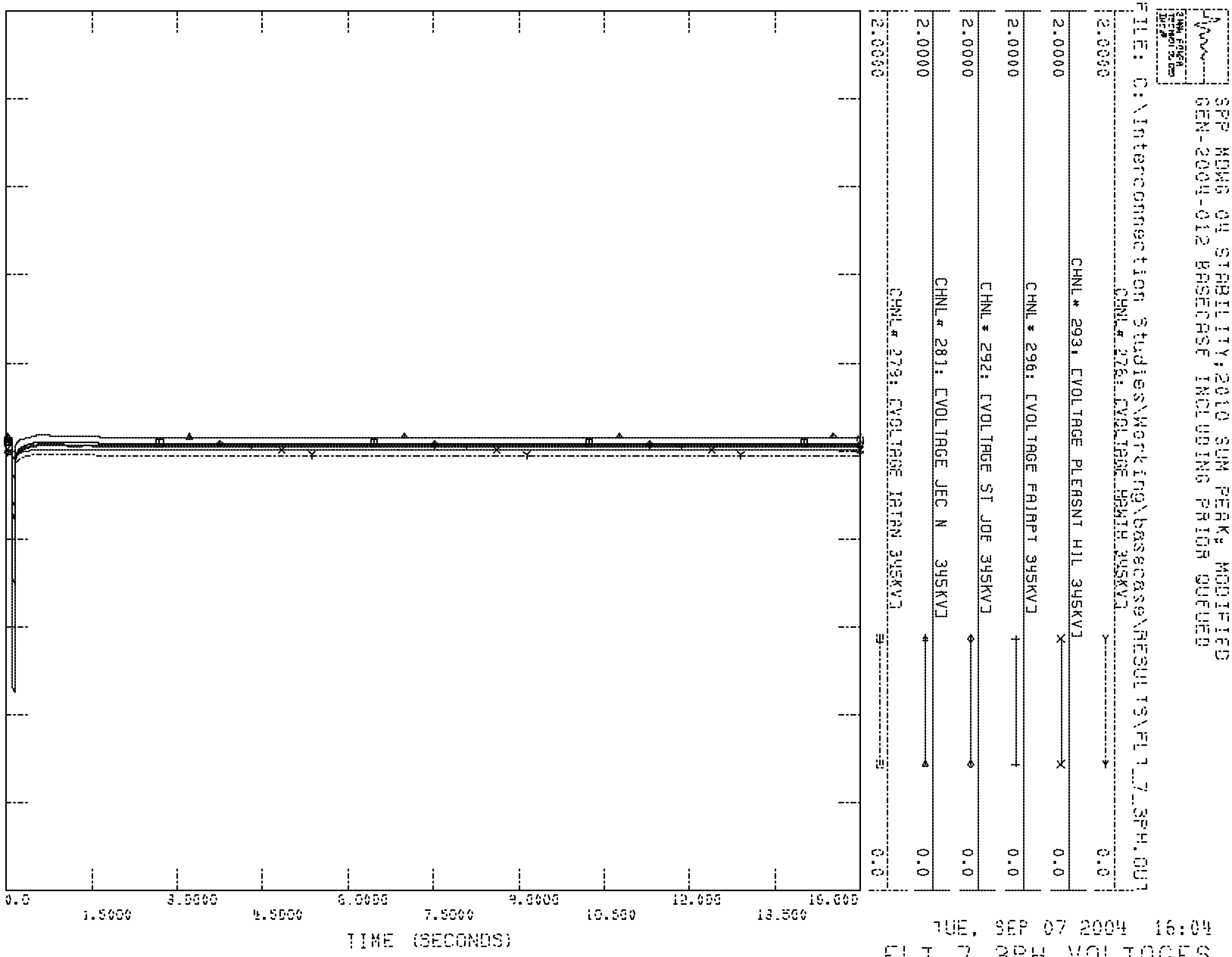

SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\basecase\RESULTS\FLT_6_1PH.OUT
CHNL# 276: [VOLTAGE WAKITA 345KV]
2.0000
0.0
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE IATAN 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, SEP 07 2004 16:04
FLT_6_1PH_VOLTAGES


SPP MDWG 04 STABILITY;2010 SUM PEAK, MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\basecase\RESULTS\FLT_6_3PH.OUT
CHNL # 276: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL # 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL # 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL # 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL # 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL # 279: [VOLTAGE IATAN 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, SEP 07 2004 16:04
FLT_6_3PH_VOLTAGES



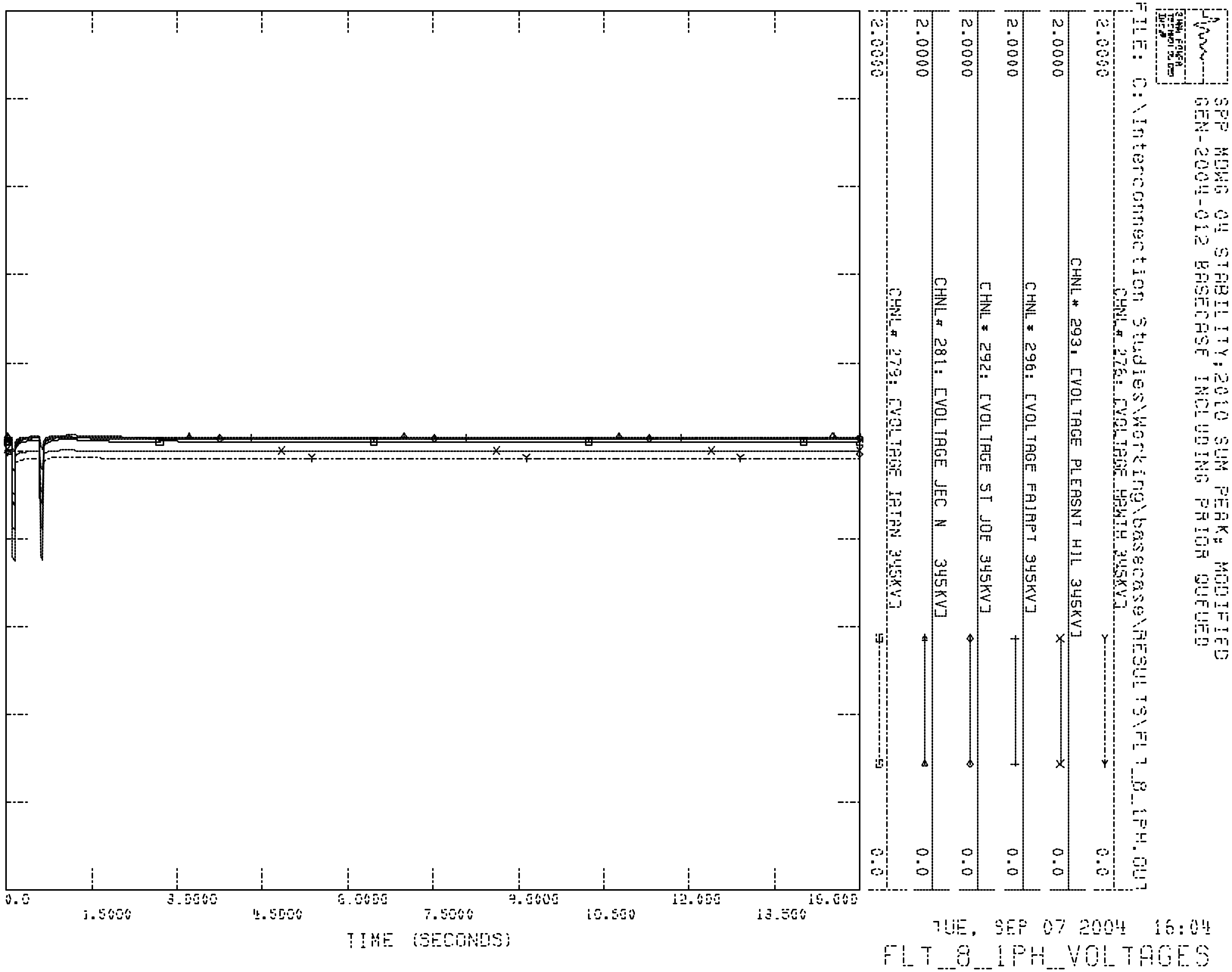
TUE, SEP 07 2004 16:04

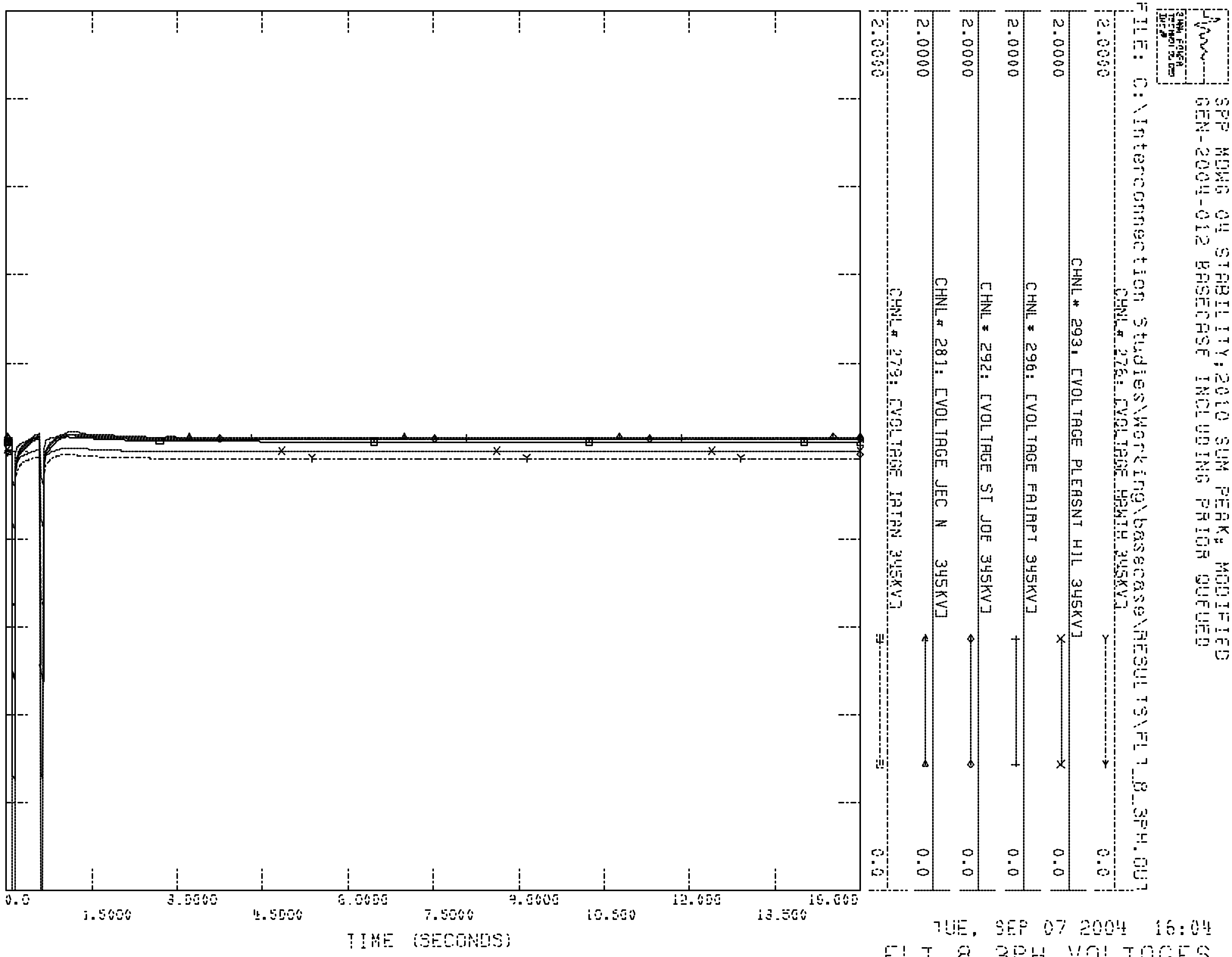
FLT_7_1PH_VOLTAGES



TUE, SEP 07 2004 16:04

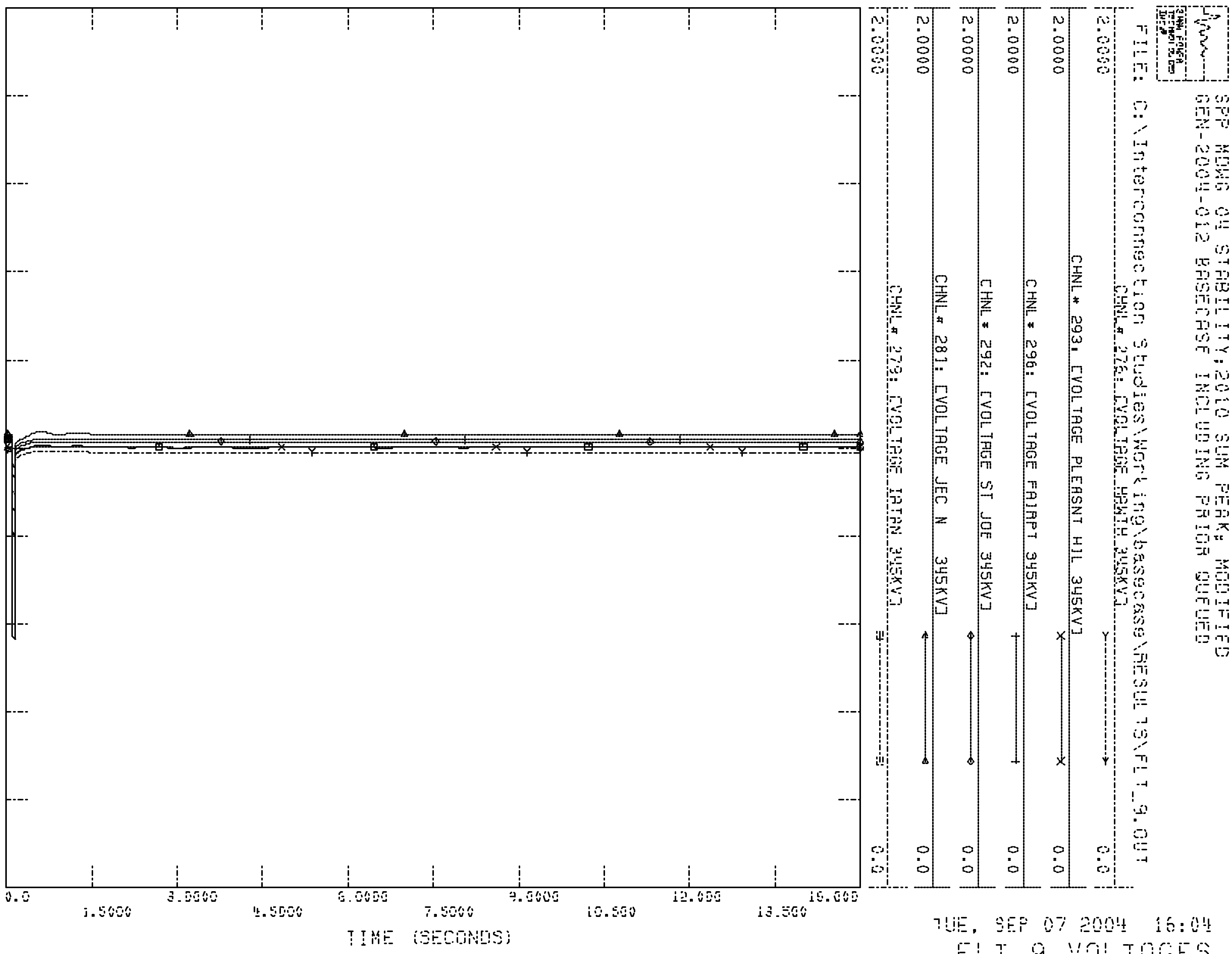
FLT_7_3PH_VOLTAGES


SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-012 BASECASE INCLUDING PRIOR QUEUED
FILE: C:\Interconnection Studies\Working\basecase\RESULTS\FLT_8_1PH.OUT
CHNL # 276: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL # 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL # 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL # 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL # 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL # 279: [VOLTAGE IATAN 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, SEP 07 2004 16:04
FLT_8_1PH_VOLTAGES



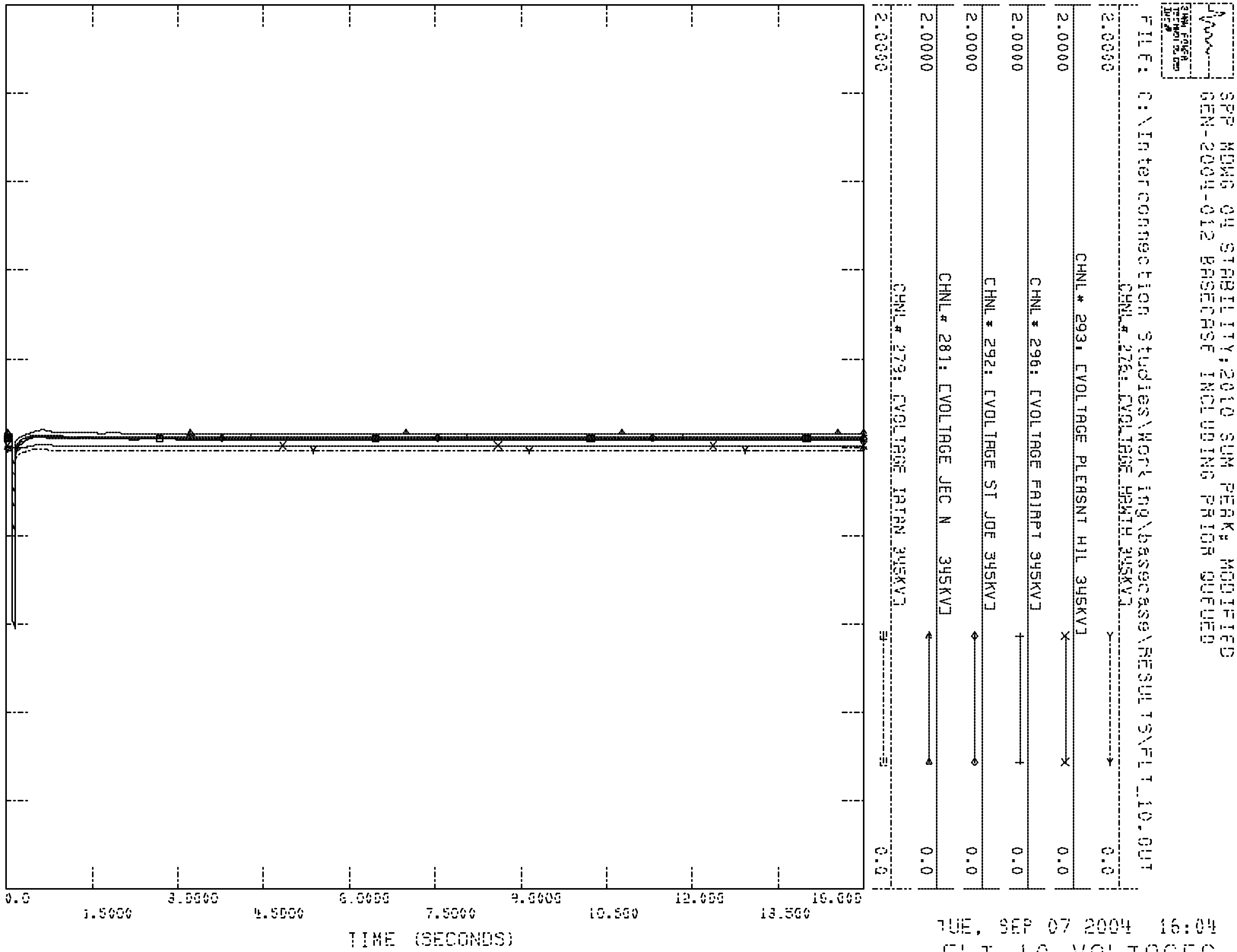
TUE, SEP 07 2004 16:04

FLT_8_3PH_VOLTAGES



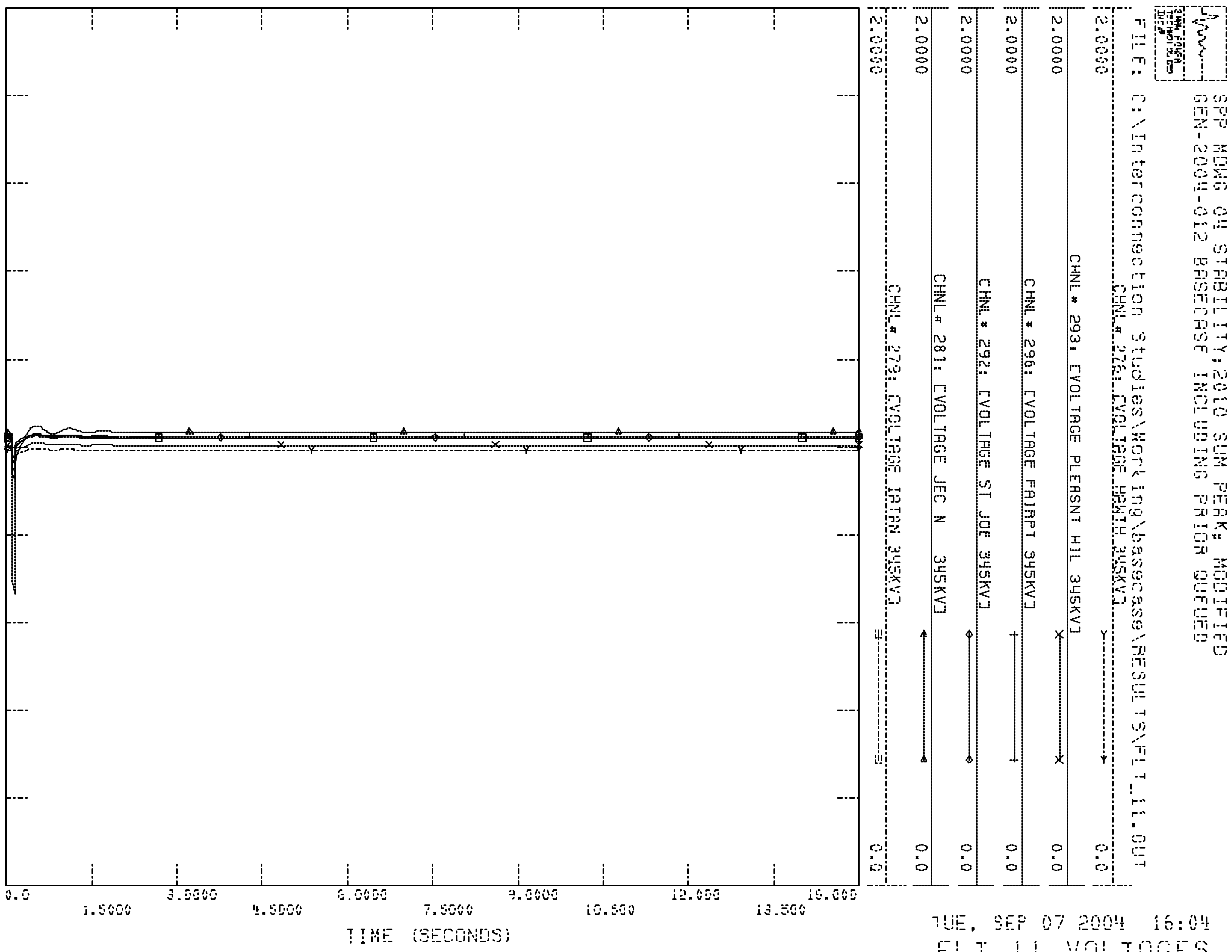
TUE, SEP 07 2004 16:04

FLT_9_VOLTAGES



TUE, SEP 07 2004 16:04

FLT_10_VOLTAGES



TUE, SEP 07 2004 16:04

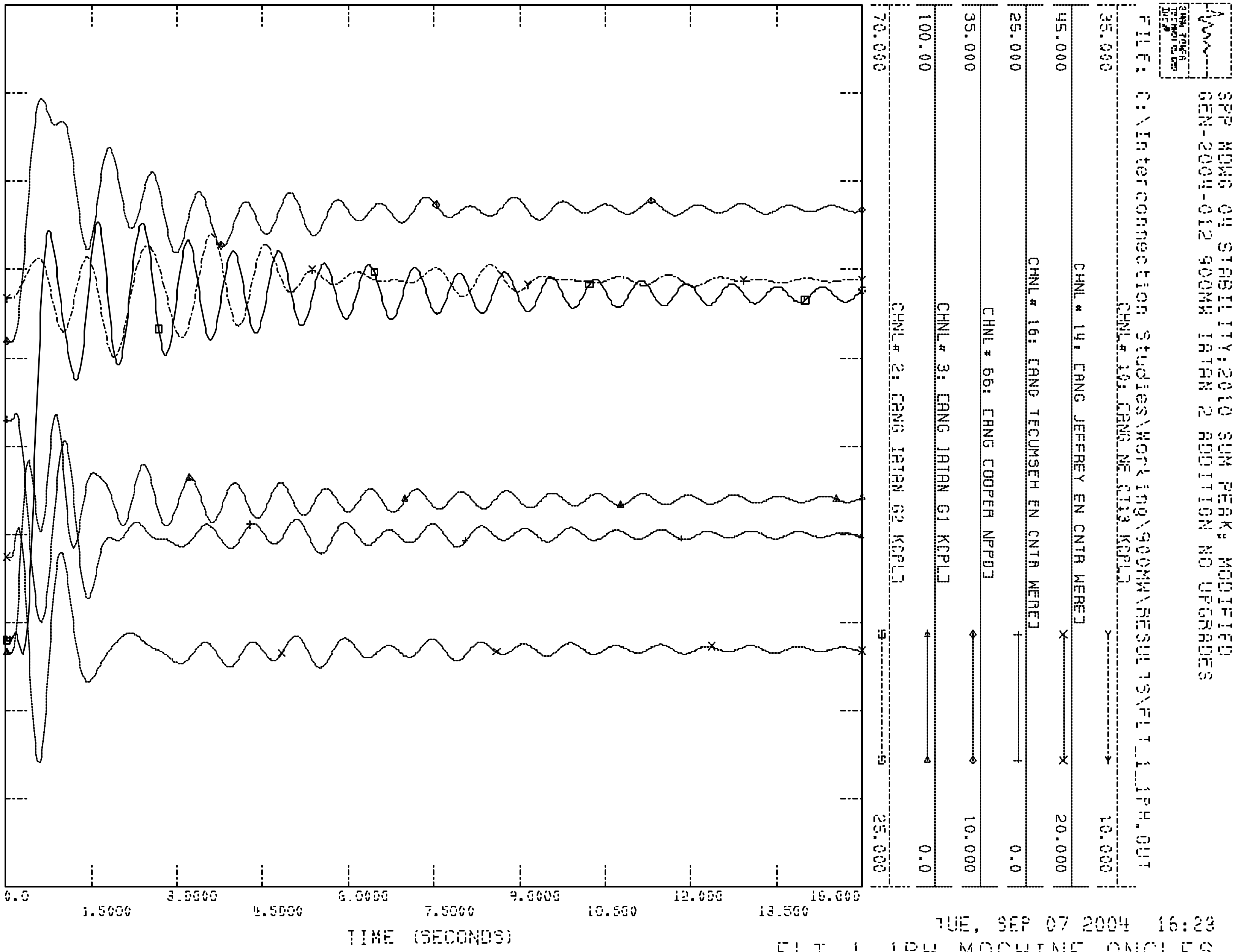
FLT_11_VOLTAGES

Appendix B-1

Plots of Fault Simulations

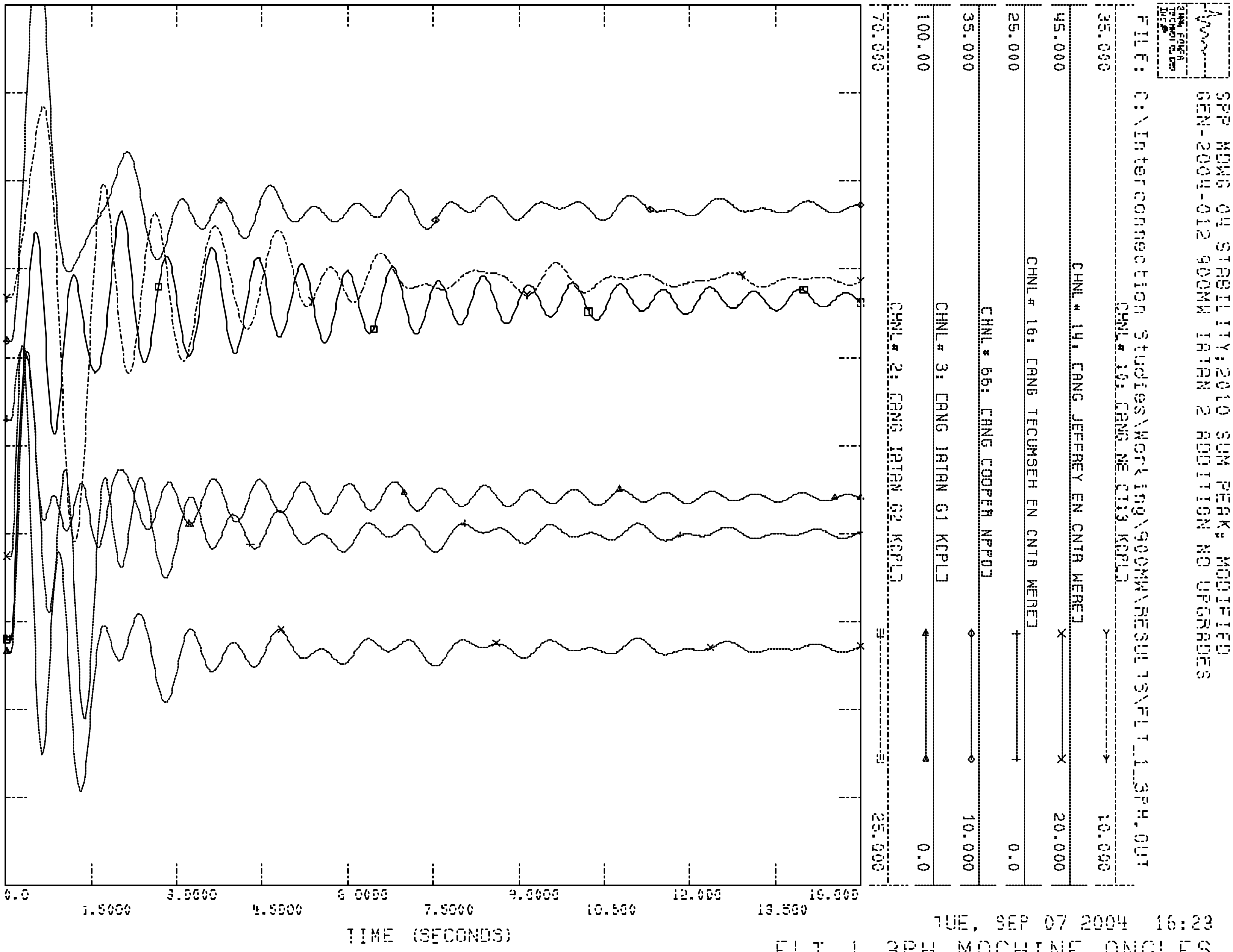
Plots of selected machine angle response during faults

Scenario:
2010 Summer Peak
900MW
[Customer Plant at 900MW – No Network upgrades]



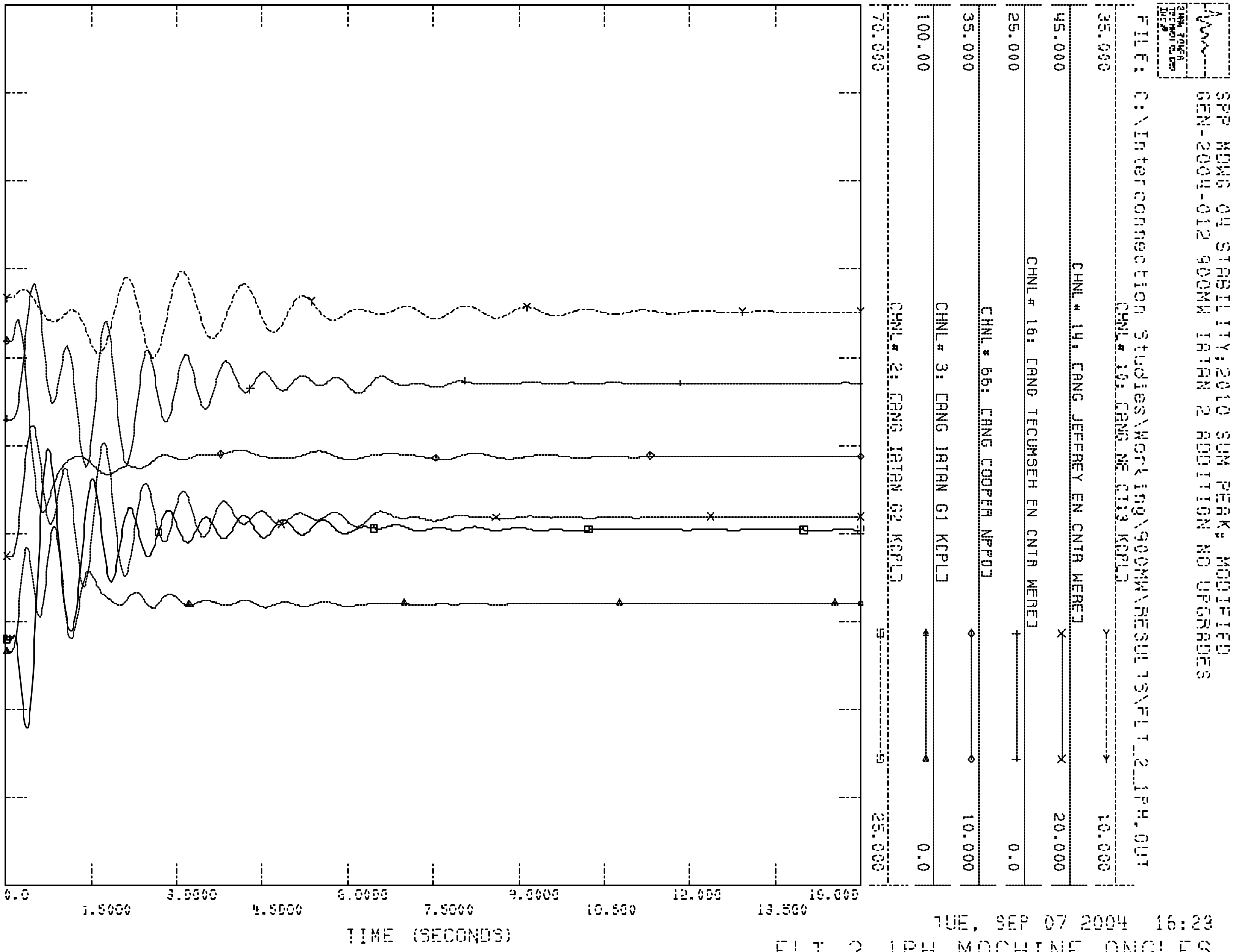
TUE, SEP 07 2004 16:23

FLT_1_1PH_MACHINE ANGLES



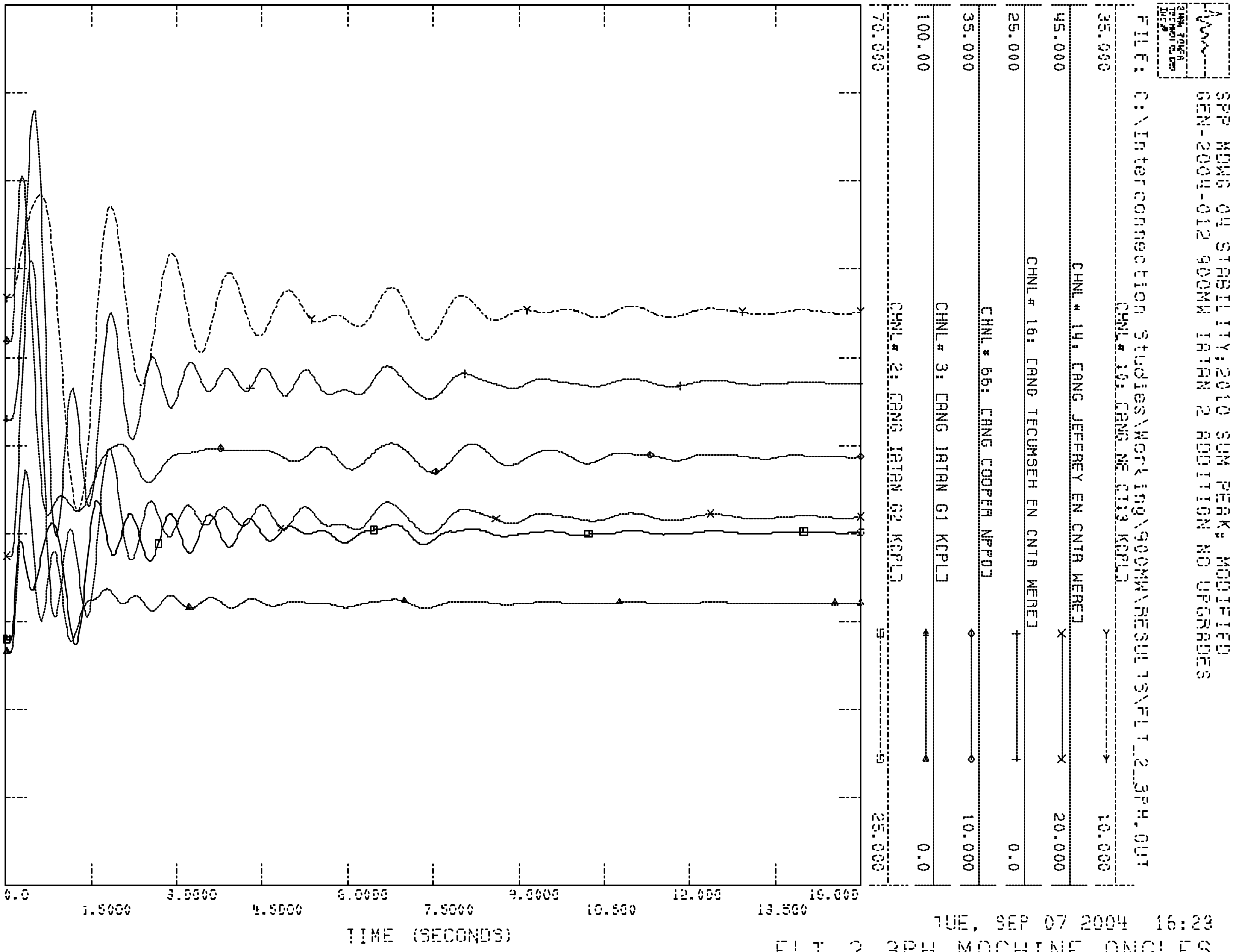
TUE, SEP 07 2004 16:23

FLT_1_3PH_MACHINE ANGLES



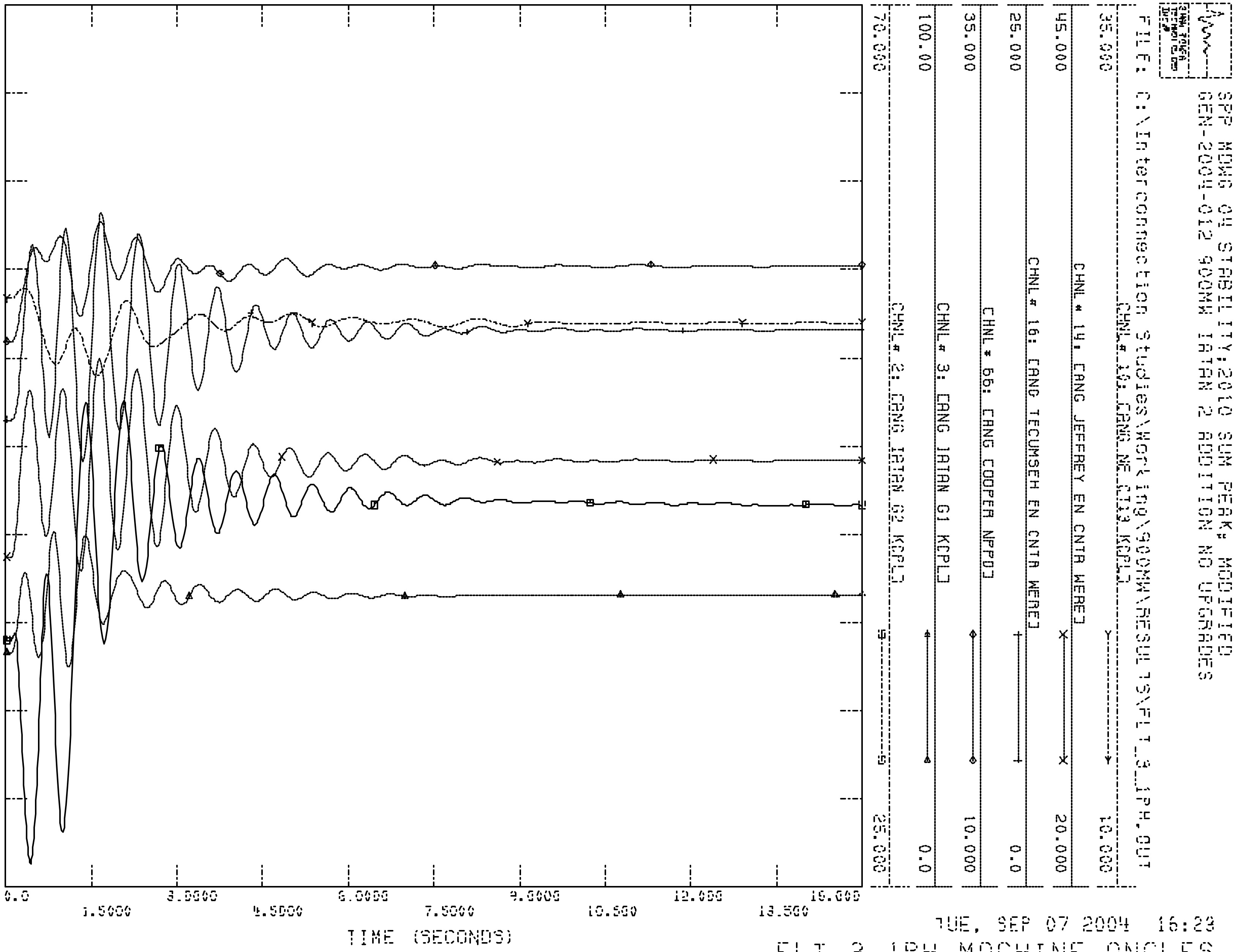
TUE, SEP 07 2004 16:23

FLT_2_1PH_MACHINE ANGLES



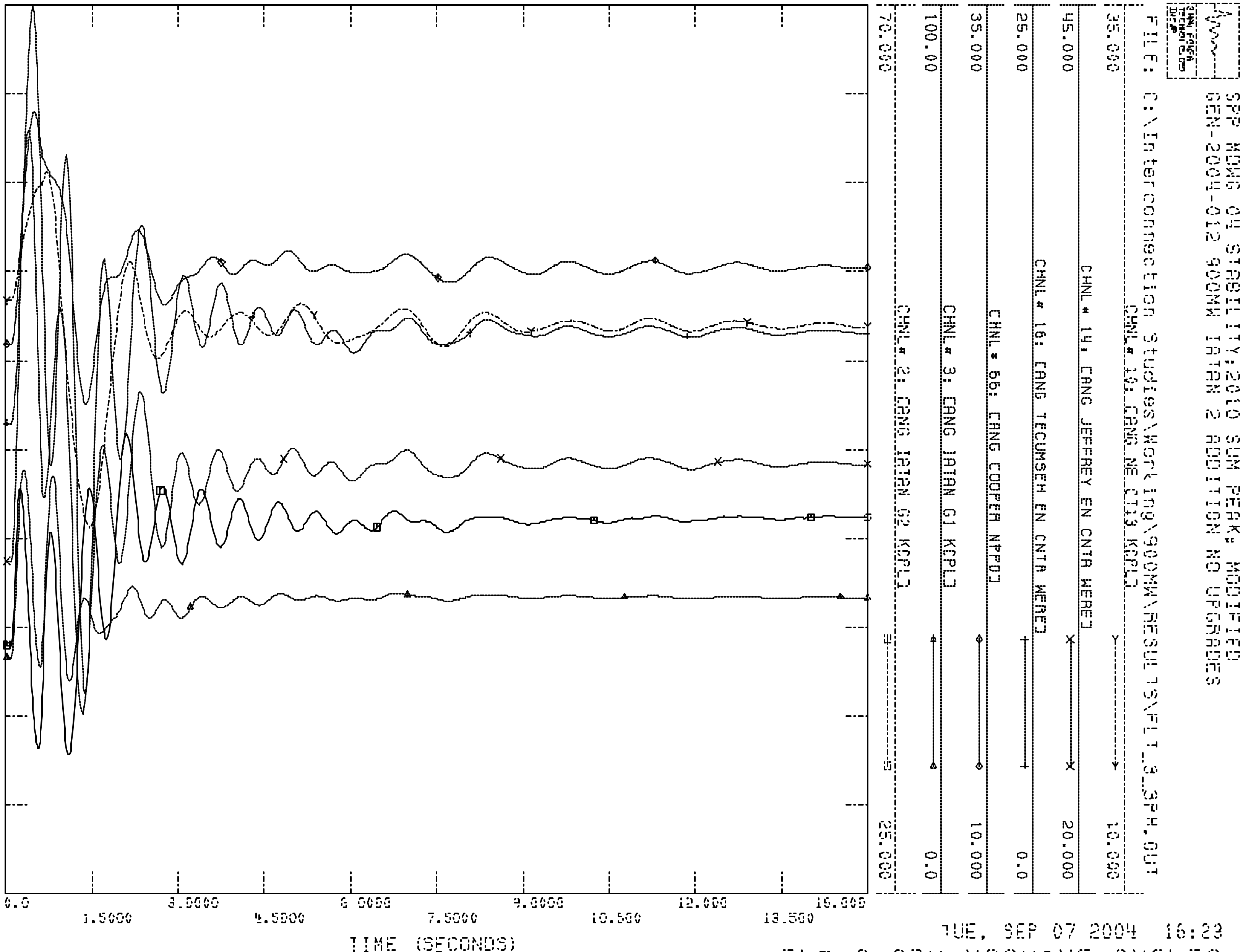
TUE, SEP 07 2004 16:23

FLT_2_3PH_MACHINE ANGLES



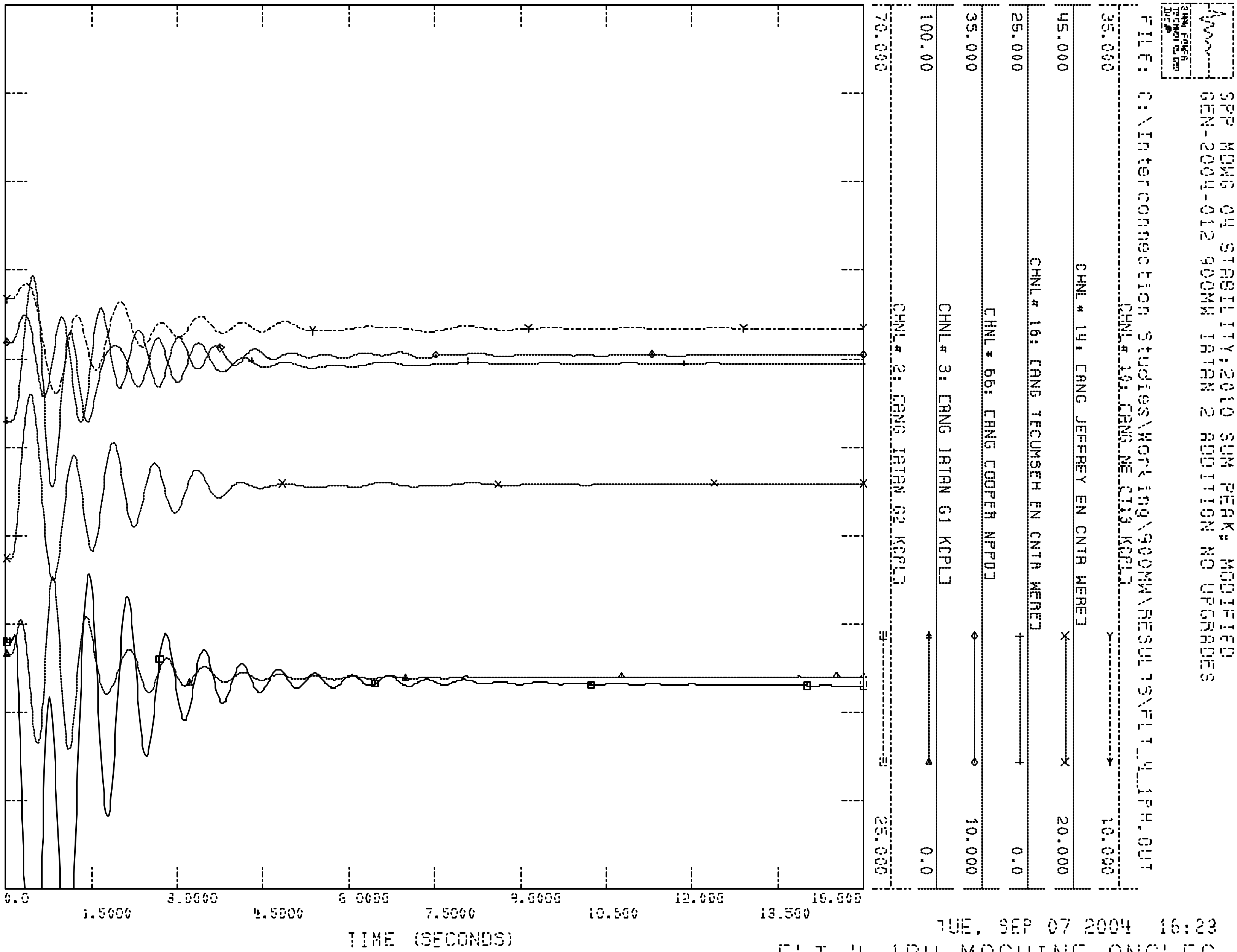
TUE, SEP 07 2004 16:23

FLT_3_1PH_MACHINE ANGLES



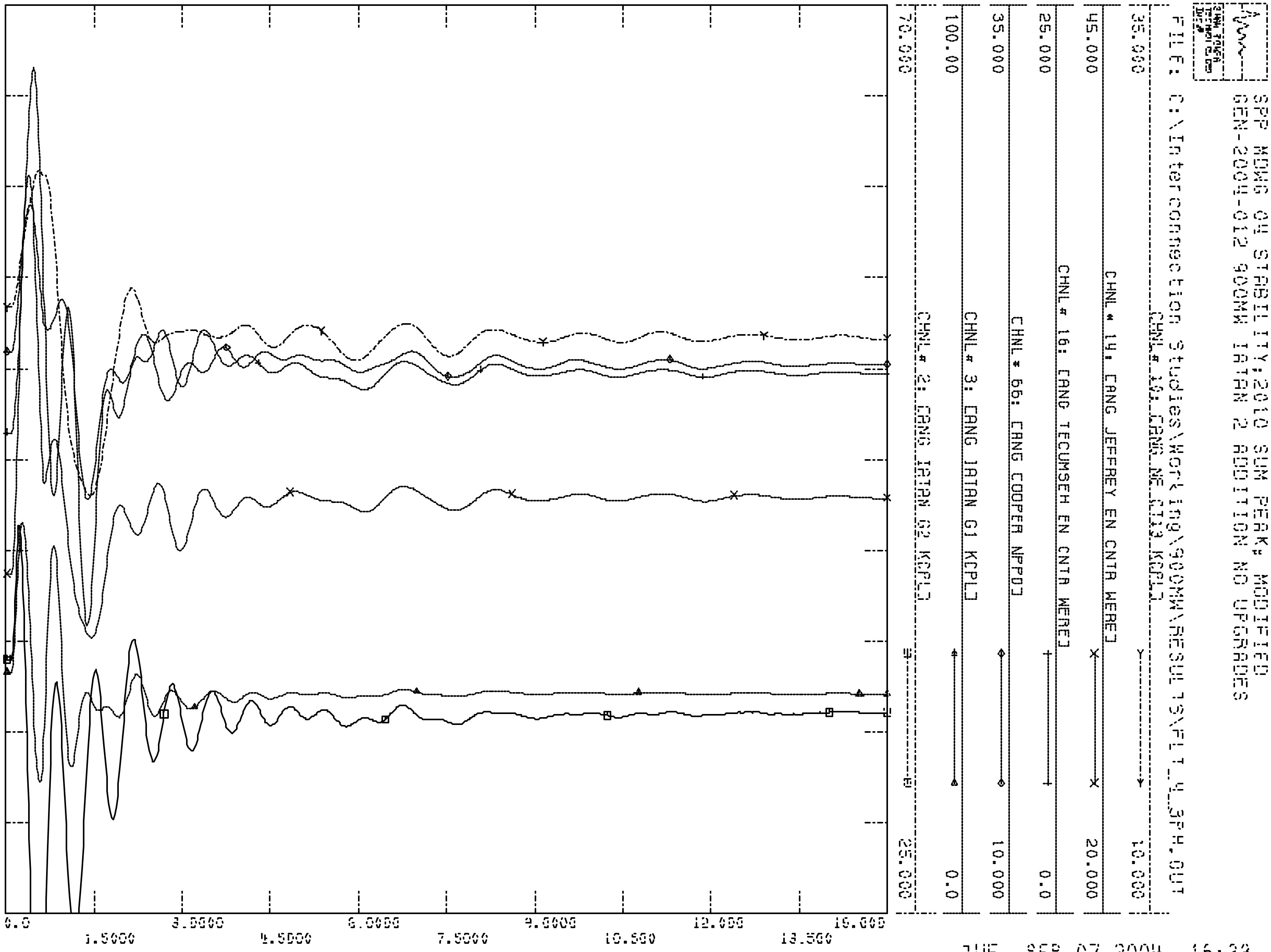
TUE, SEP 07 2004 16:23

FLT_3_3PH_MACHINE ANGLES



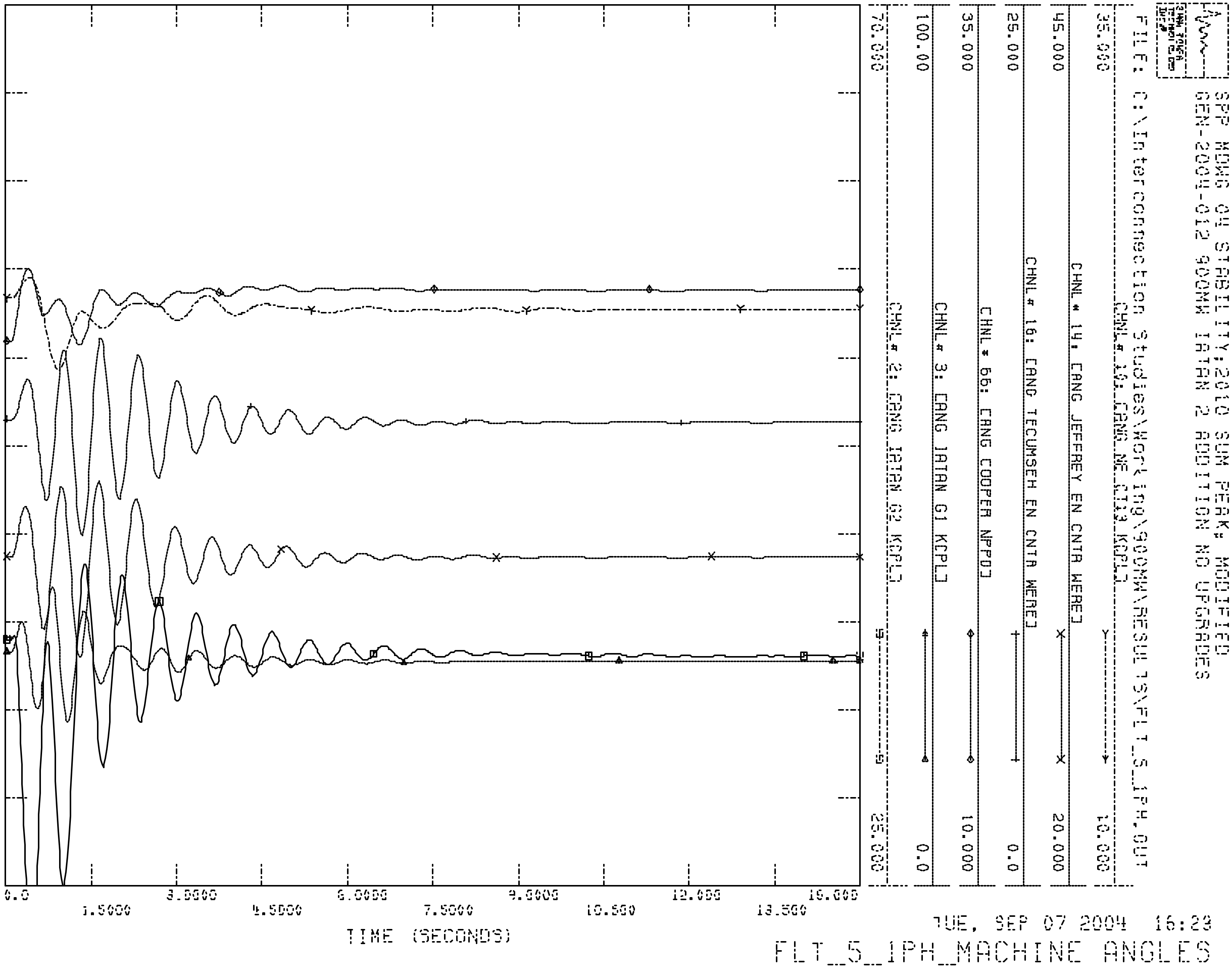
TUE, SEP 07 2004 16:23

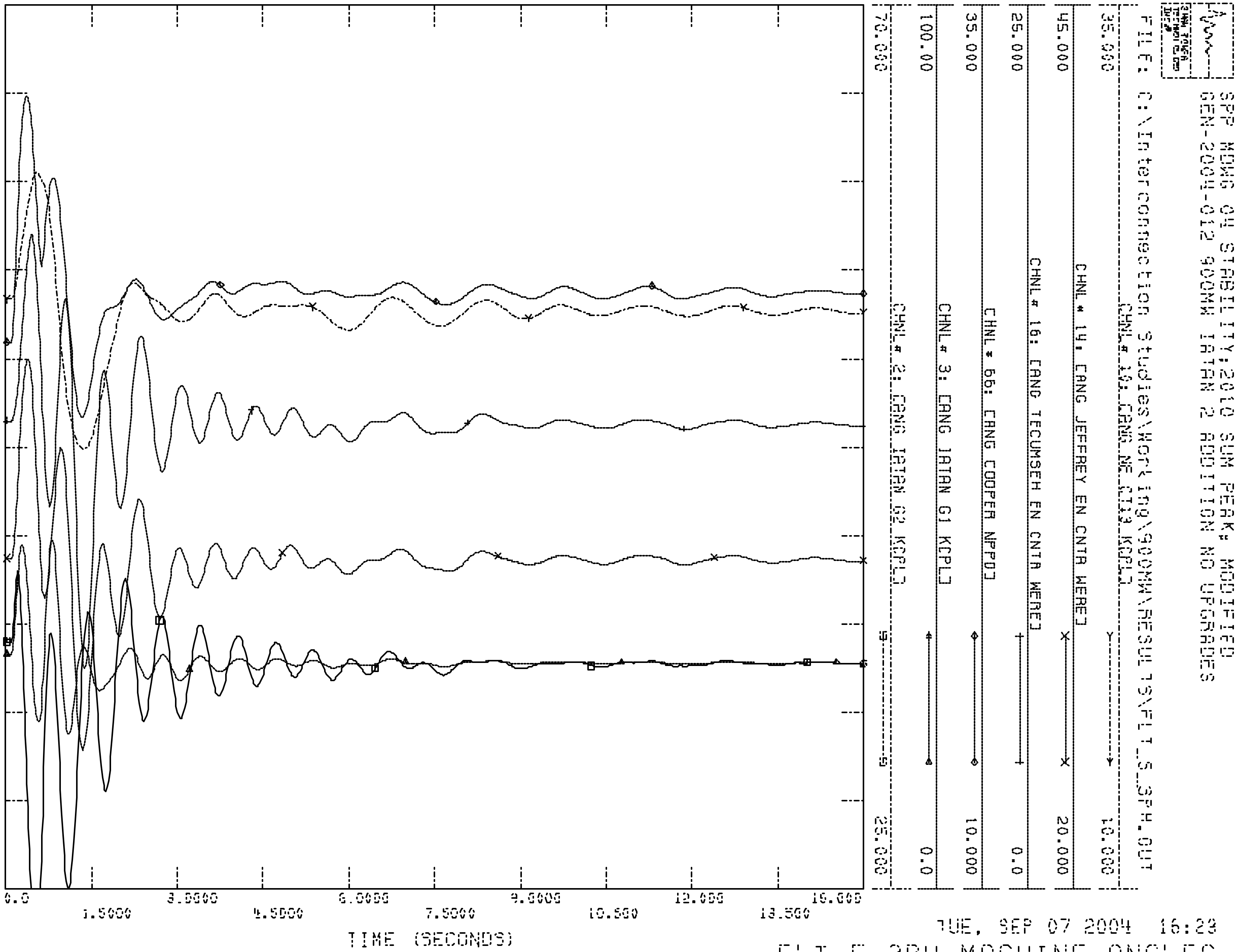
FLT_4_1PH_MACHINE ANGLES



TUE, SEP 07 2004 16:23

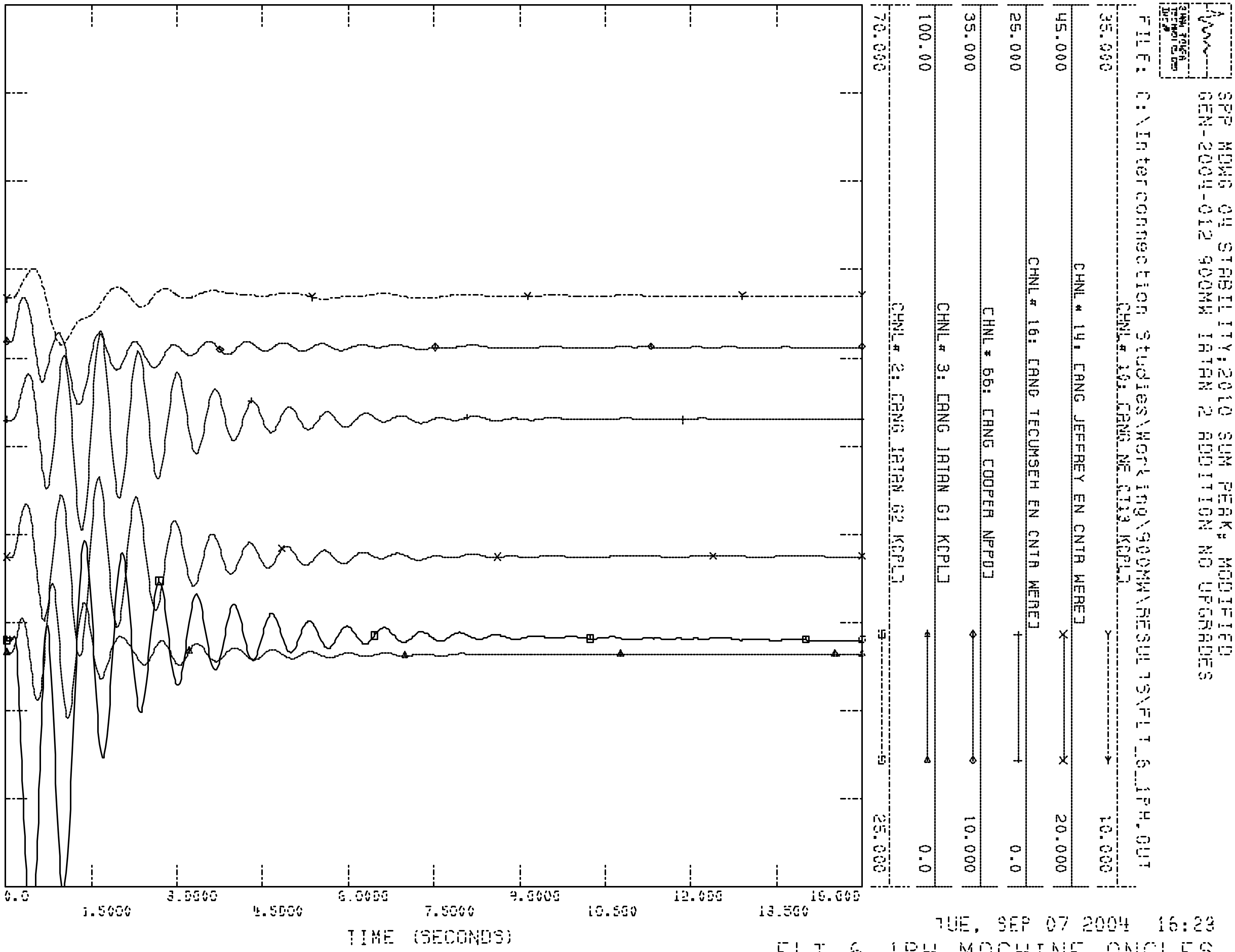
FLT_4_3PH_MACHINE ANGLES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW IATAN 2 ADDITION NO UPGRADES
FILE: C:\Interconnection Studies\Working\900MW\RESULTS\FLT_5_1PH.OUT
CHNL# 10: CANG NE C13 KCPL
35.000
10.000
CHNL# 14: CANG JEFFREY EN CNTR WERE]
45.000
20.000
CHNL# 16: CANG TECUMSEH EN CNTR WERE]
25.000
0.0
CHNL# 66: CANG COOPER NPPD]
35.000
10.000
CHNL# 3: CANG IATAN G1 KCPL]
100.00
0.0
CHNL# 2: CANG IATAN G2 KCPL]
70.000
25.000
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, SEP 07 2004 16:23
FLT_5_1PH_MACHINE ANGLES

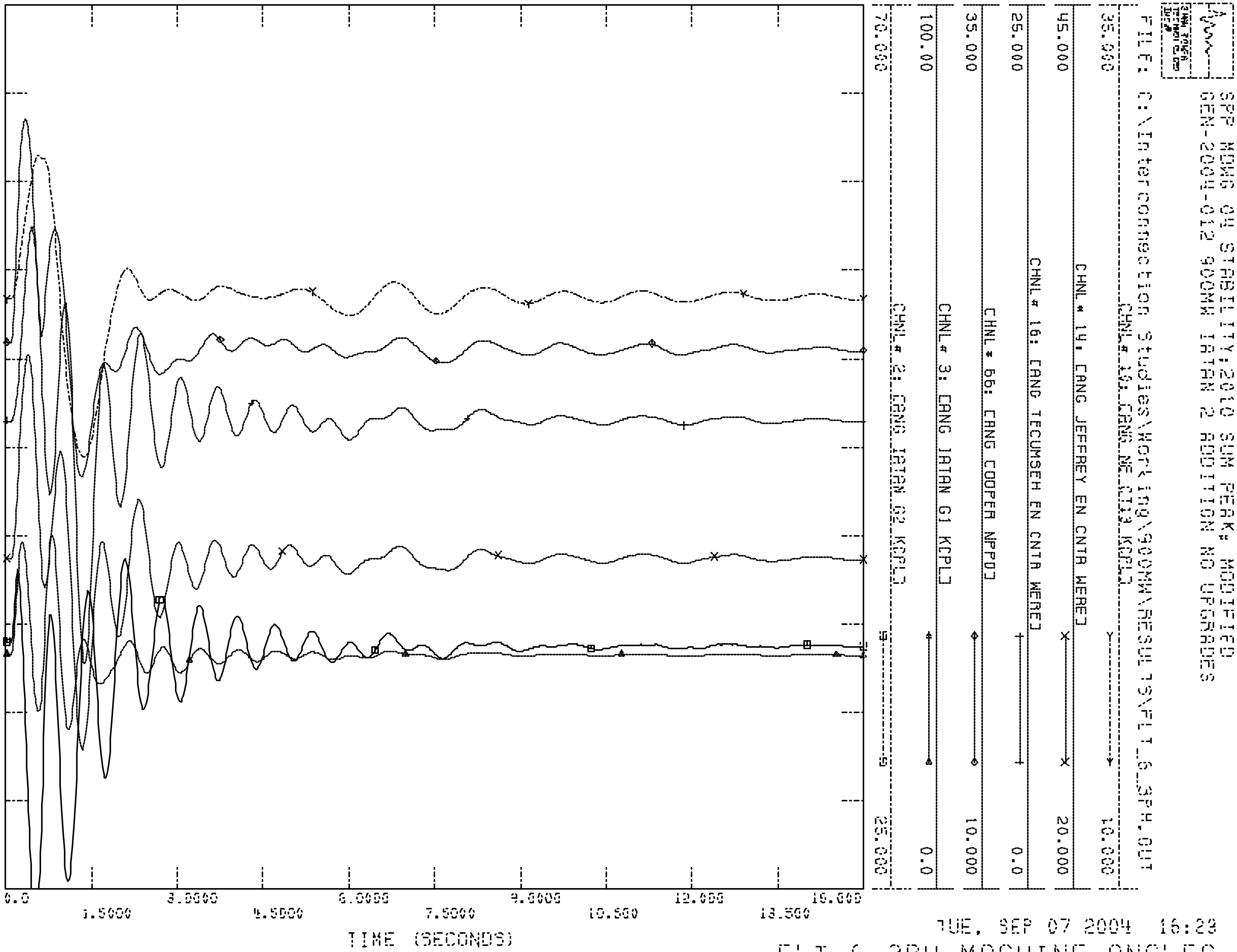


TUE, SEP 07 2004 16:23

FLT_5_3PH_MACHINE ANGLES

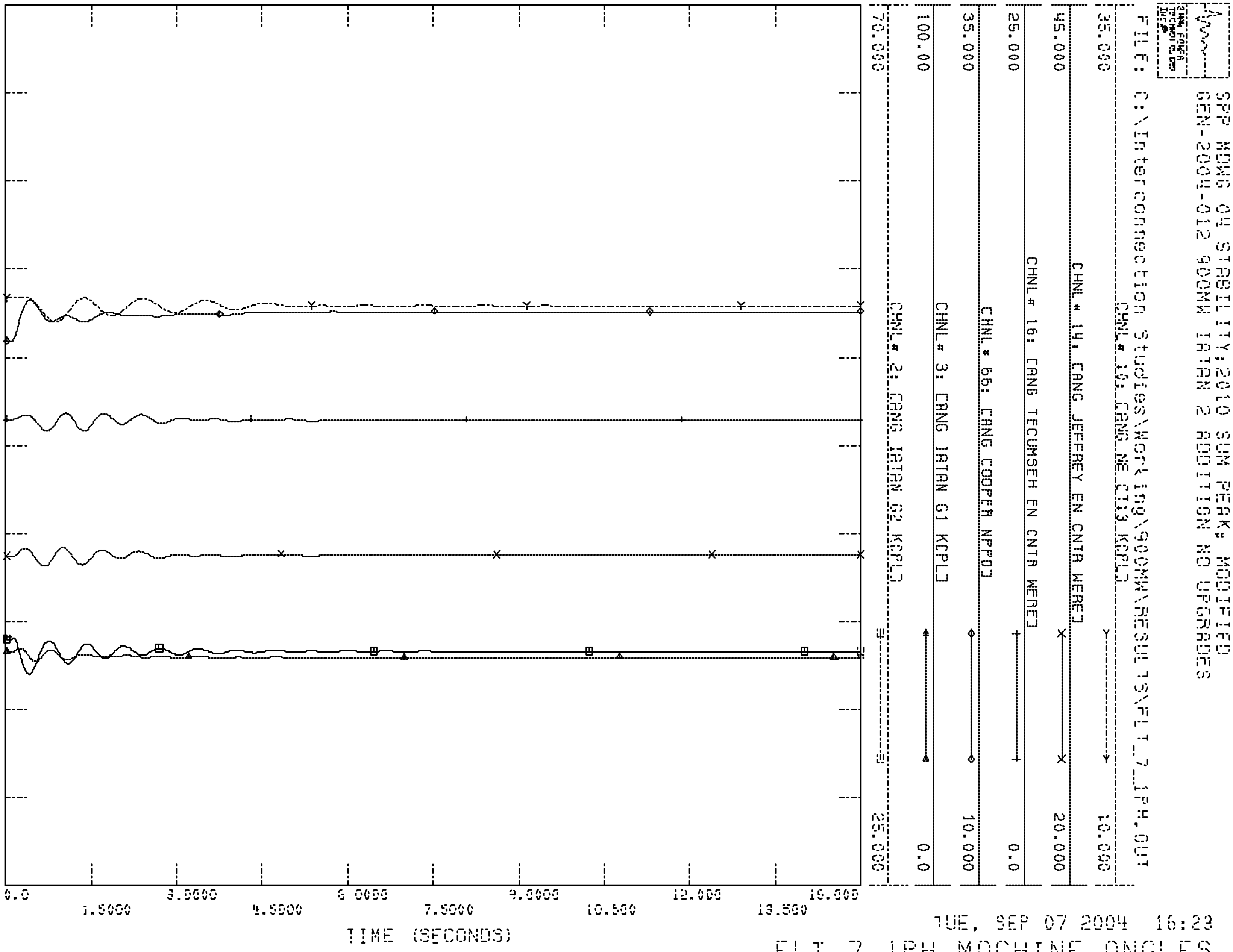


FLT_6_1PH_MACHINE ANGLES



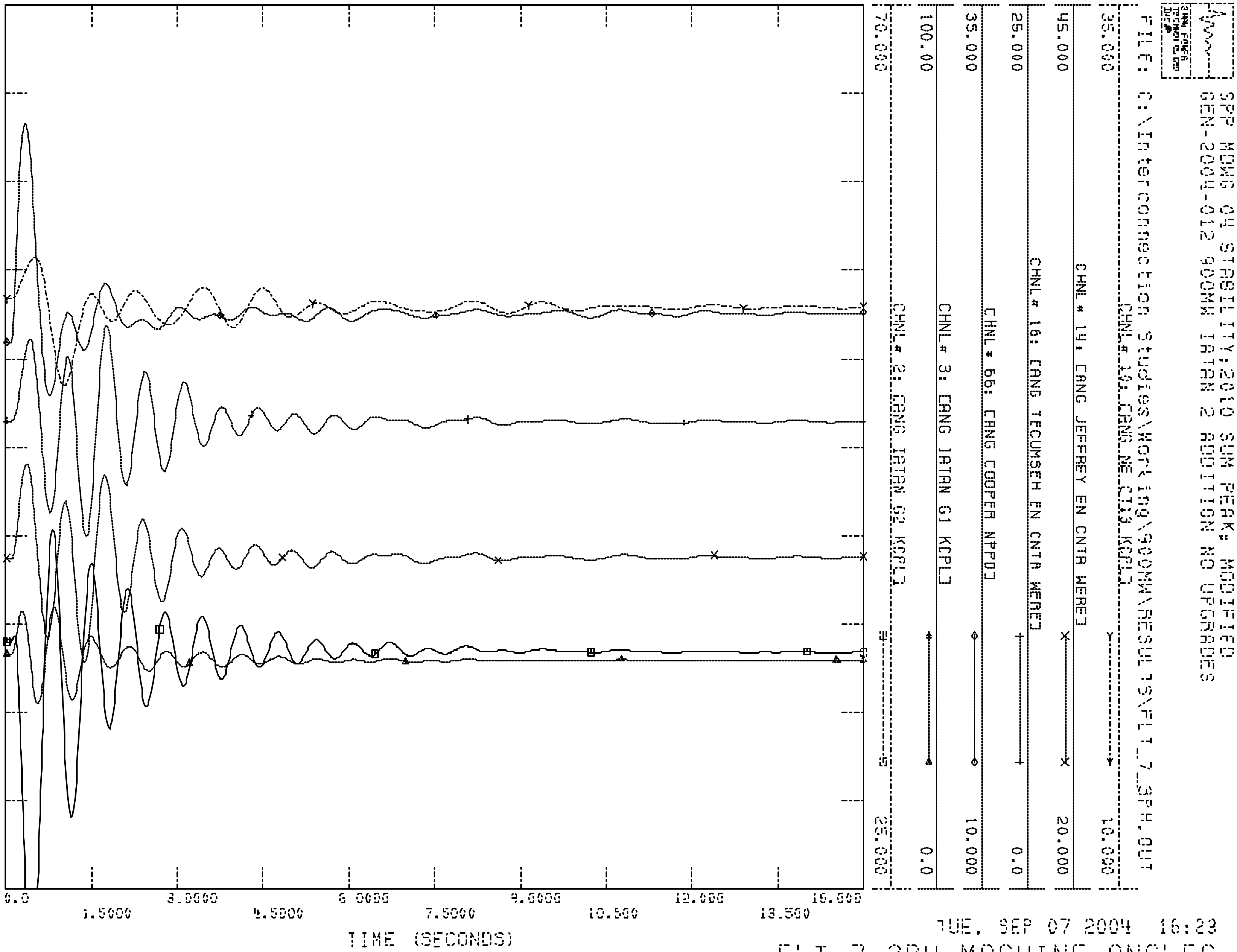
TUE, SEP 07 2004 16:23

FLT_6_3PH_MACHINE ANGLES



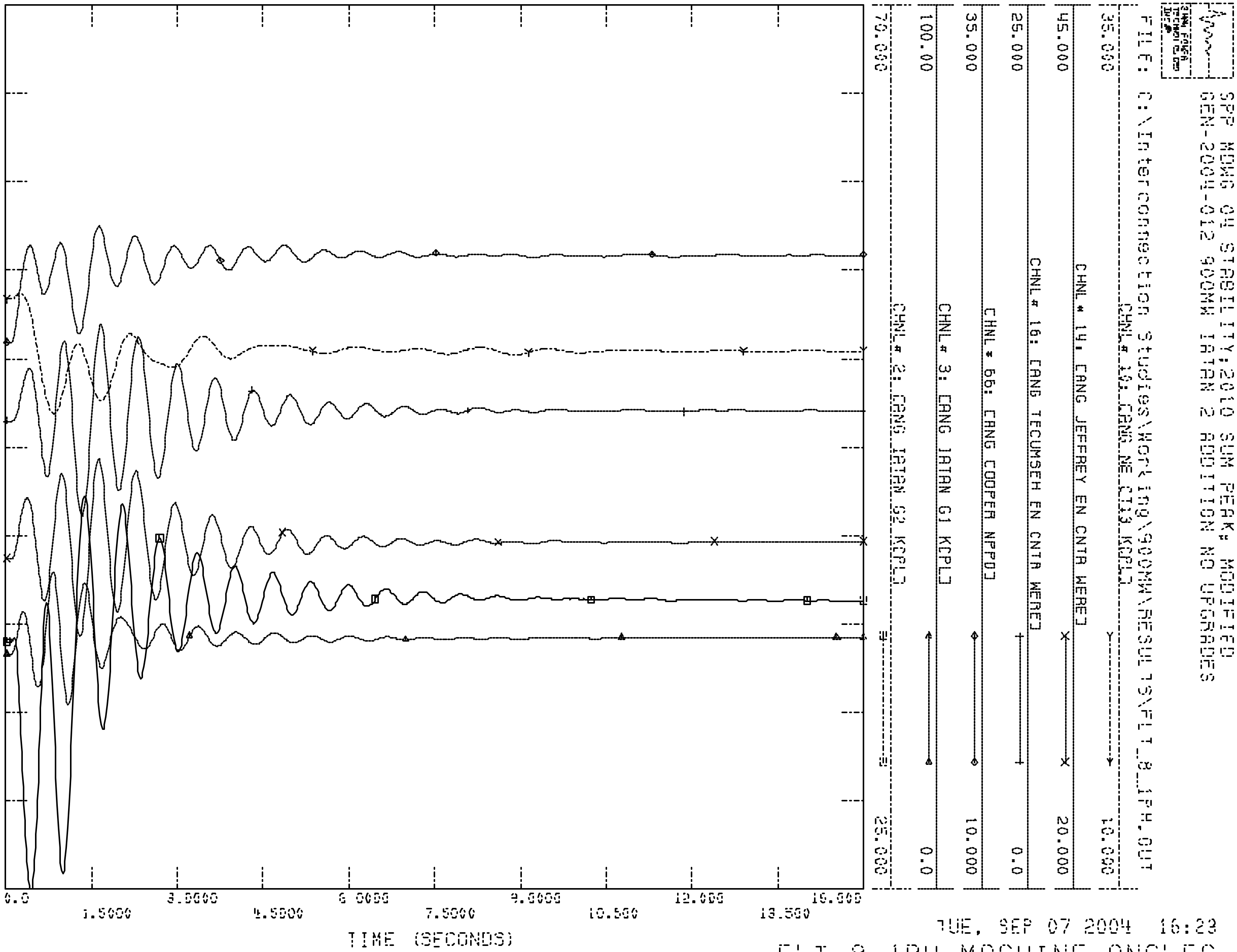
TUE, SEP 07 2004 16:23

FLT_7_1PH_MACHINE ANGLES



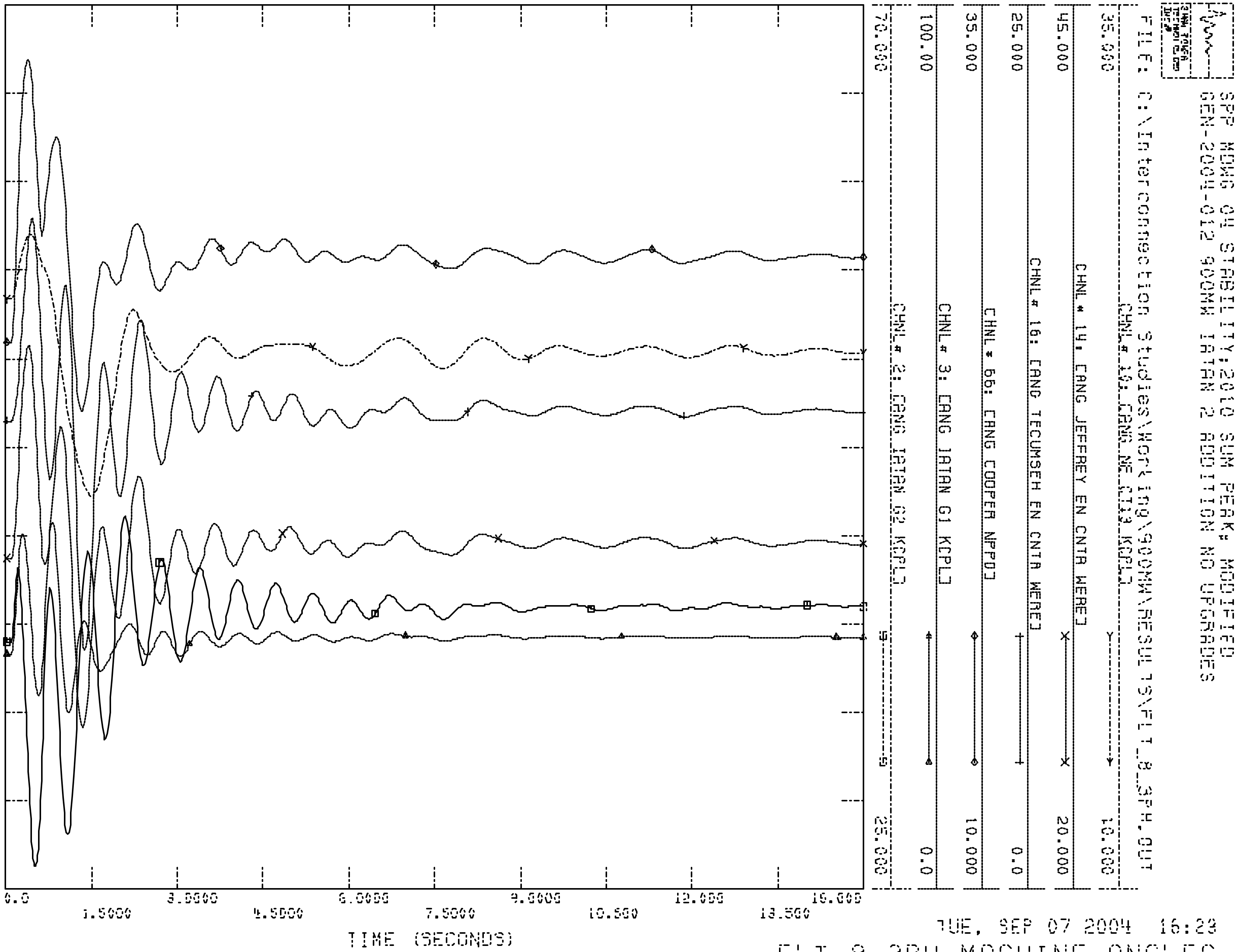
TUE, SEP 07 2004 16:23

FLT_7_3PH_MACHINE ANGLES

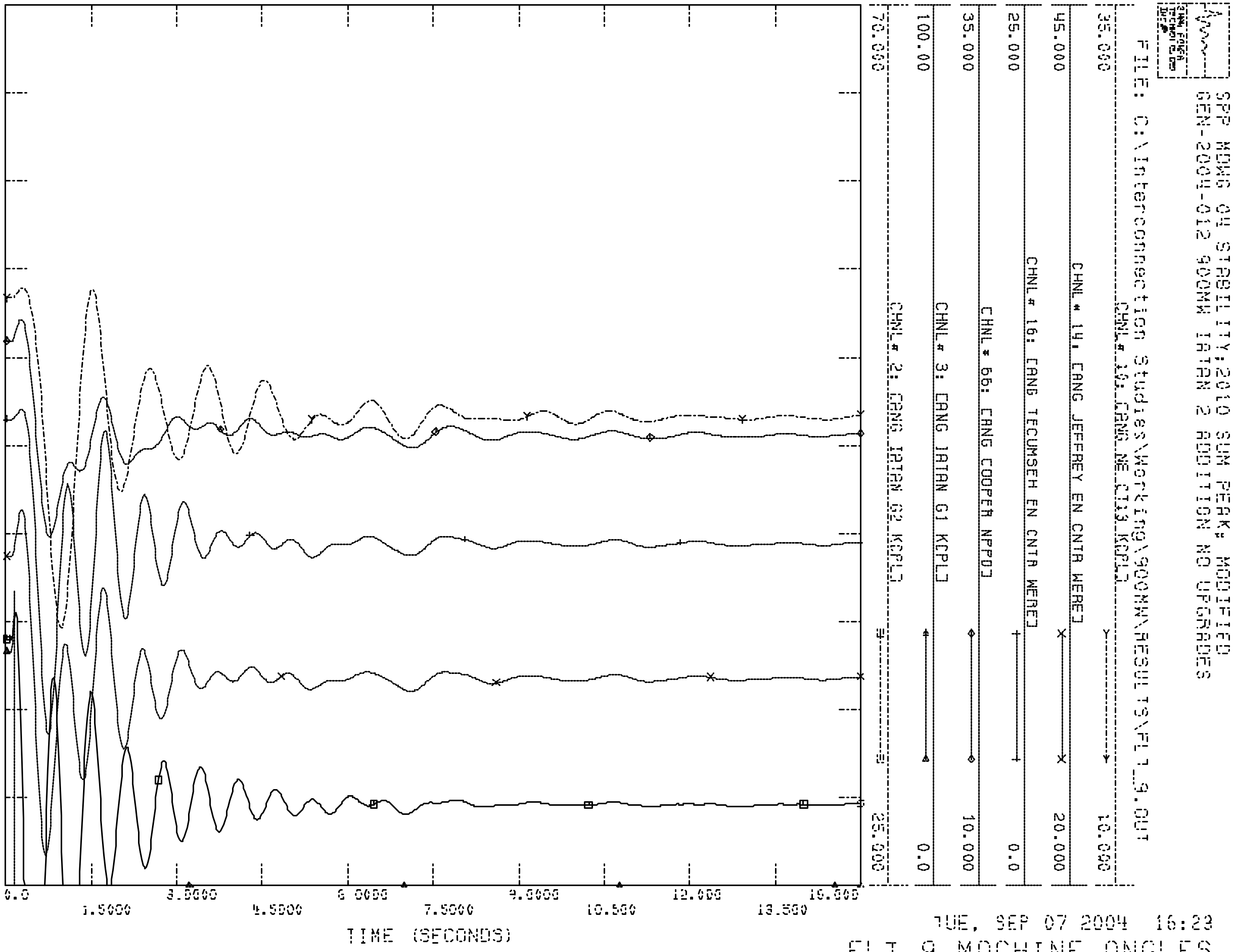


TUE, SEP 07 2004 16:23

FLT_8_1PH_MACHINE ANGLES

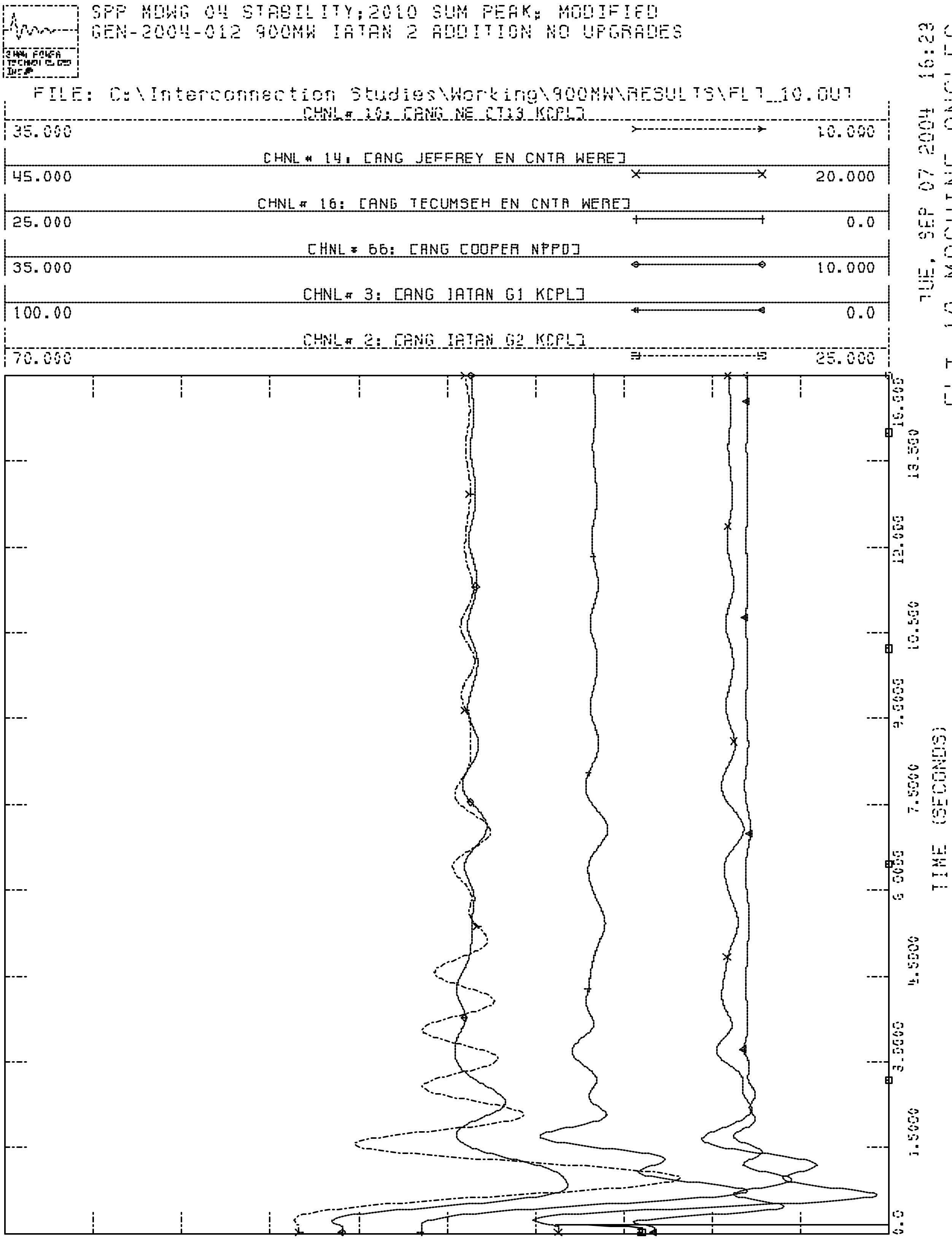


FLT_8_3PH_MACHINE ANGLES



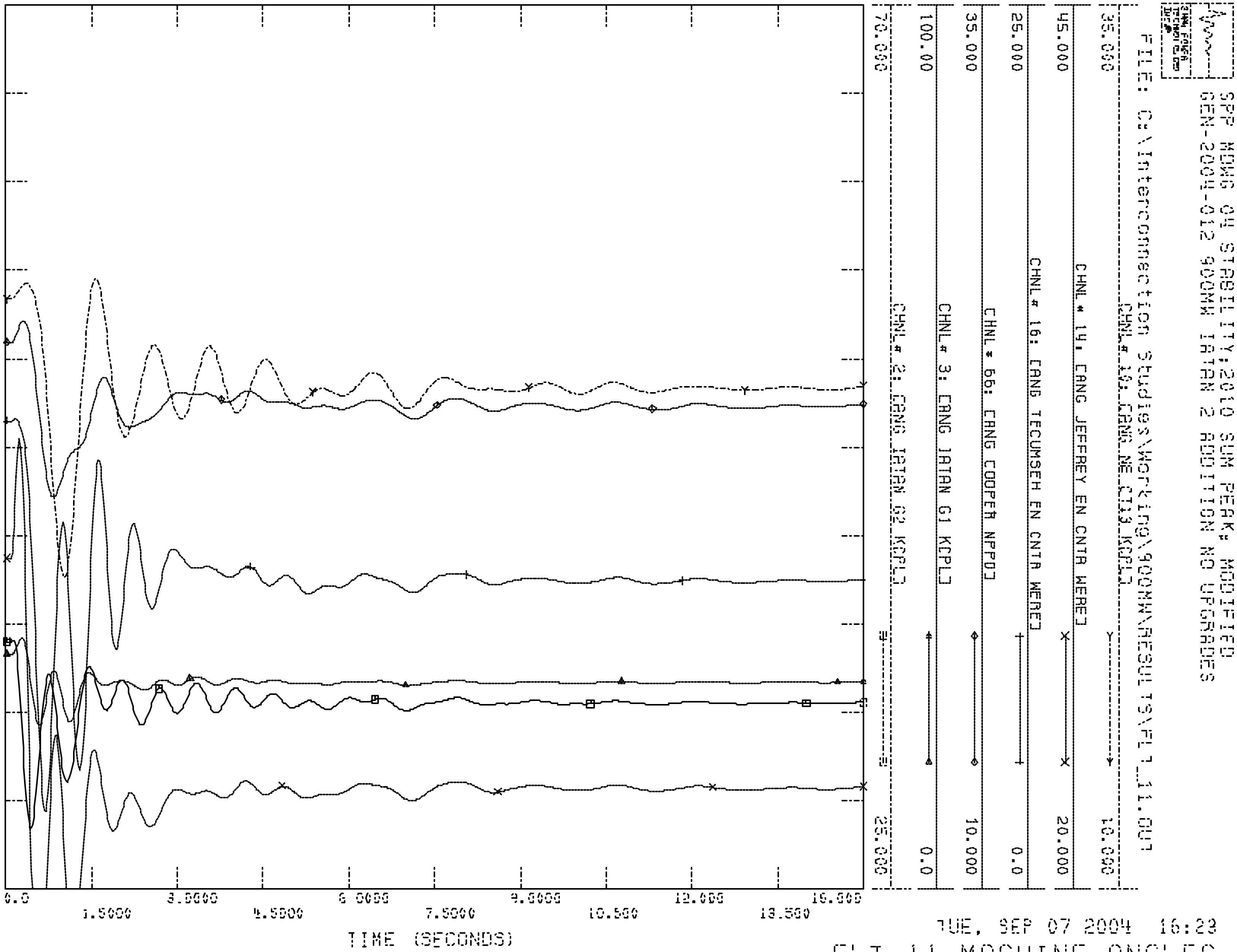
TUE, SEP 07 2004 16:23

FLT_9_MACHINE ANGLES



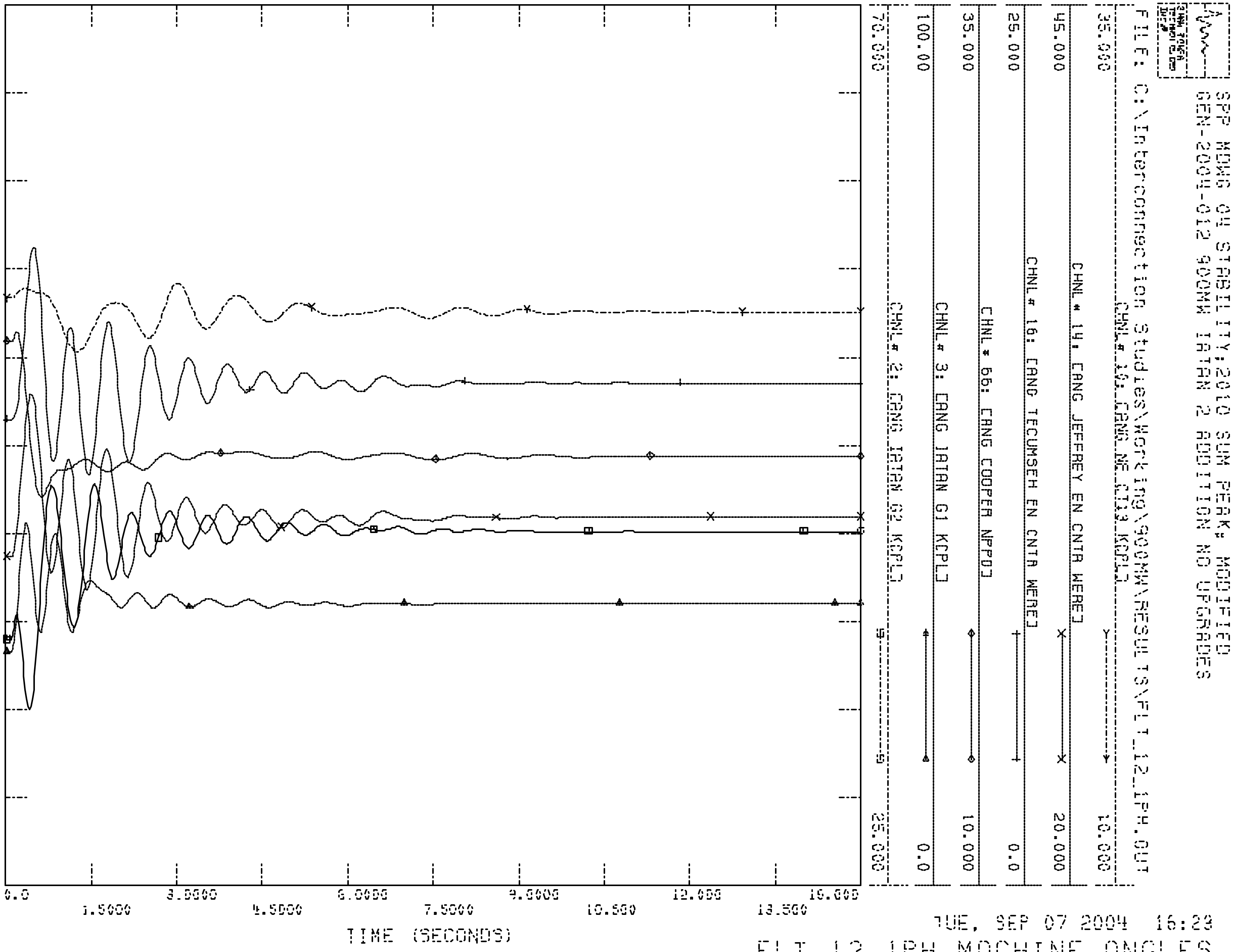
TUE, SEP 07 2004 16:23

FLT_10_MACHINE ANGLES

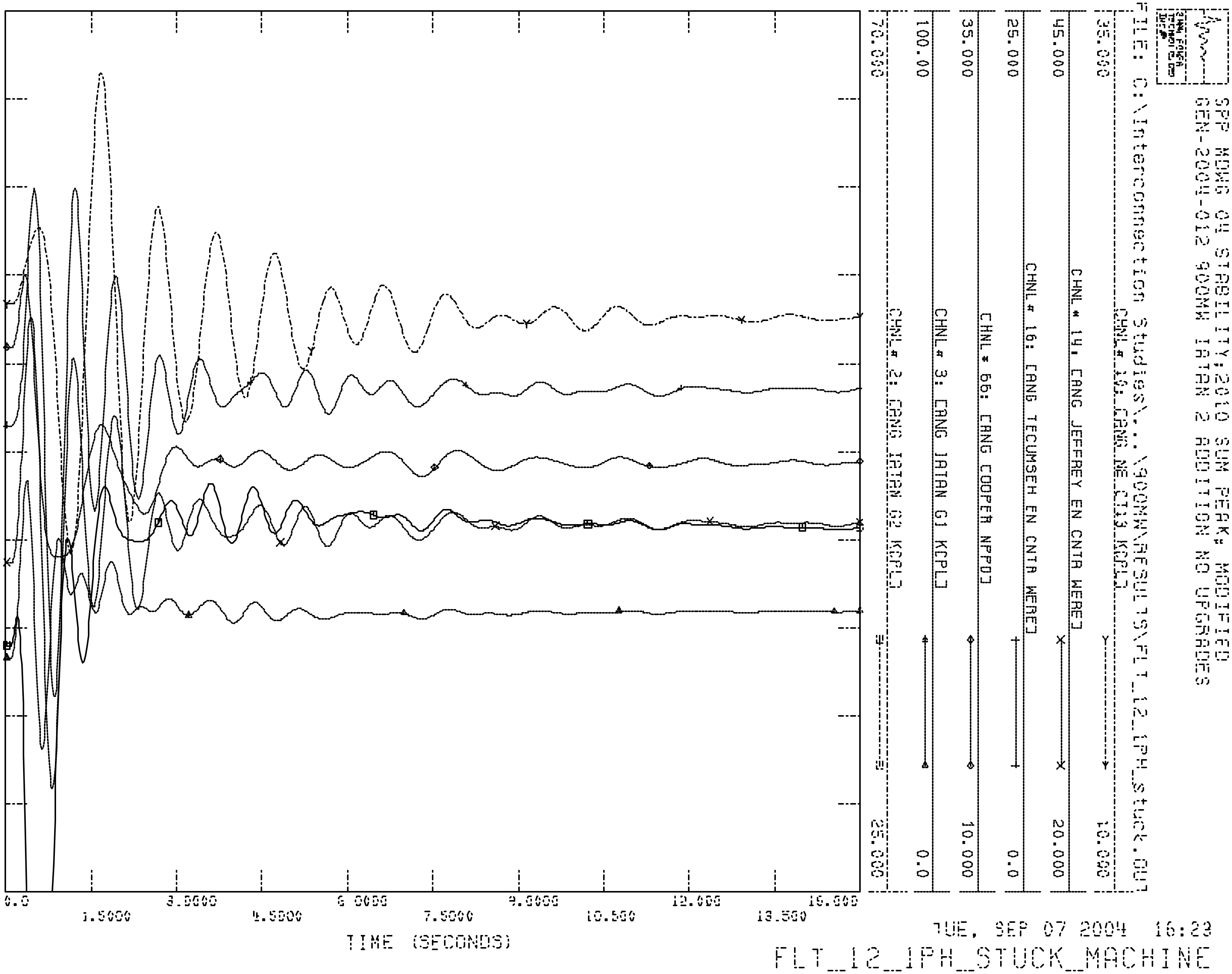


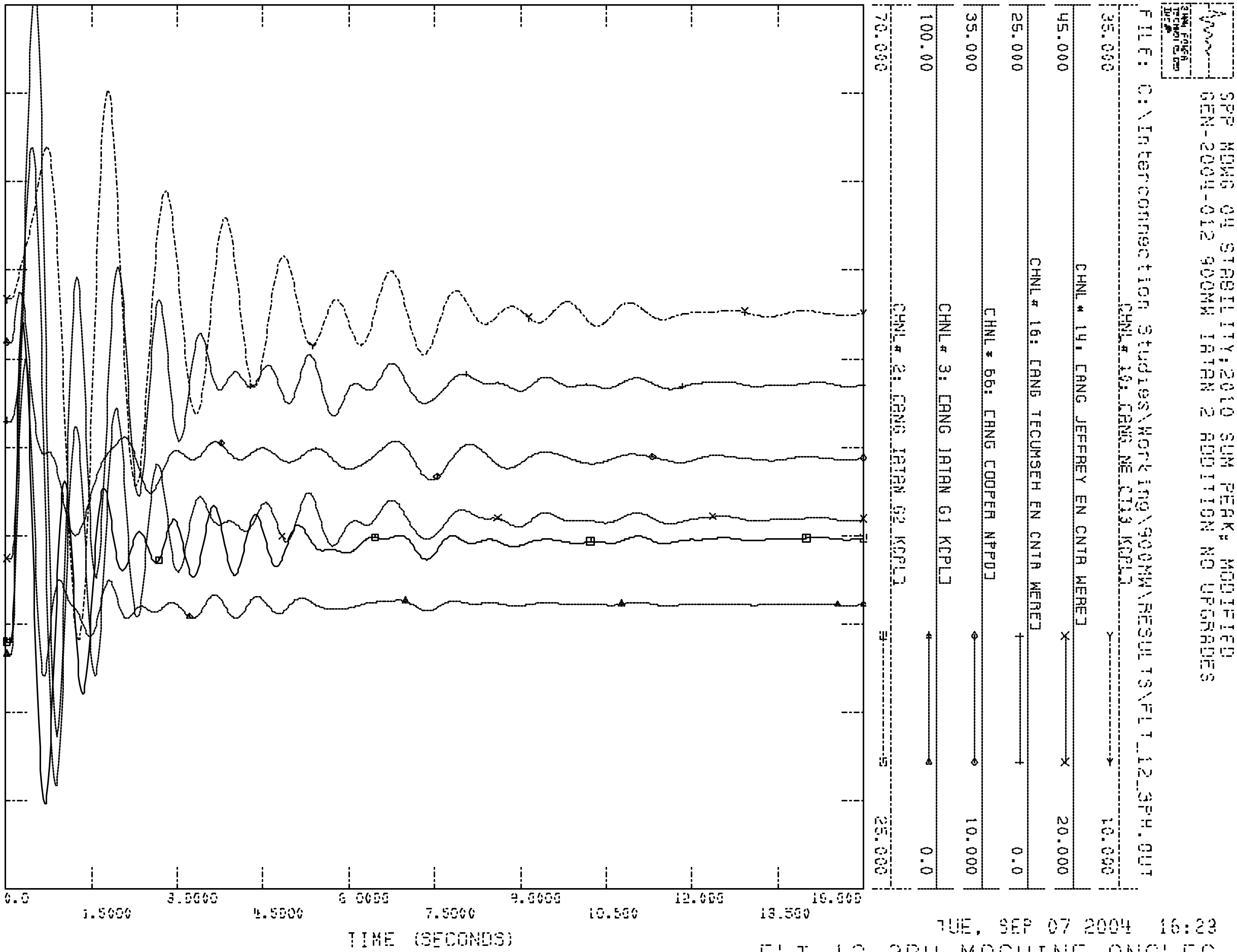
TUE, SEP 07 2004 16:23

FLT_11_MACHINE ANGLES



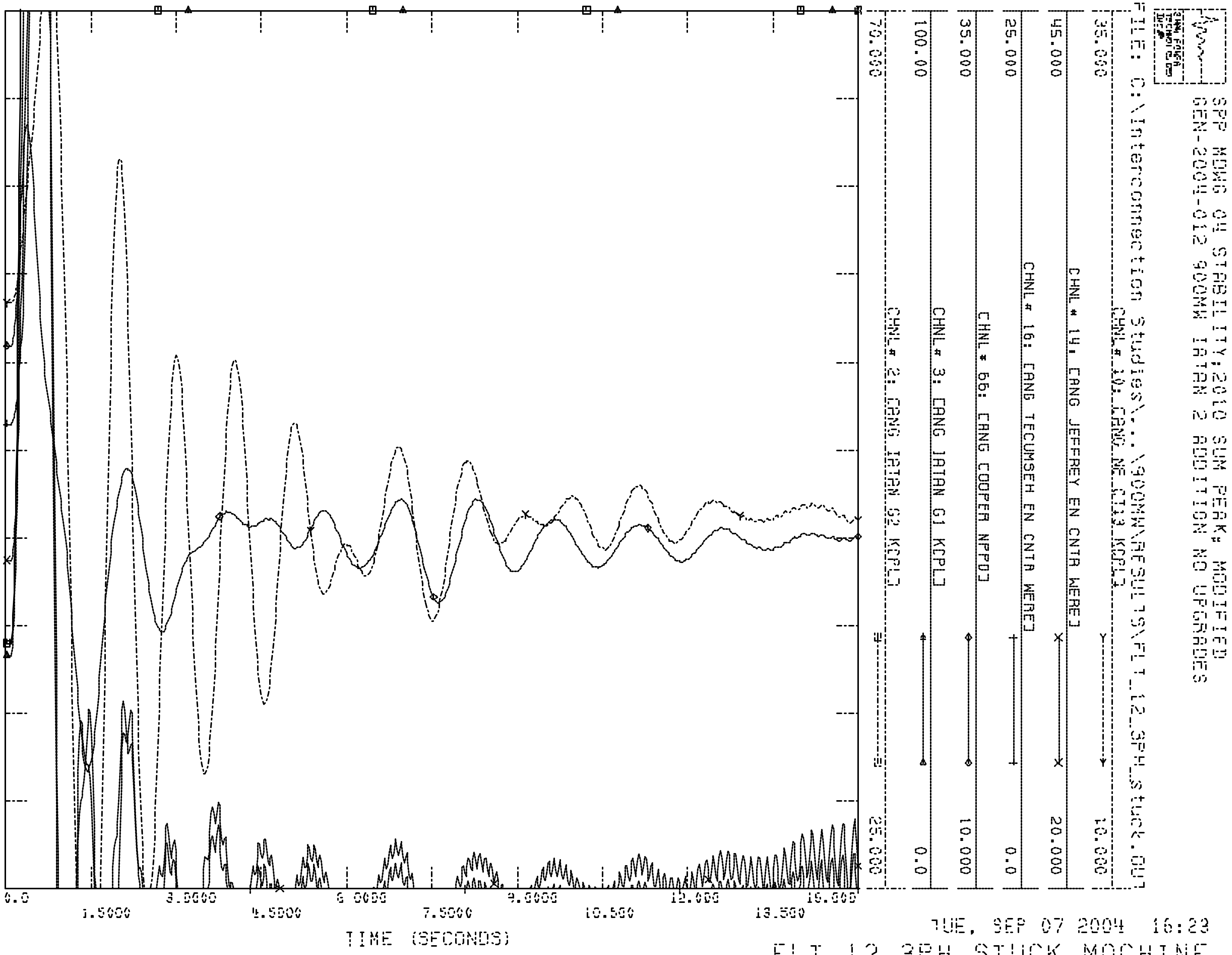
FLT_12_1PH_MACHINE ANGLES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW IATAN 2 ADDITION NO UPGRADES
FILE: C:\Interconnection Studies\...\900MW\RESULTS\FLT_12_1PH_stuck.OUT
CHNL# 10: CANG NE CT13 KCPL]
35.000 10.000
CHNL# 14: CANG JEFFREY EN CNTR WERE]
45.000 20.000
CHNL# 16: CANG TECUMSEH EN CNTR WERE]
25.000 0.0
CHNL# 66: CANG COOPER NPPD]
35.000 10.000
CHNL# 3: CANG IATAN G1 KCPL]
100.00 0.0
CHNL# 2: CANG IATAN G2 KCPL]
70.000 25.000
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, SEP 07 2004 16:23
FLT_12_1PH_STUCK_MACHINE



TUE, SEP 07 2004 16:23

FLT_12_3PH_MACHINE ANGLES



TUE, SEP 07 2004 16:23

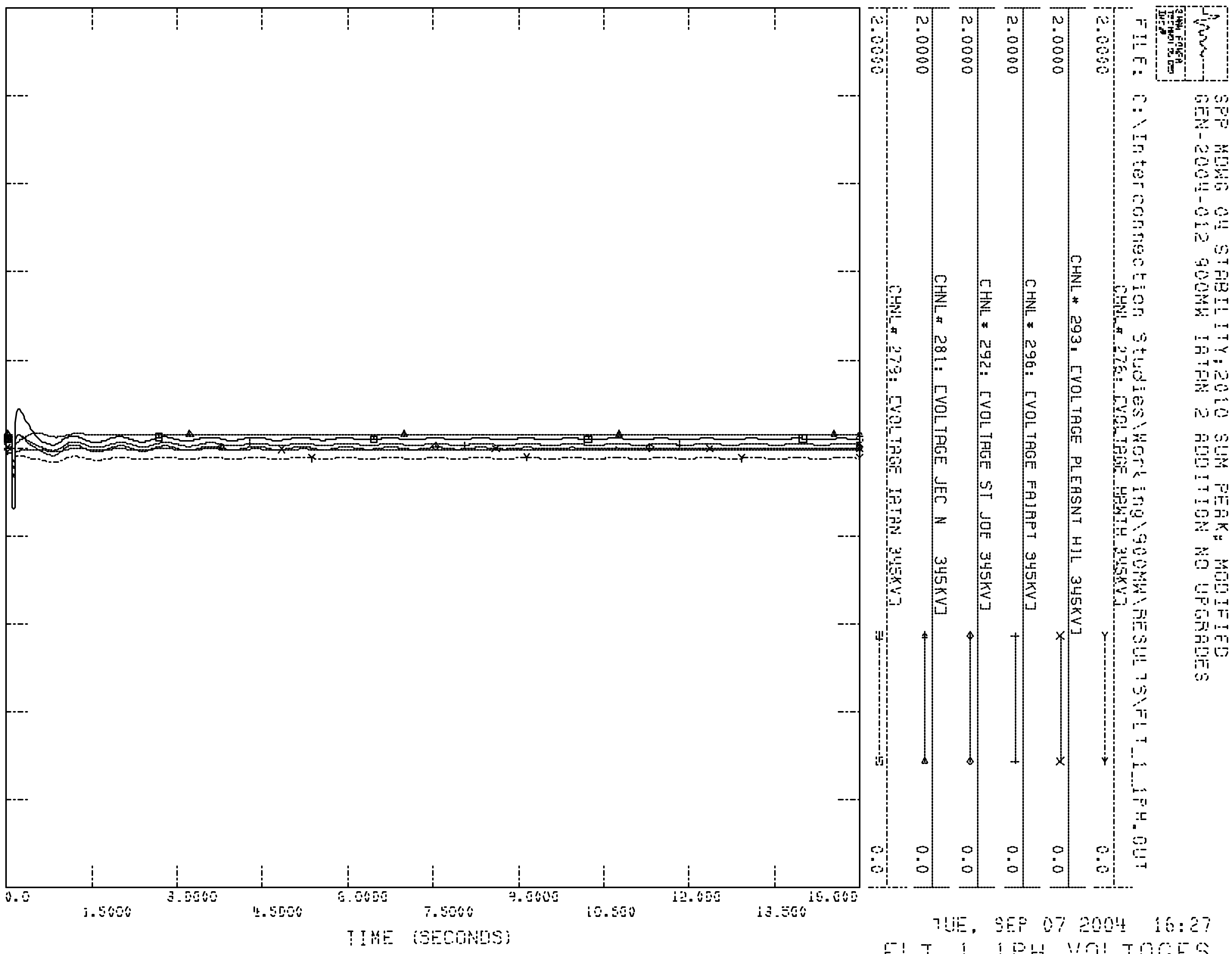
FLT_12_3PH_STUCK_MACHINE

Appendix B-2

Plots of Fault Simulations

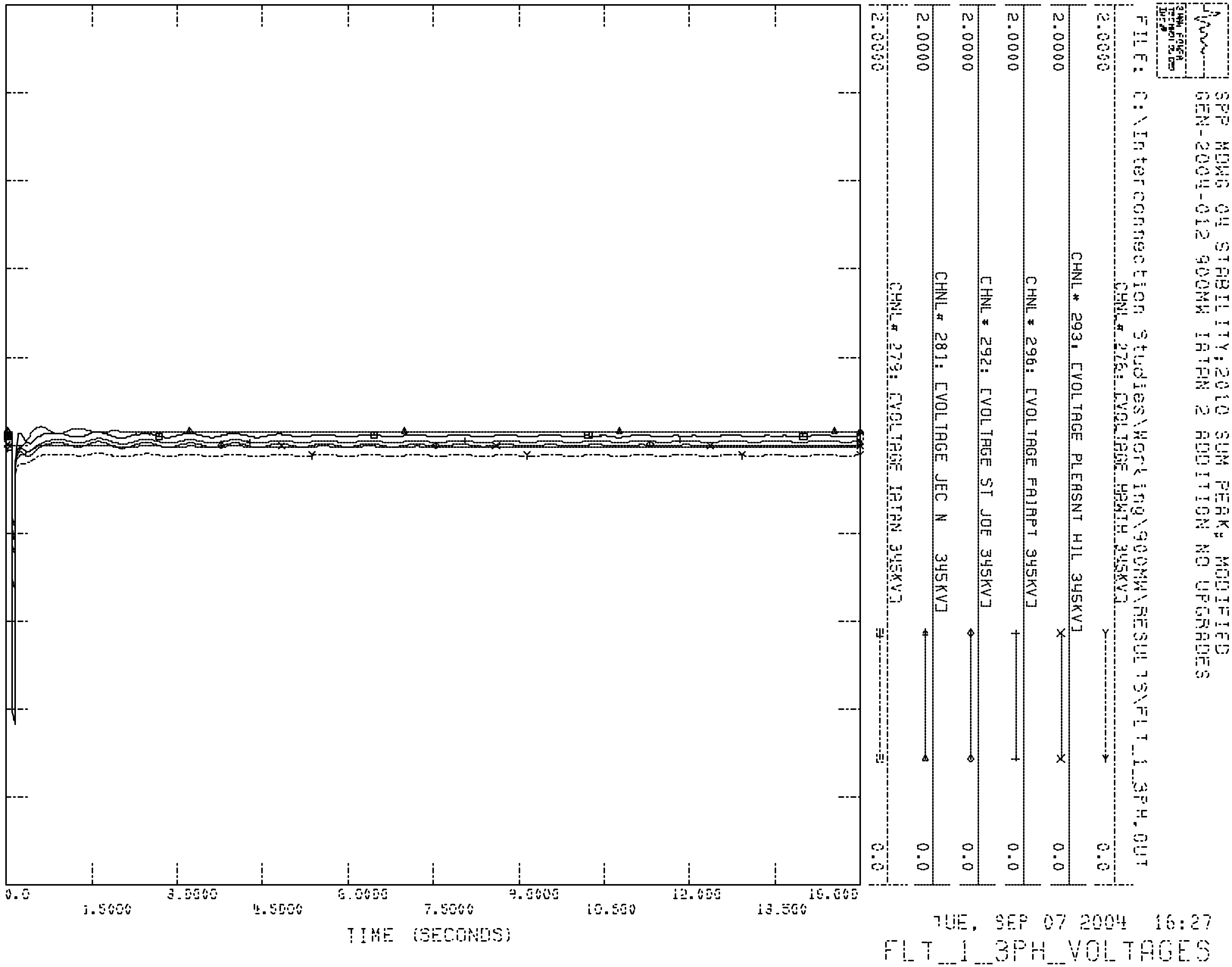
Plots of selected bus voltage response during faults

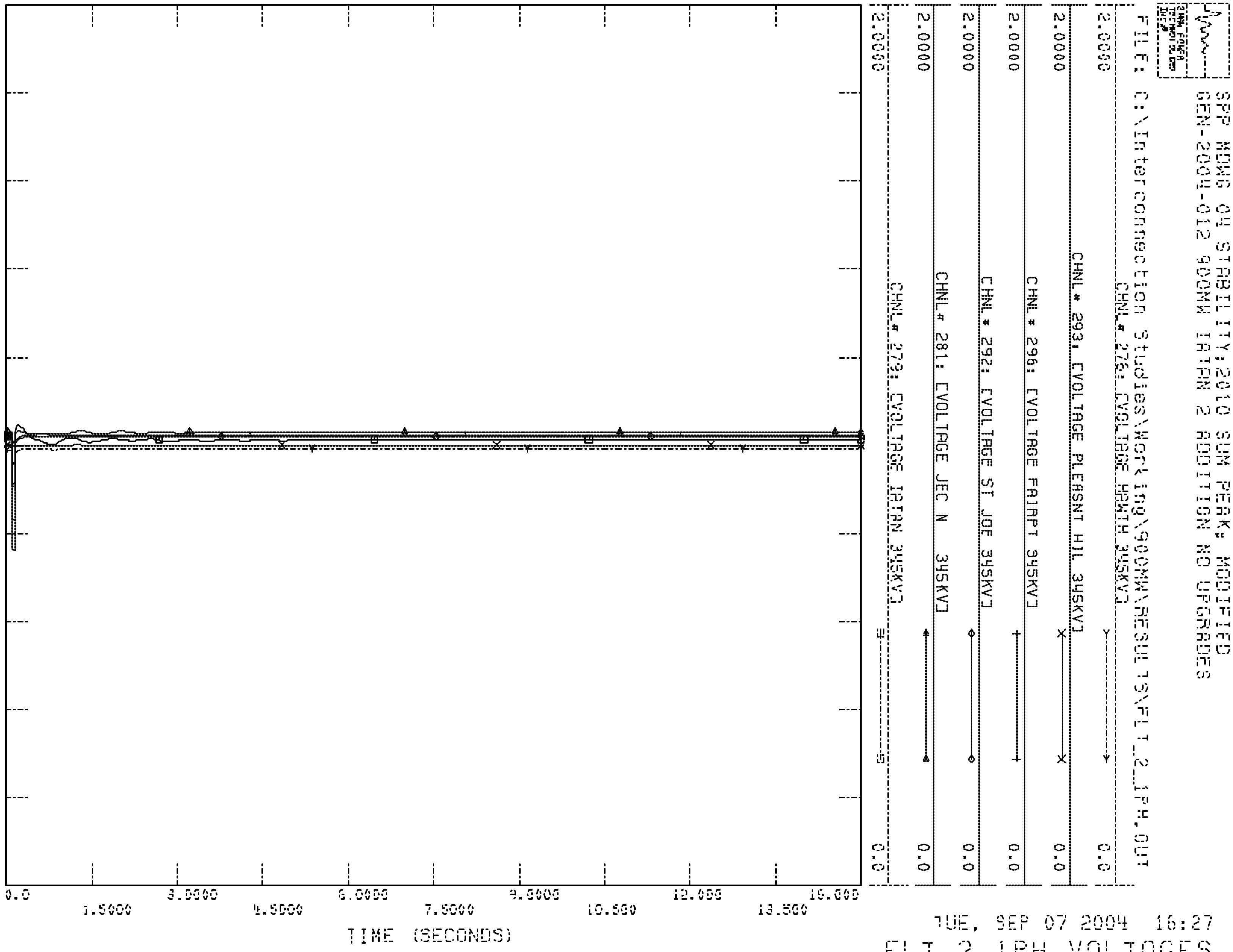
Scenario:
2010 Summer Peak
900MW
[Customer Plant at 900MW – No Network Upgrades]



TUE, SEP 07 2004 16:27

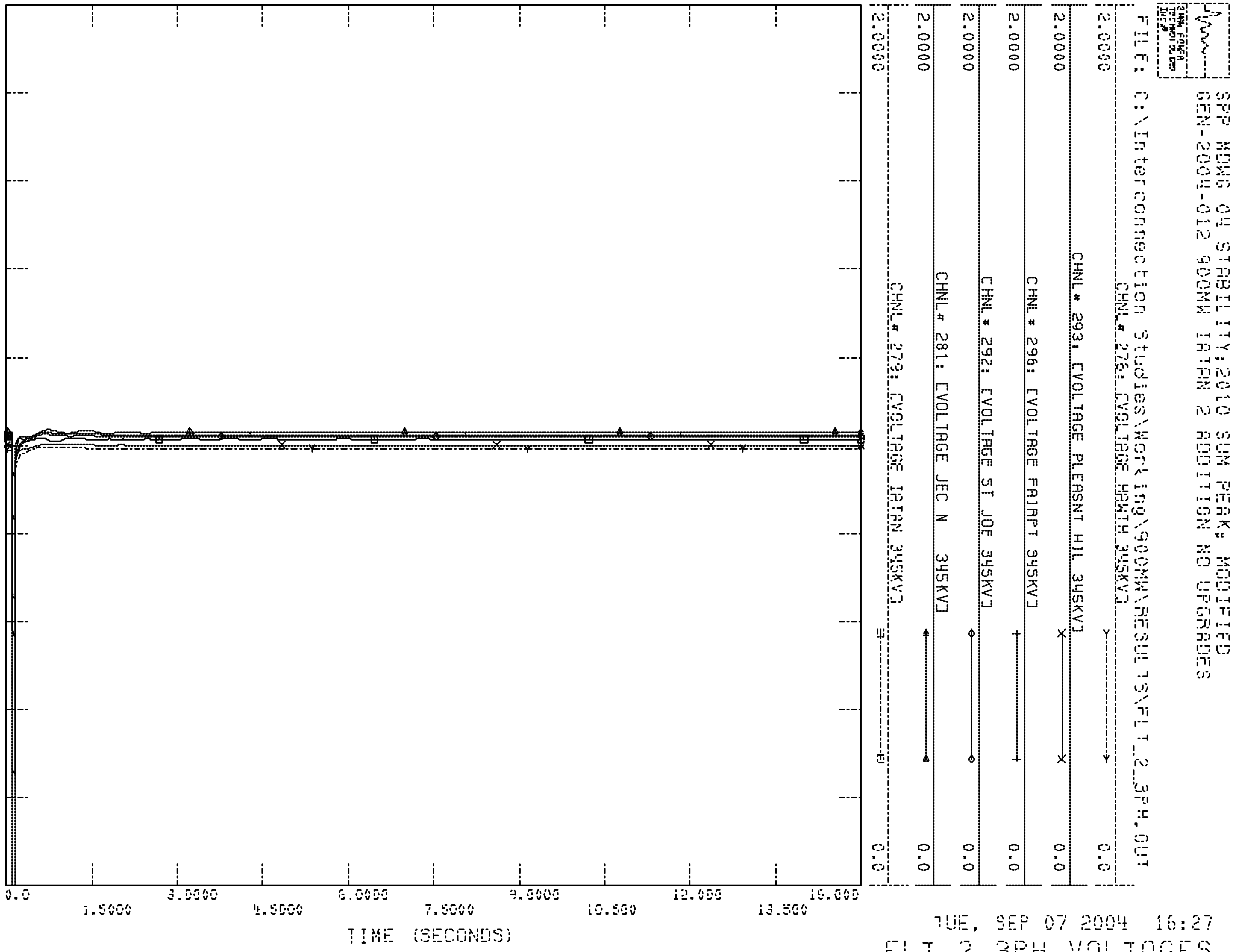
FLT_1_1PH_VOLTAGES


SPP MDWG 04 STABILITY, 2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW IATAN 2 ADDITION NO UPGRADES
FILE: C:\Interconnection Studies\Working\900MW\RESULTS\FLT_1_3PH.OUT
2.0000
CHNL # 276: [VOLTAGE HAWTH 345KV]
0.0
2.0000
CHNL # 293: [VOLTAGE PLEASNT HIL 345KV]
0.0
2.0000
CHNL # 296: [VOLTAGE FAIRPT 345KV]
0.0
2.0000
CHNL # 292: [VOLTAGE ST JOE 345KV]
0.0
2.0000
CHNL # 281: [VOLTAGE JEC N 345KV]
0.0
2.0000
CHNL # 279: [VOLTAGE IATAN 345KV]
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, SEP 07 2004 16:27
FLT_1_3PH_VOLTAGES



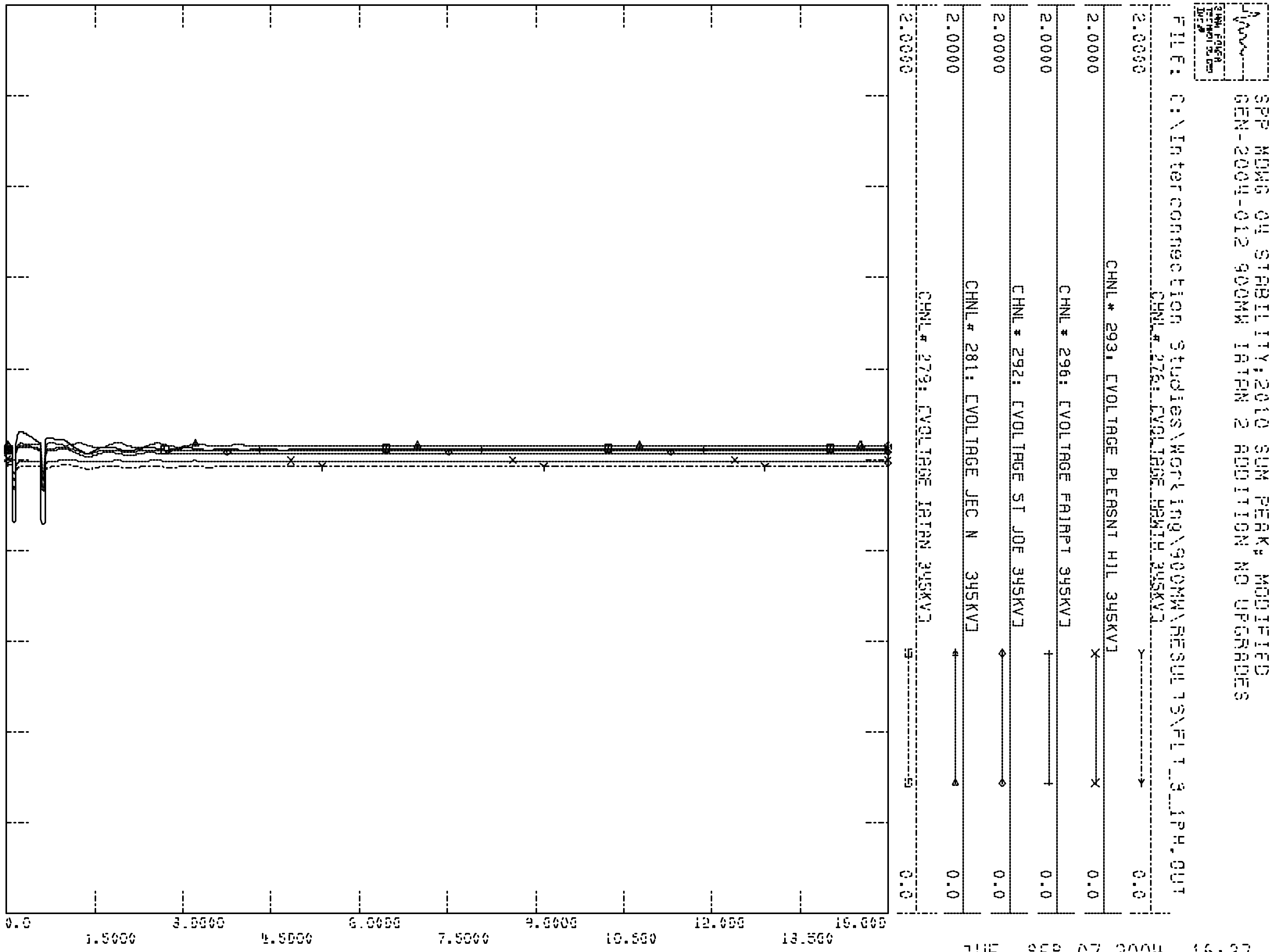
TUE, SEP 07 2004 16:27

FLT_2_1PH_VOLTAGES



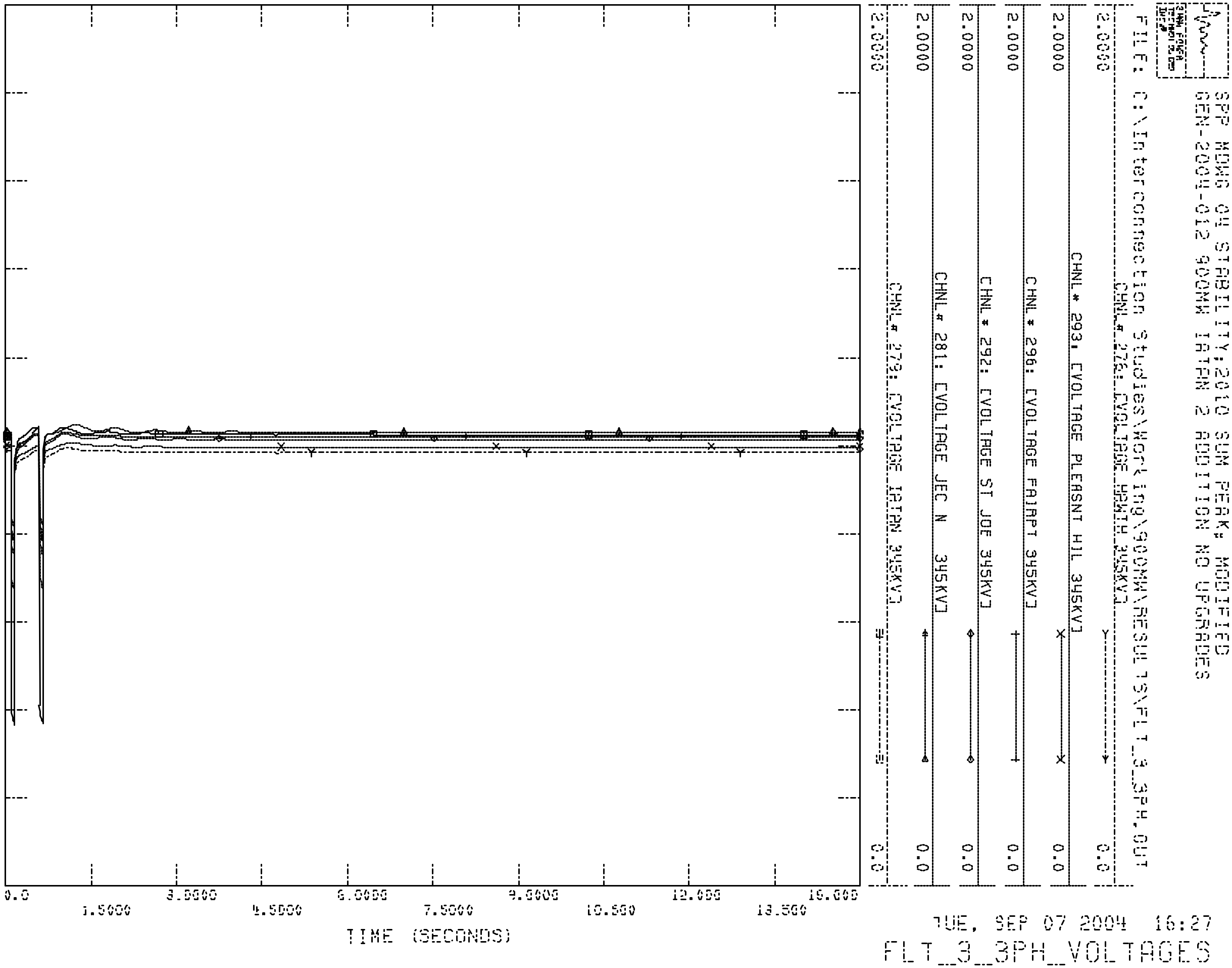
TUE, SEP 07 2004 16:27

FLT_2_3PH_VOLTAGES



TUE, SEP 07 2004 16:27

FLT_3_1PH_VOLTAGES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW IATAN 2 ADDITION NO UPGRADES
FILE: C:\Interconnection Studies\Working\900MW\RESULTS\FLT_3_3PH.OUT
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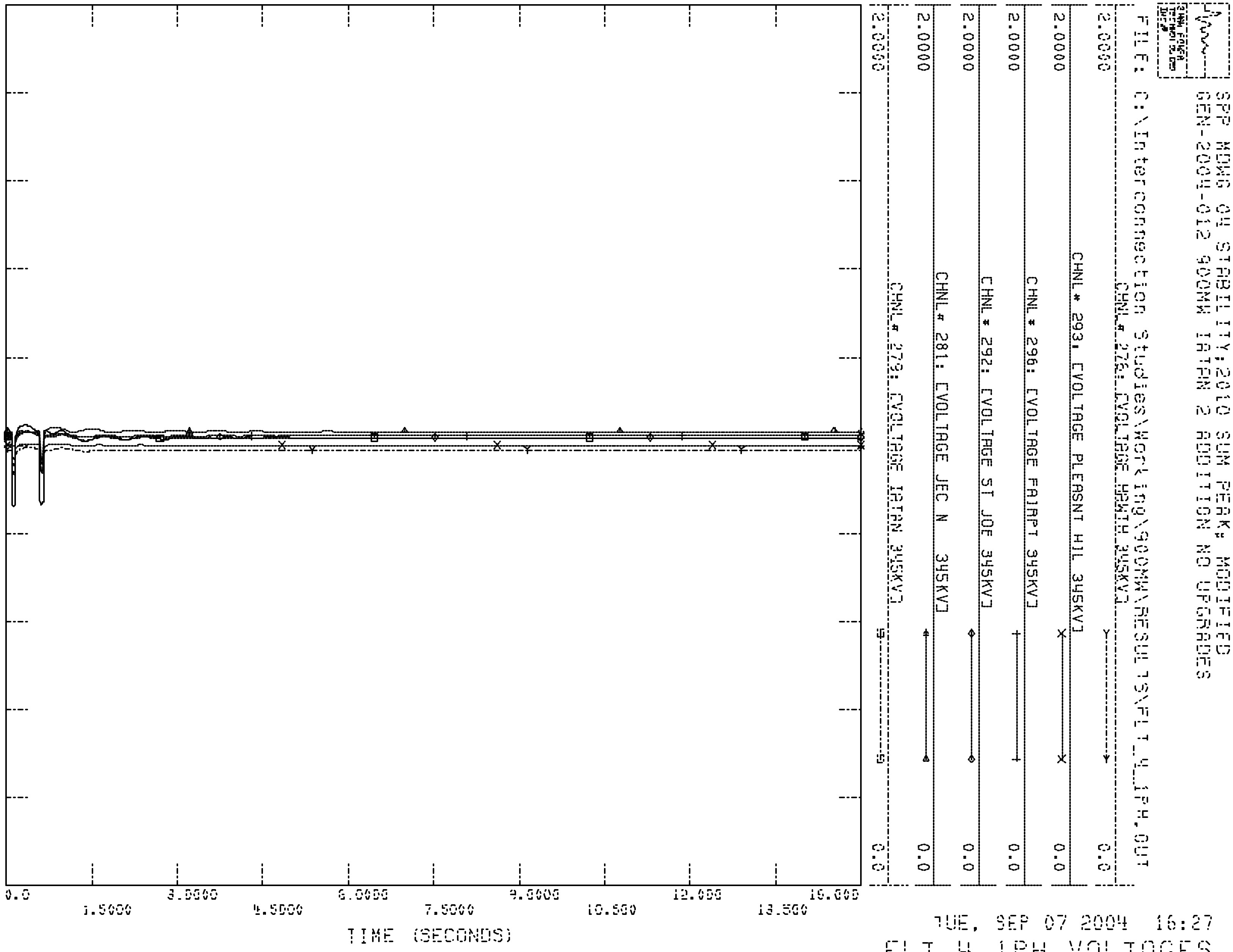
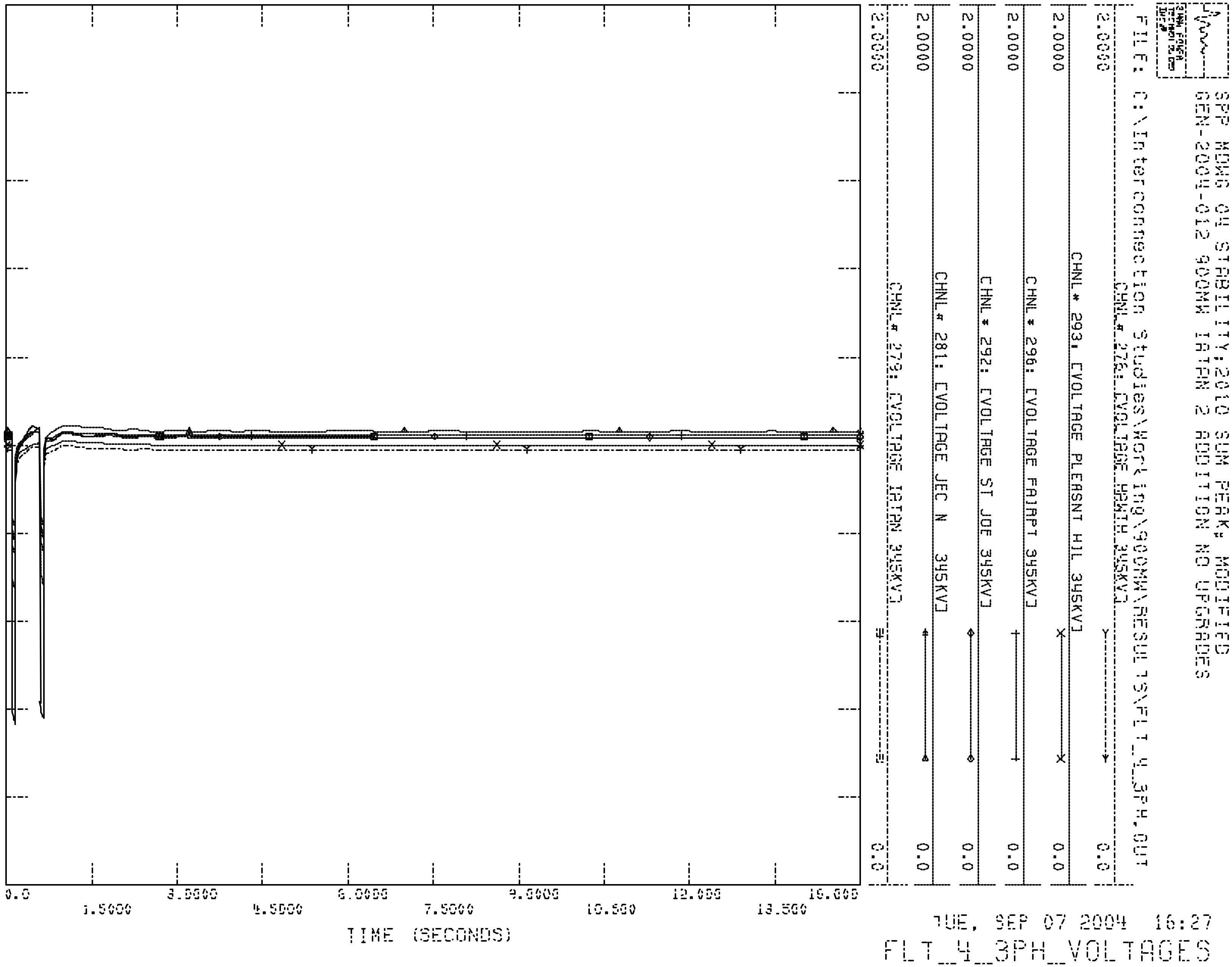
2.0000
0.0
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE IATAN 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, SEP 07 2004 16:27
FLT_3_3PH_VOLTAGES



TUE, SEP 07 2004 16:27

FLT_4_1PH_VOLTAGES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW IATAN 2 ADDITION NO UPGRADES
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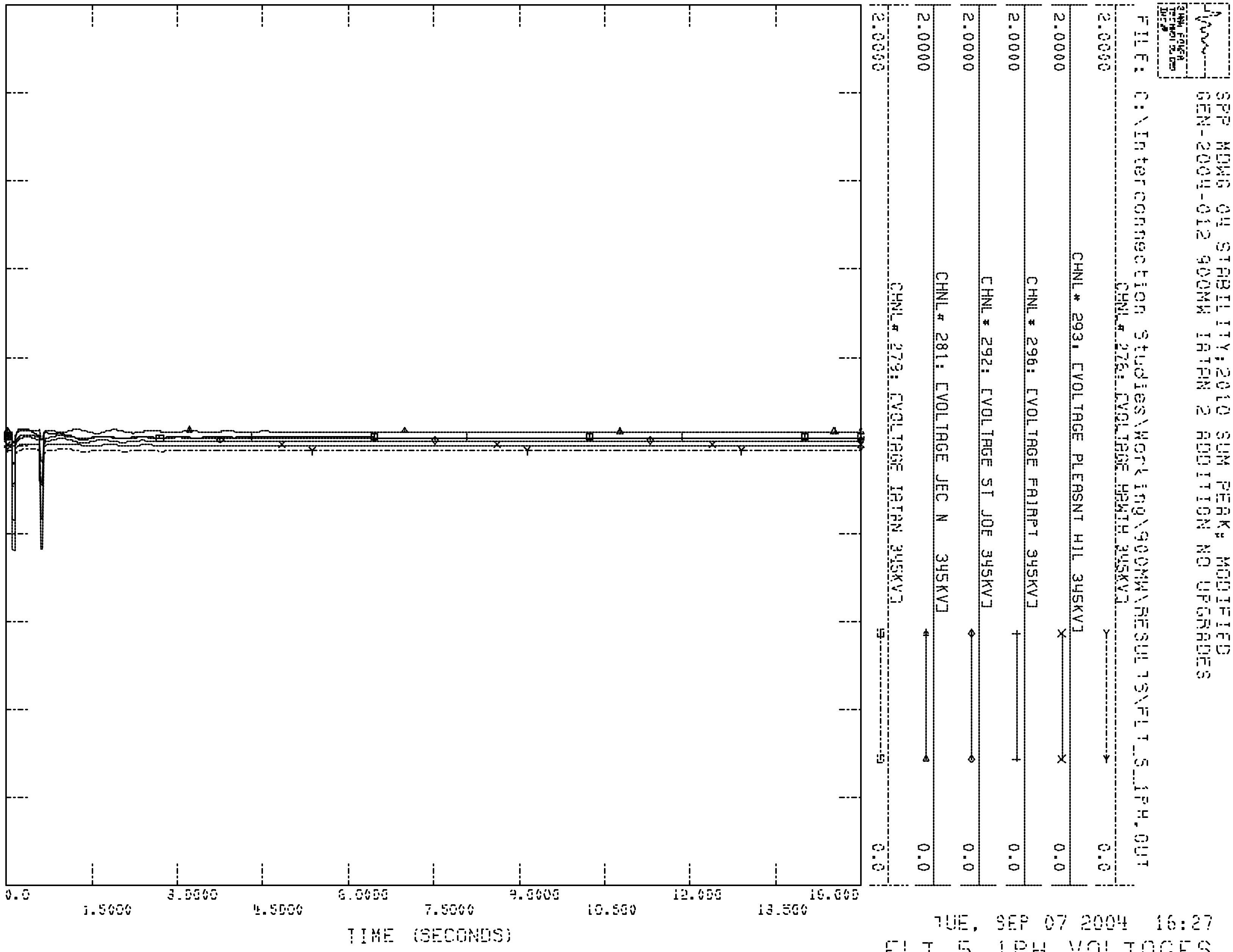
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
CHNL# 296: [VOLTAGE FAIRPT 345KV]
CHNL# 292: [VOLTAGE ST JOE 345KV]
CHNL# 281: [VOLTAGE JEC N 345KV]
CHNL# 279: [VOLTAGE IATAN 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, SEP 07 2004 16:27
FLT_4_3PH_VOLTAGES



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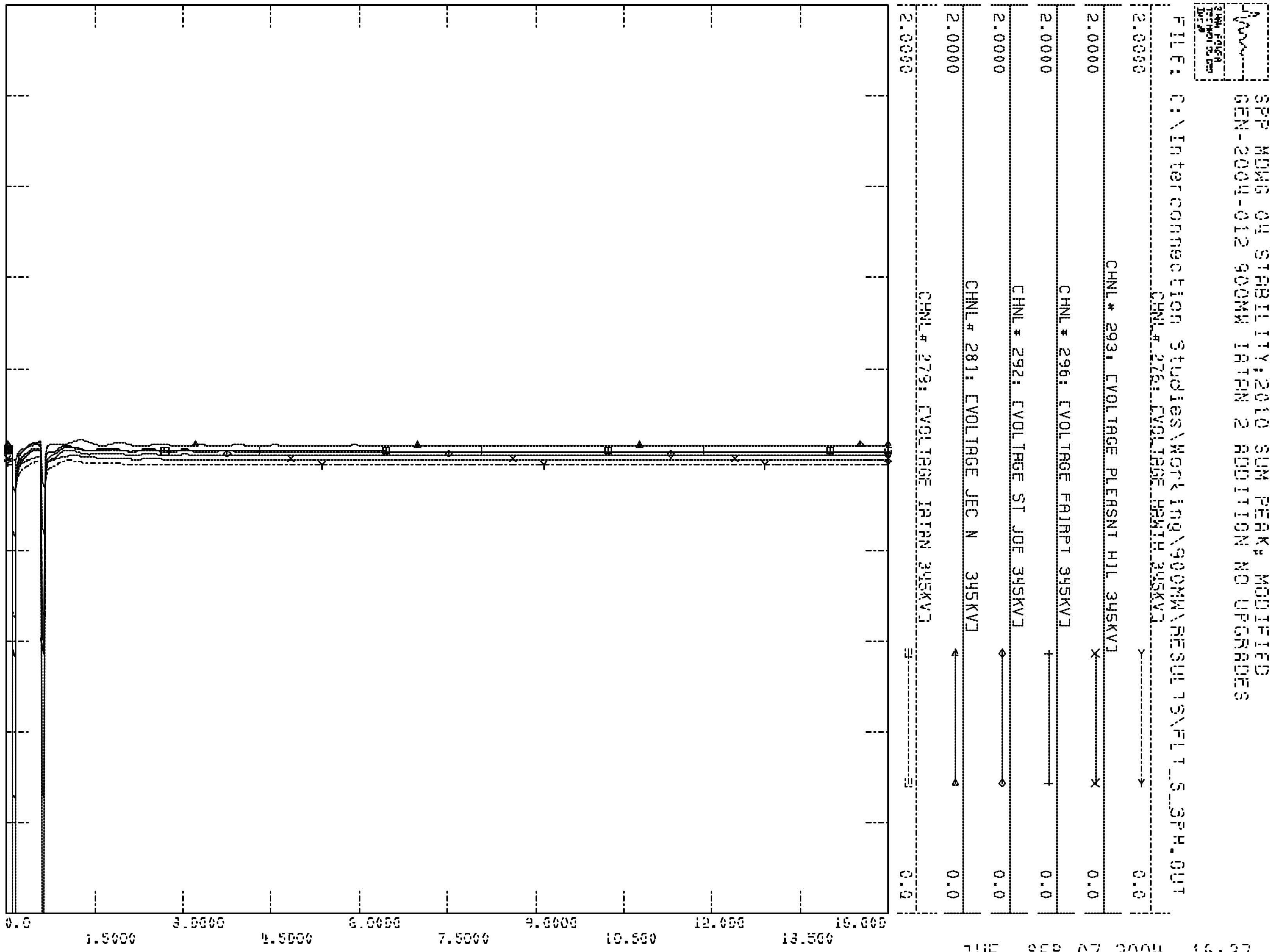
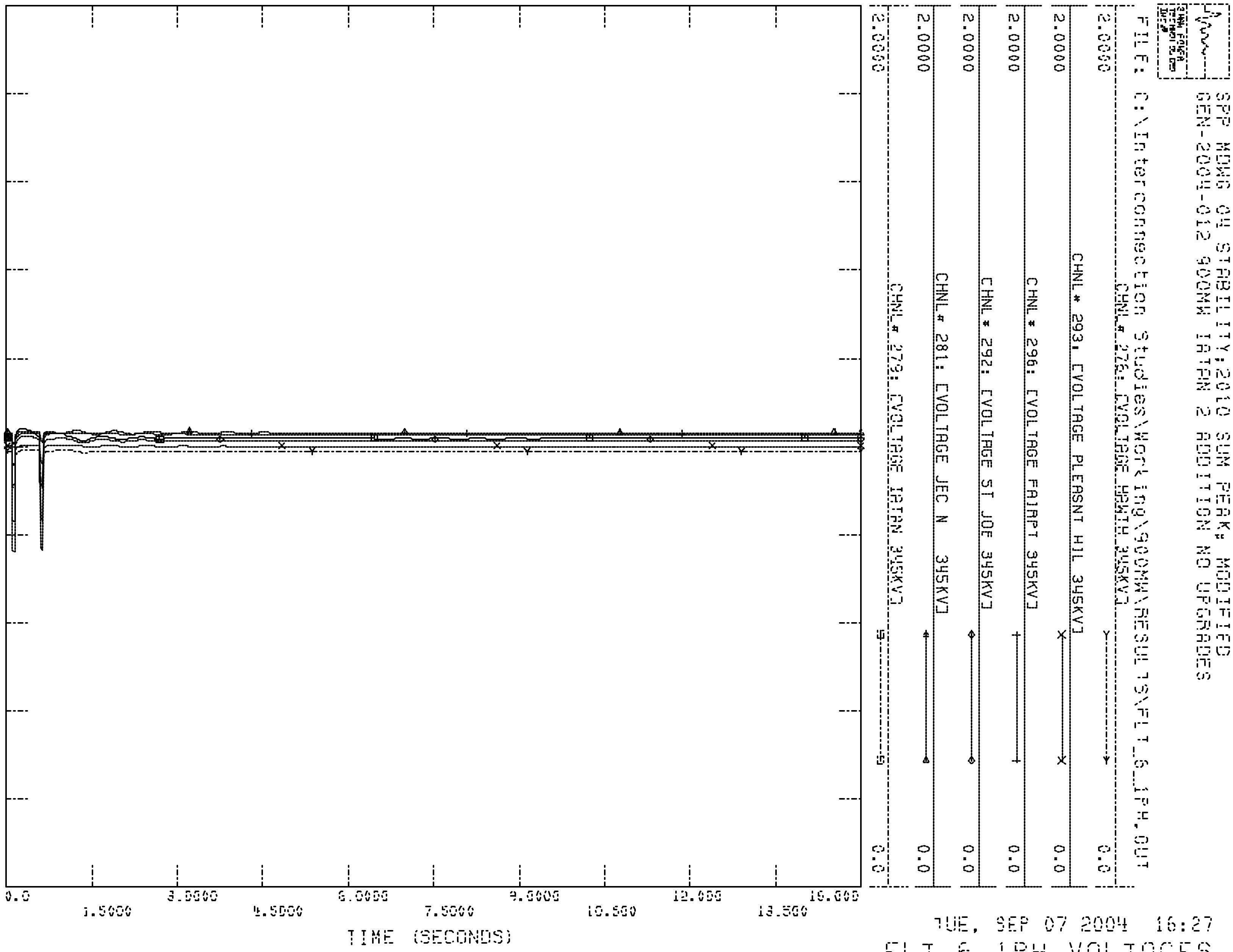
FLT_5_1PH_VOLTAGES



TUE, SEP 07 2004 16:27

FLT_5_3PH_VOLTAGES



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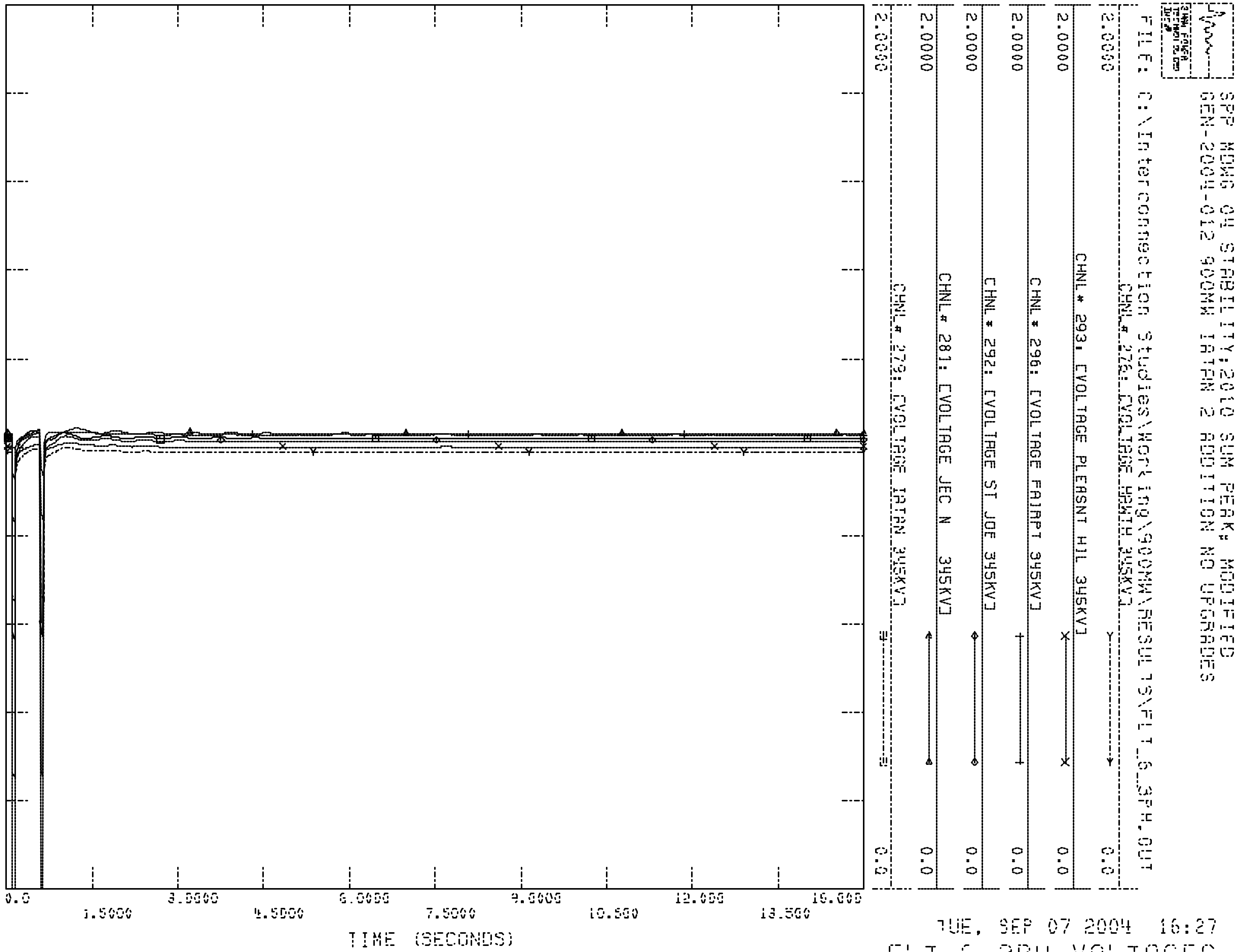
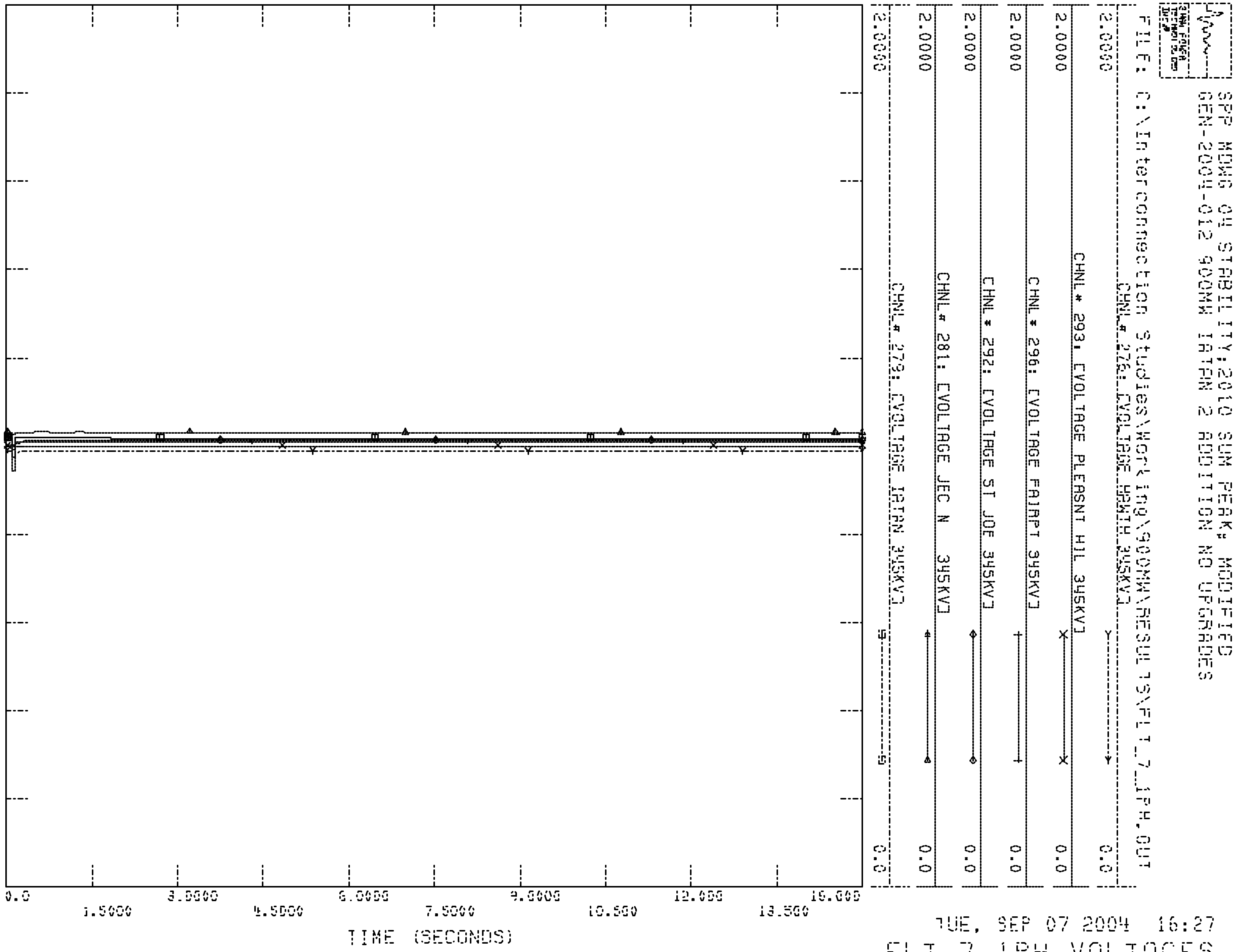
FLT_6_1PH_VOLTAGES



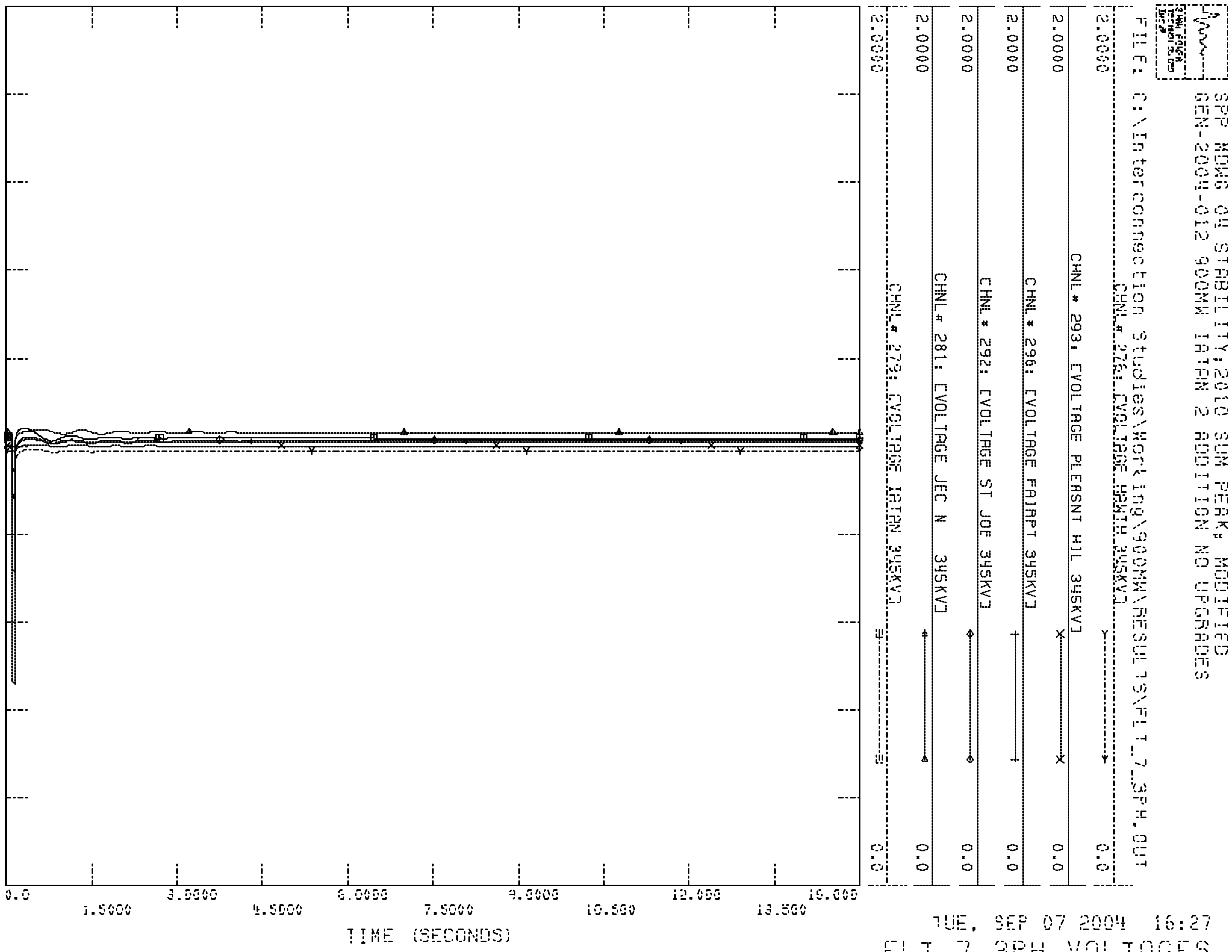
TUE, SEP 07 2004 16:27

FLT_6_3PH_VOLTAGES



TUE, SEP 07 2004 16:27

FLT_7_1PH_VOLTAGES



TUE, SEP 07 2004 16:27

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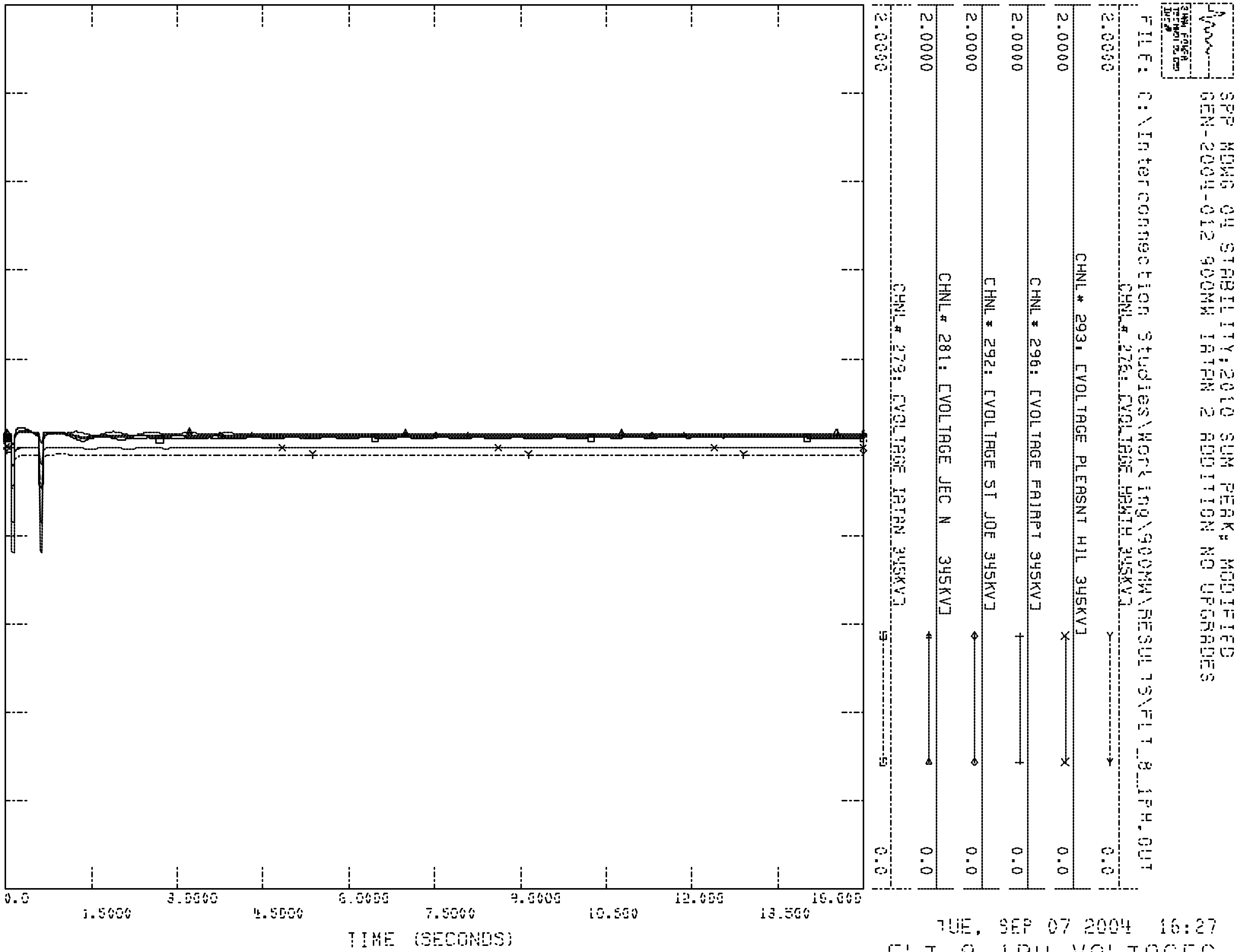

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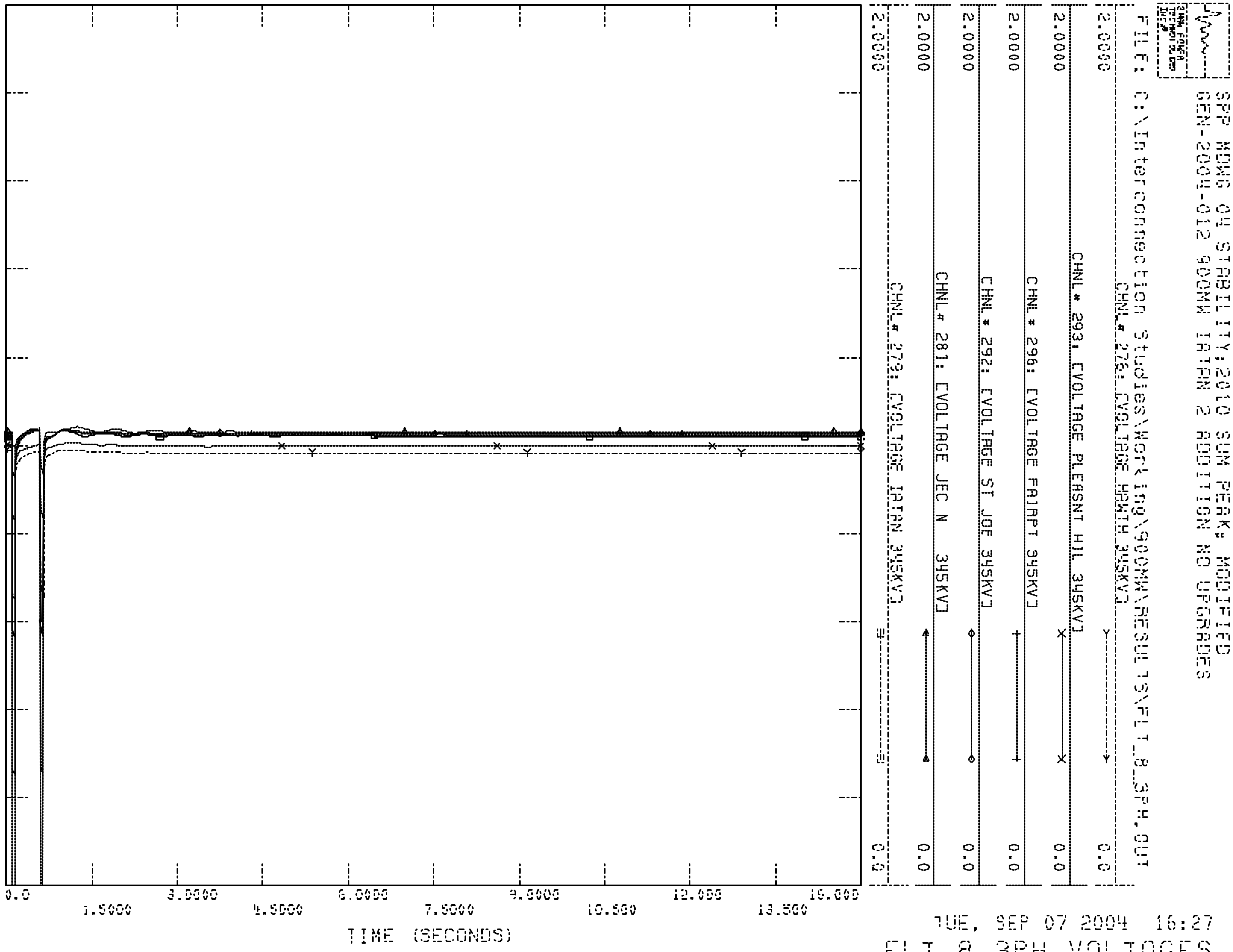
FLT_8_1PH_VOLTAGES



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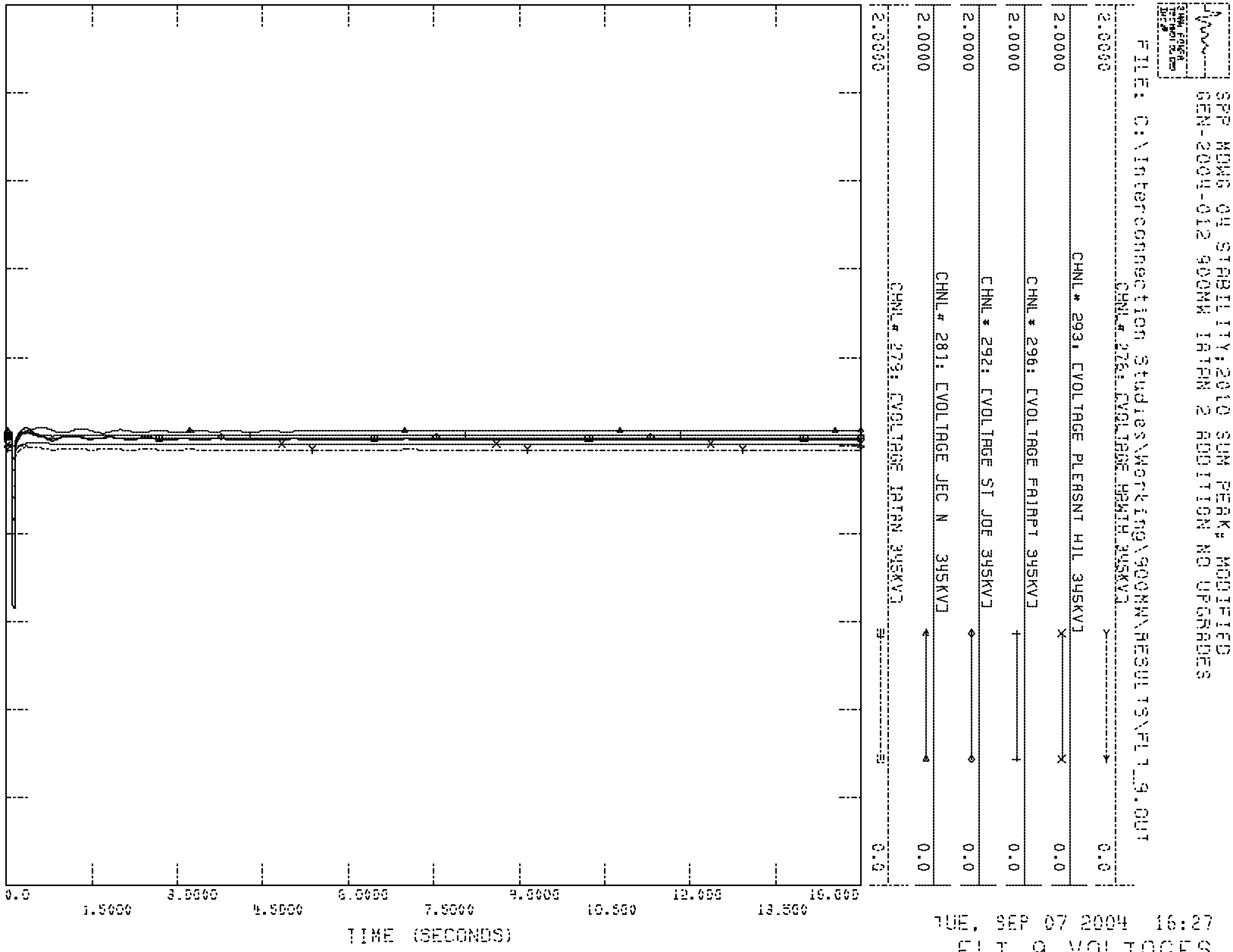
FLT_8_3PH_VOLTAGES



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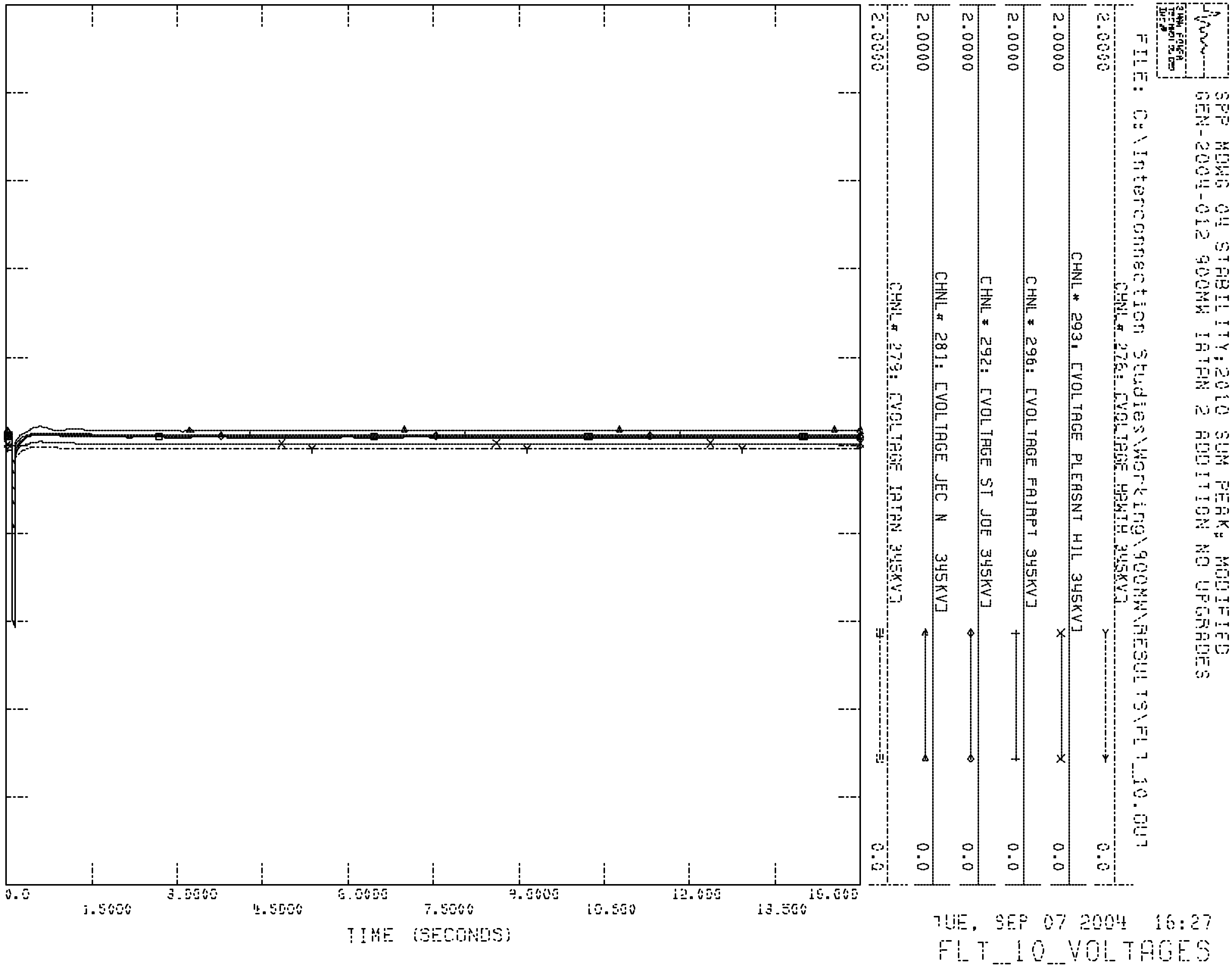
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GEN-2004-012 900MW IATAN 2 ADDITION NO UPGRADES
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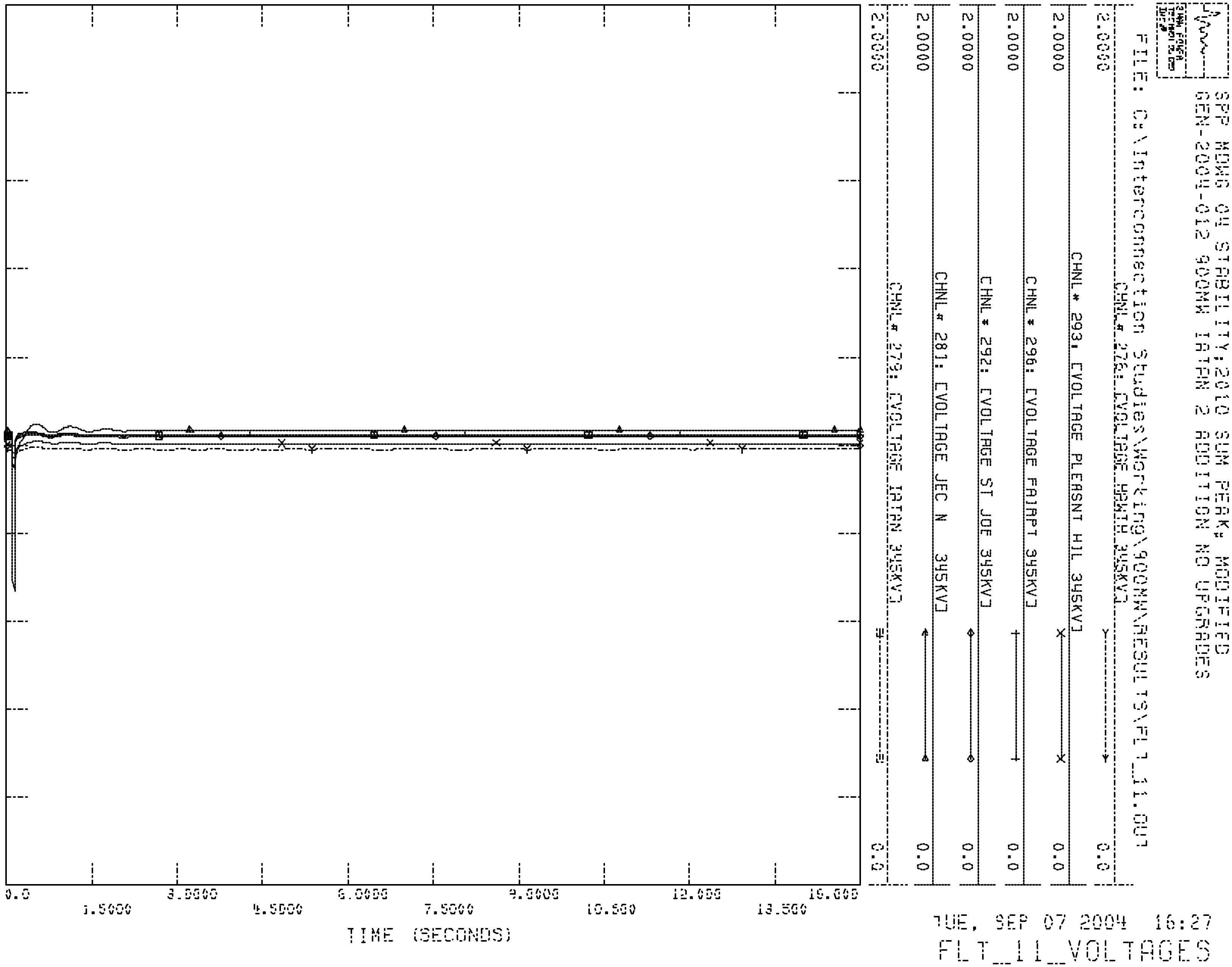
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE IATAN 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, SEP 07 2004 16:27
FLT_10_VOLTAGES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW IATAN 2 ADDITION NO UPGRADES
FILE: C:\Interconnection Studies\Working\900MW\RESULTS\FLT_11.OUT
CHNL# 276: [VOLTAGE HAWTH 345KV]
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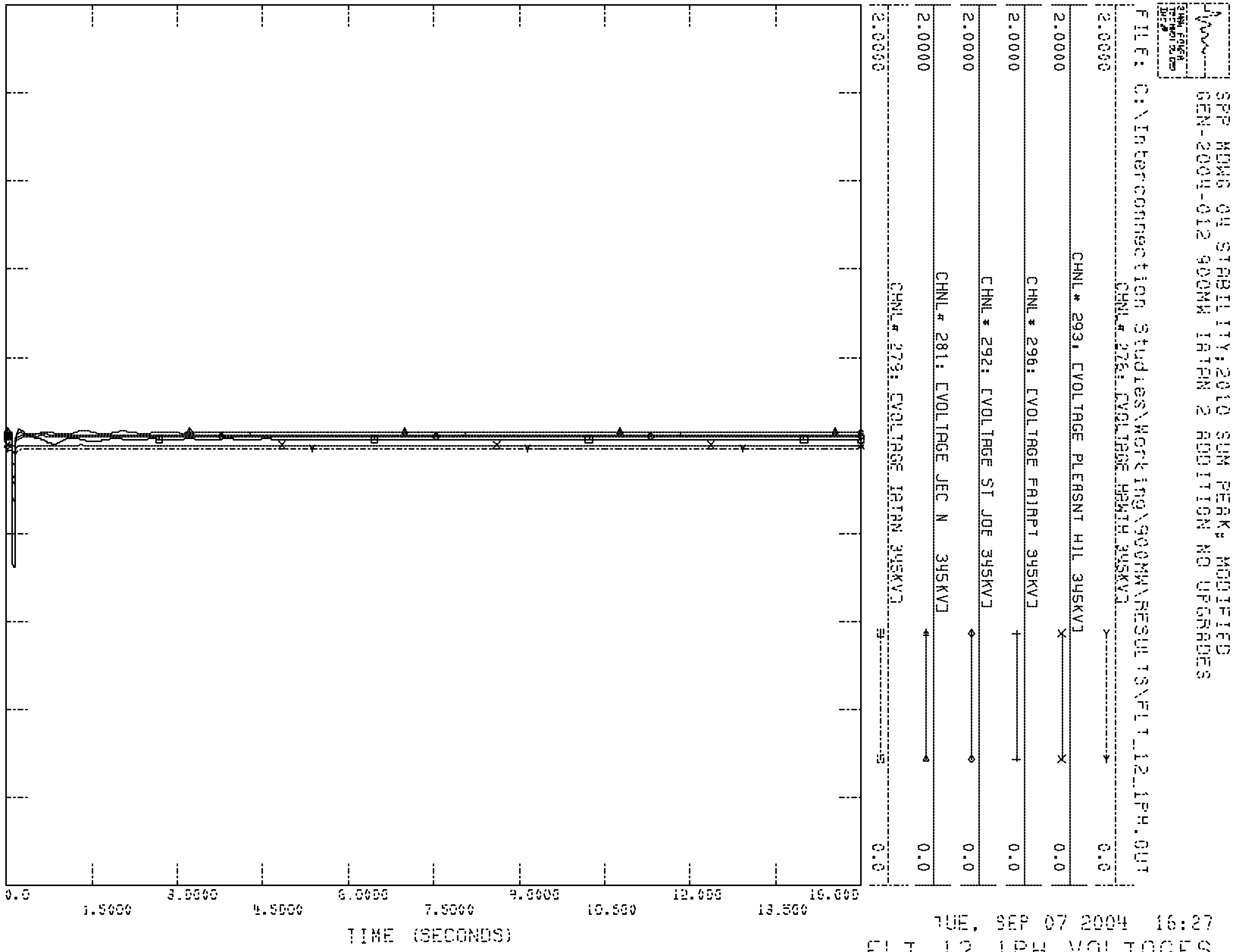
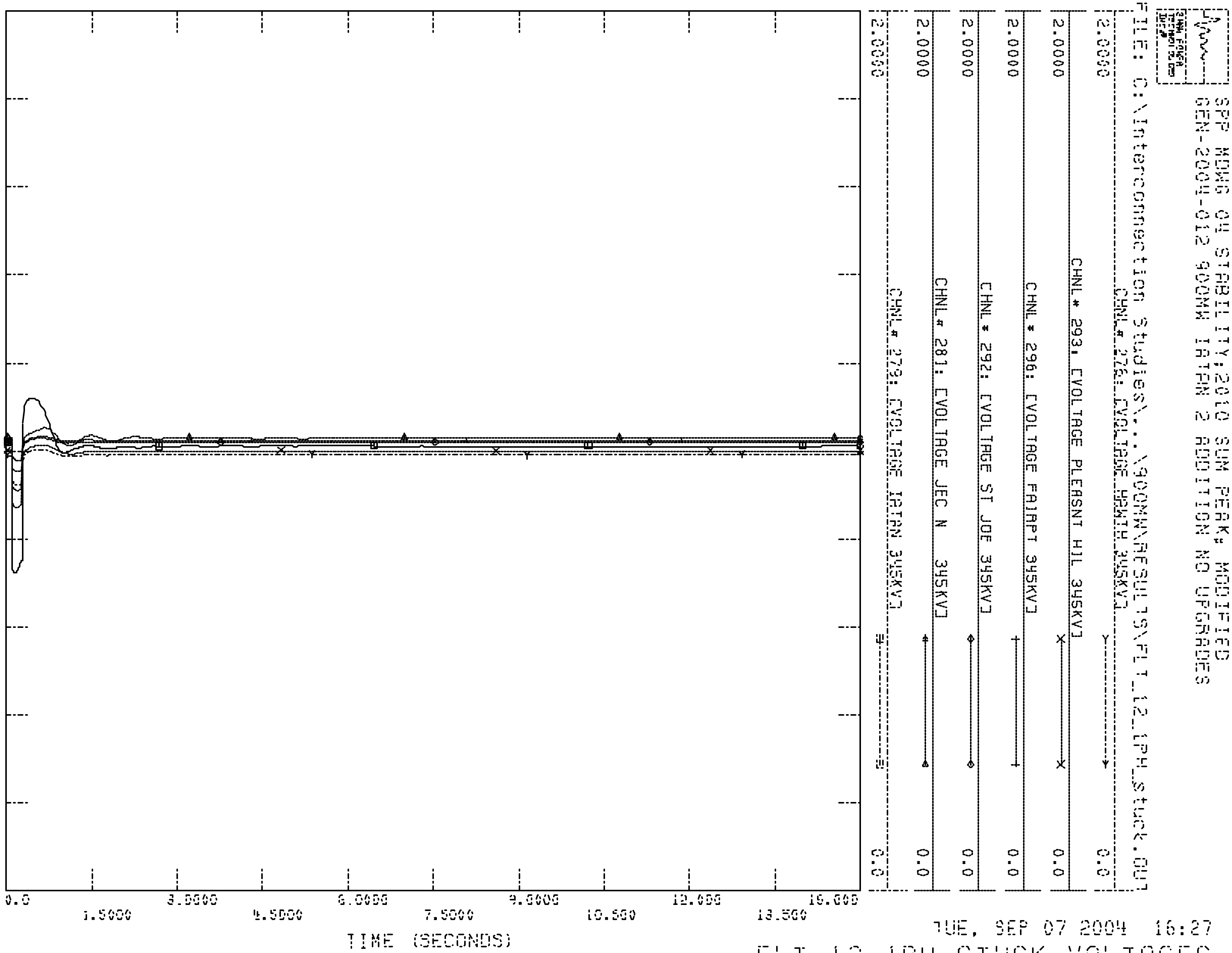
0.0
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE IATAN 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, SEP 07 2004 16:27
FLT_11_VOLTAGES

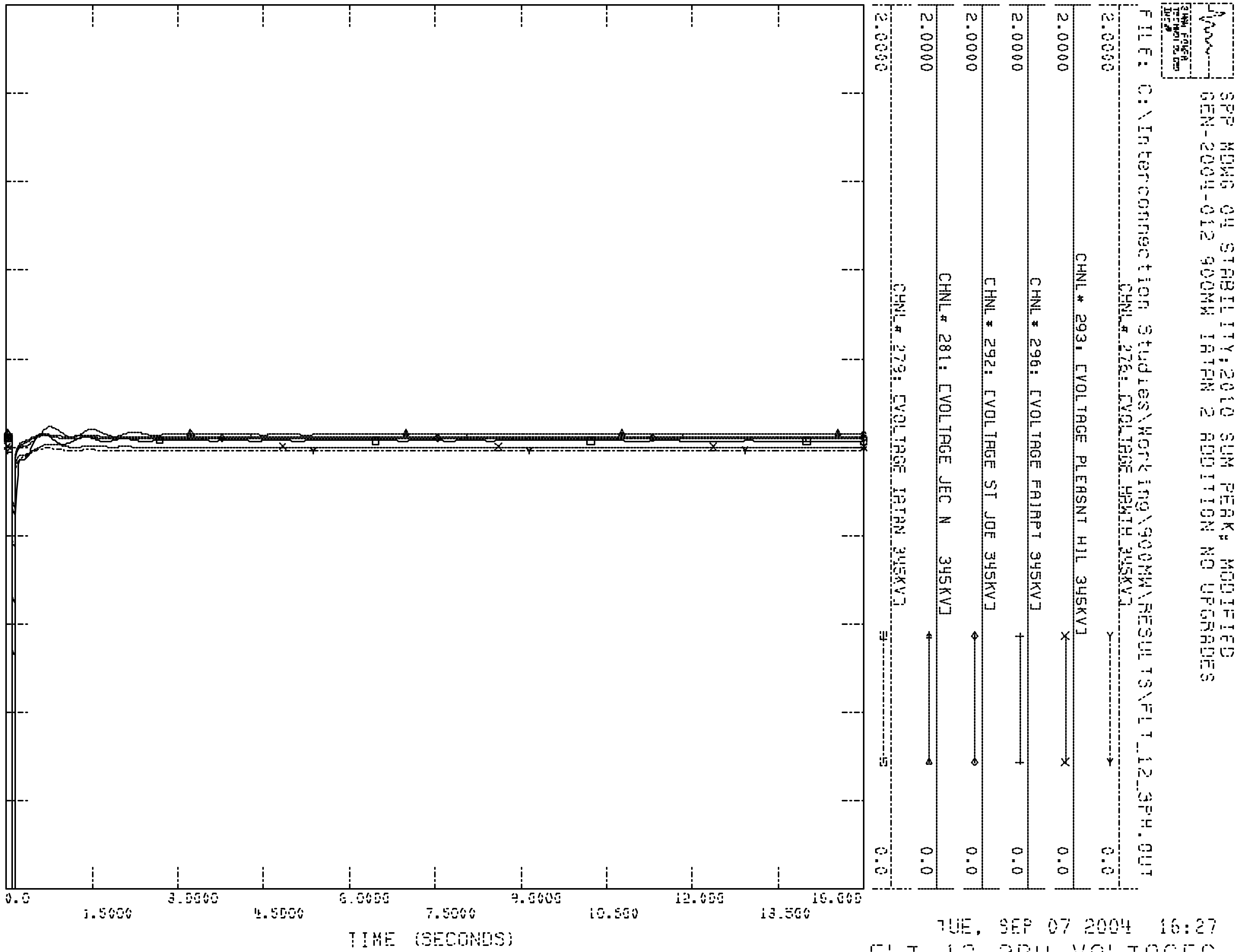


TUE, SEP 07 2004 16:27

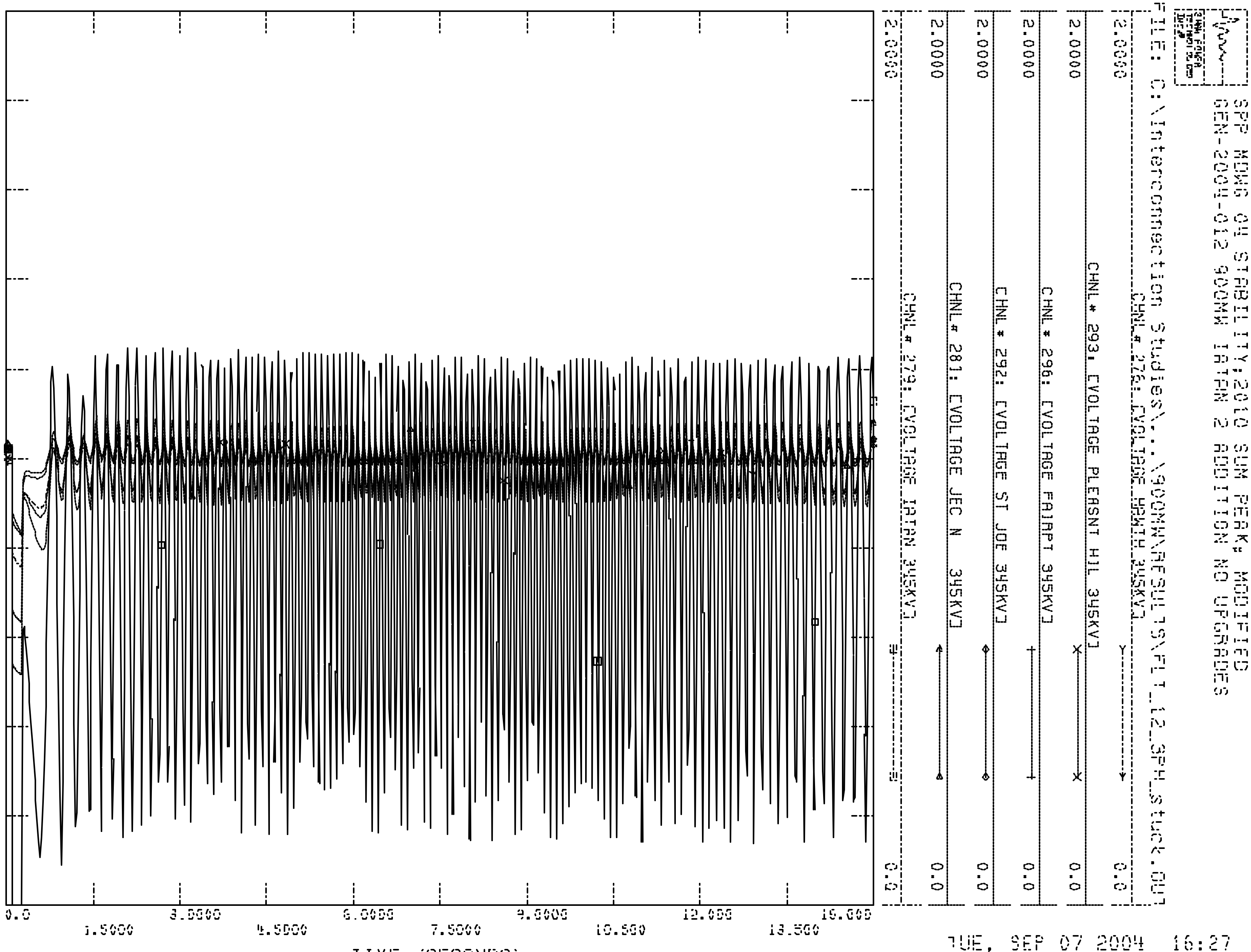
FLT_12_1PH_VOLTAGES



FLT_12_1PH_STUCK_VOLTAGES



FLT_12_3PH_VOLTAGES



TUE, SEP 07 2004 16:27

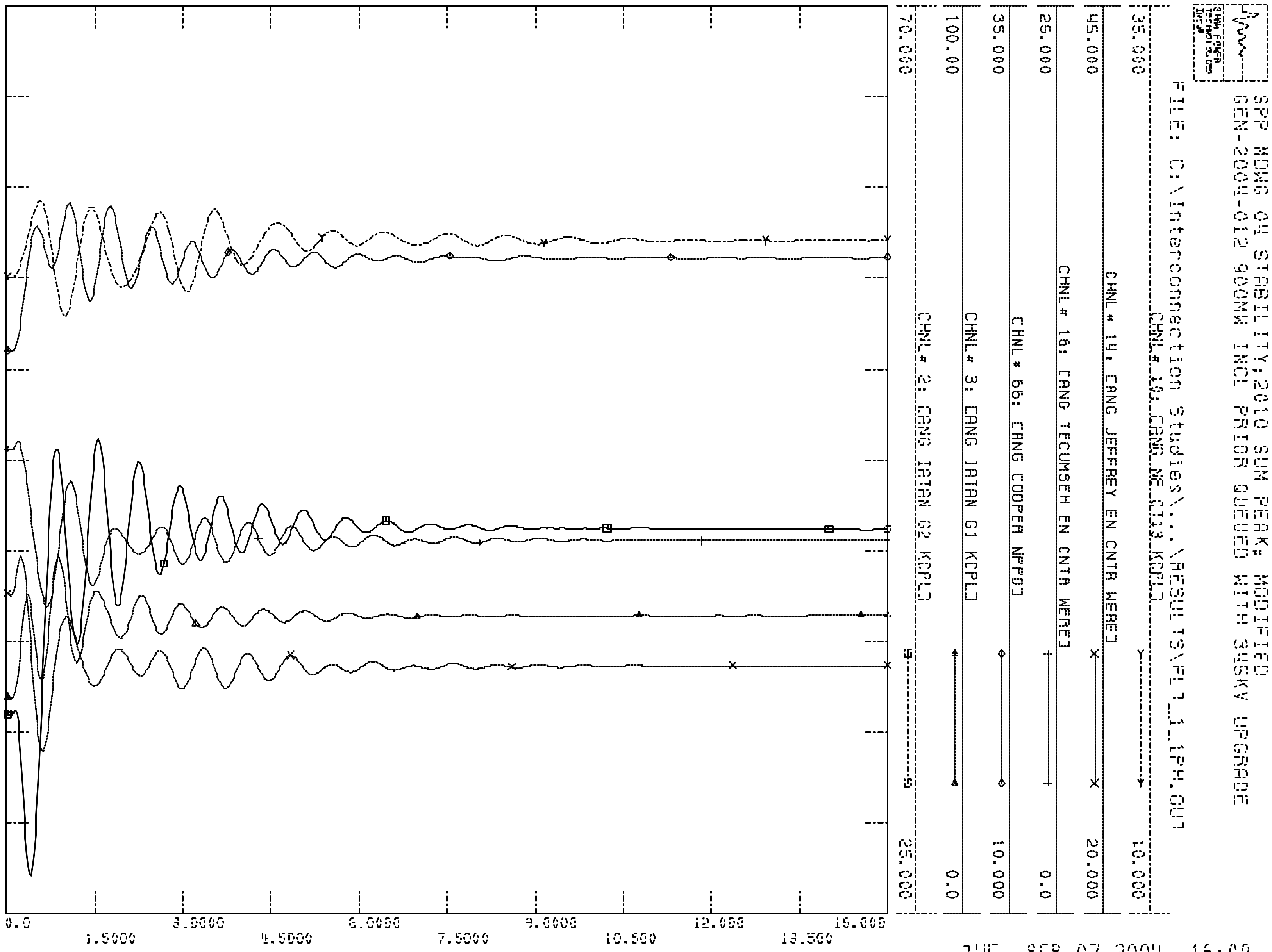
FLT_12_3PH_STUCK_VOLTAGES

Appendix C-1

Plots of Fault Simulations

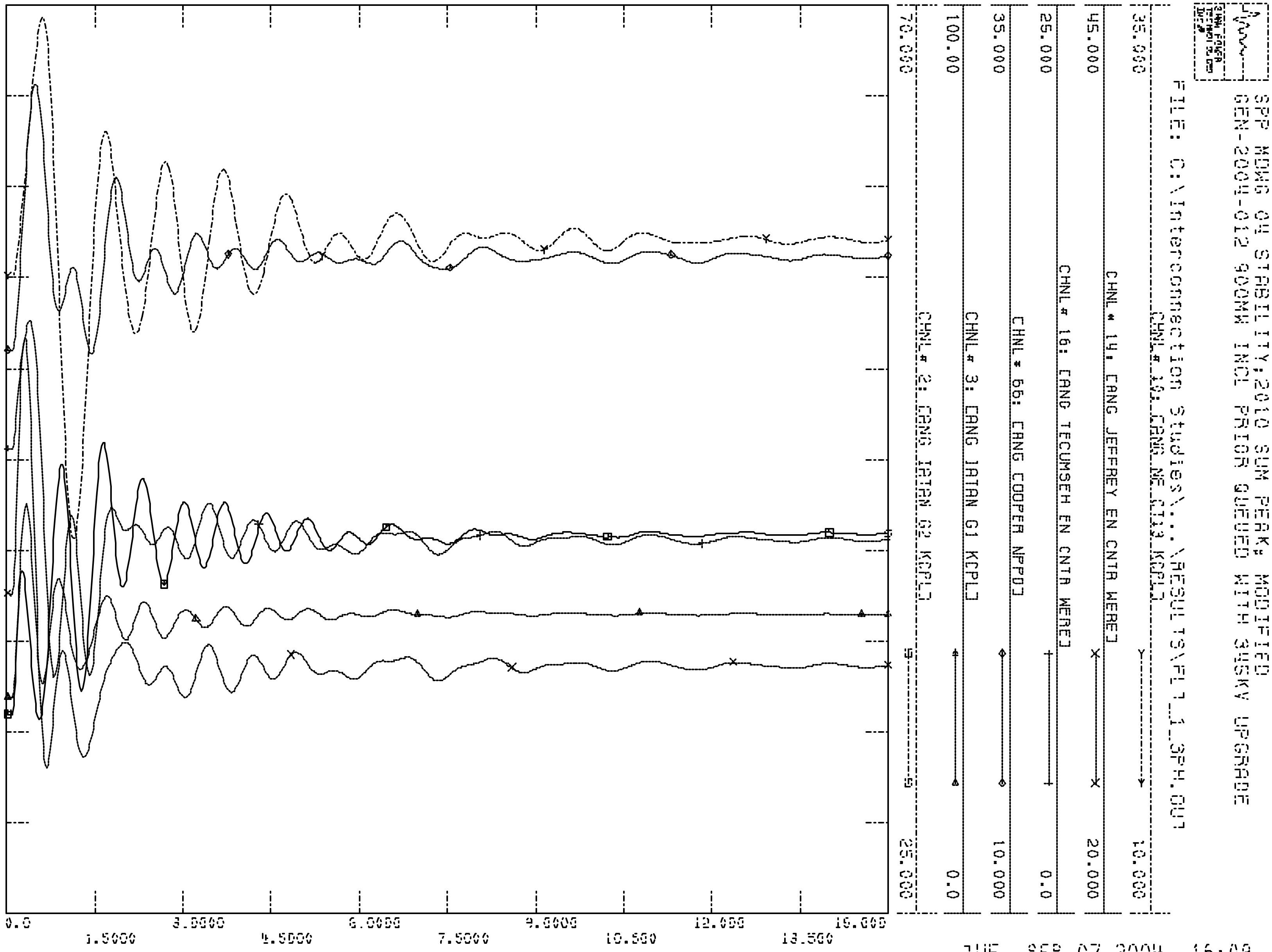
Plots of selected machine angle response during faults

Scenario:
2010 Summer Peak
900MW
[Customer Plant at 900MW – Iatan-Nashua 345kV]



TUE, SEP 07 2004 16:09

FLT_1_1PH_MACHINE ANGLES



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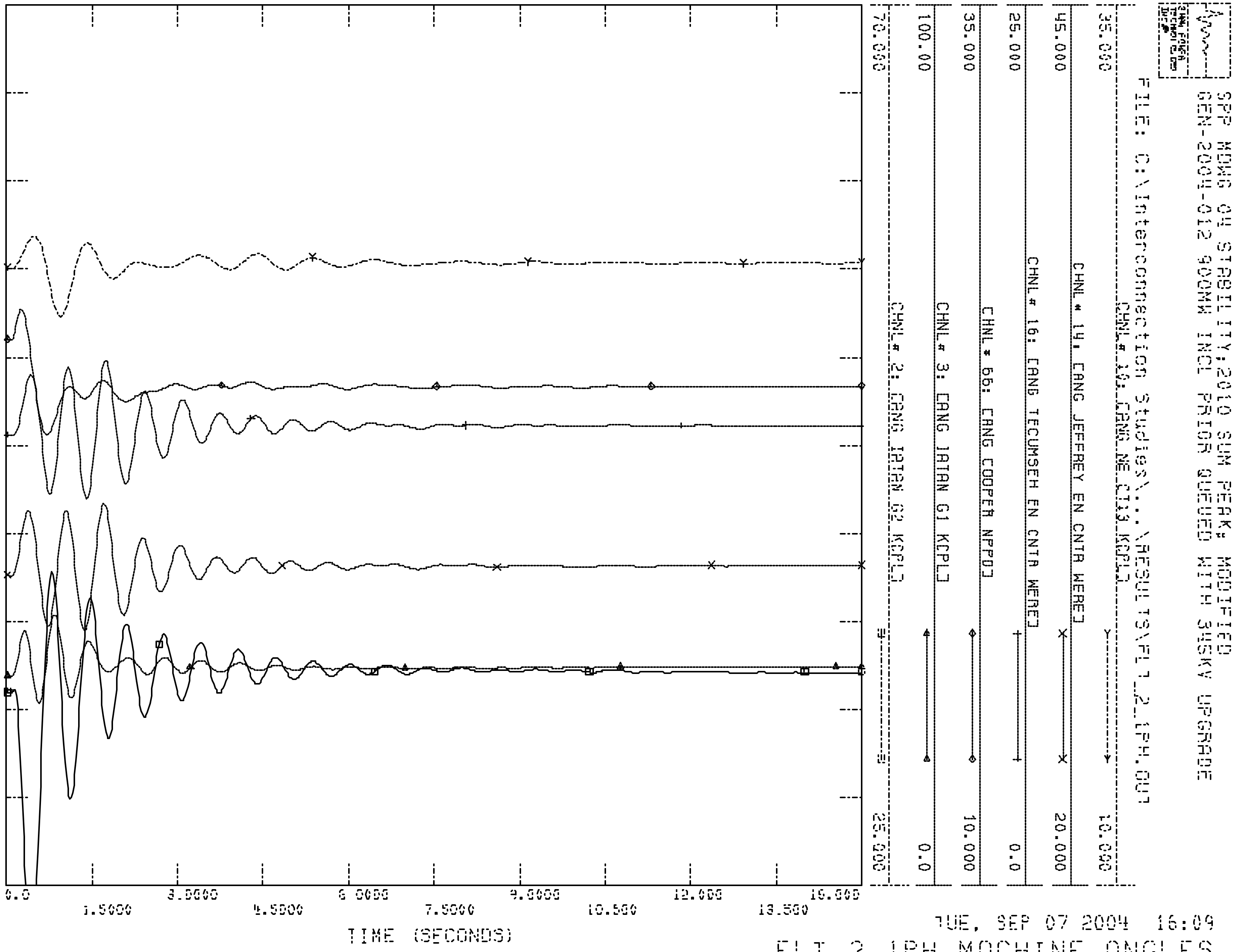
FLT_1_3PH_MACHINE ANGLES



TUE, SEP 07 2004 16:09

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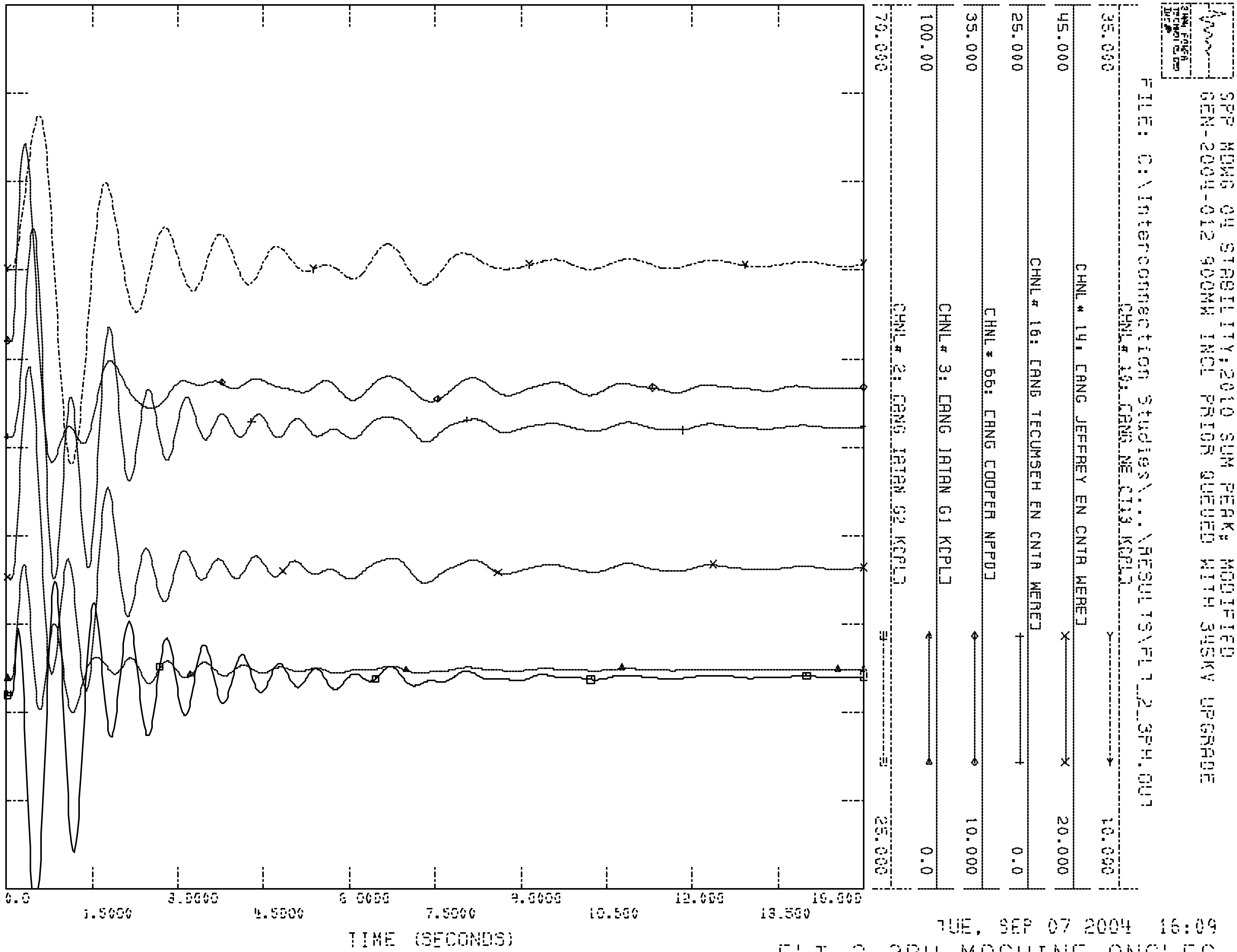
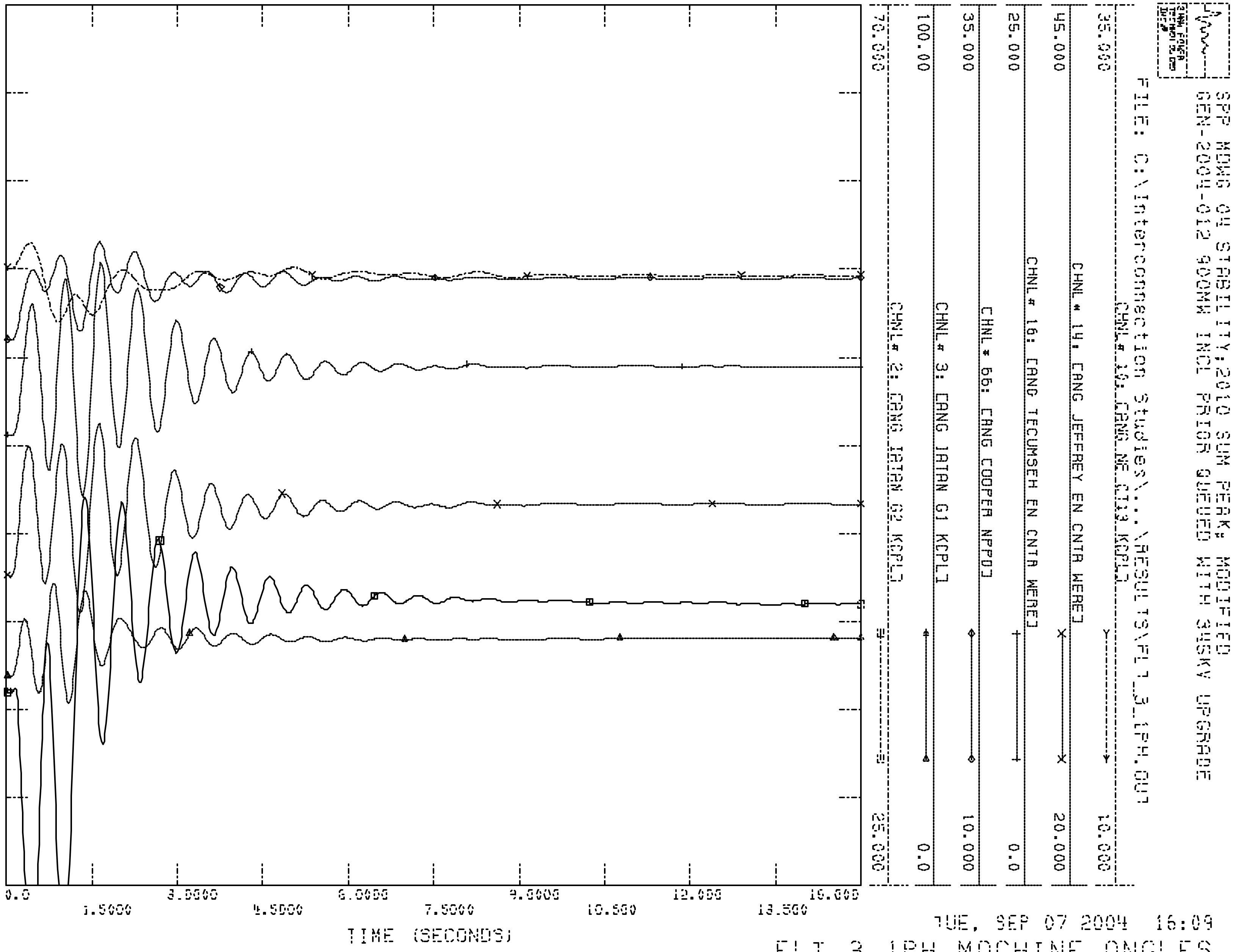
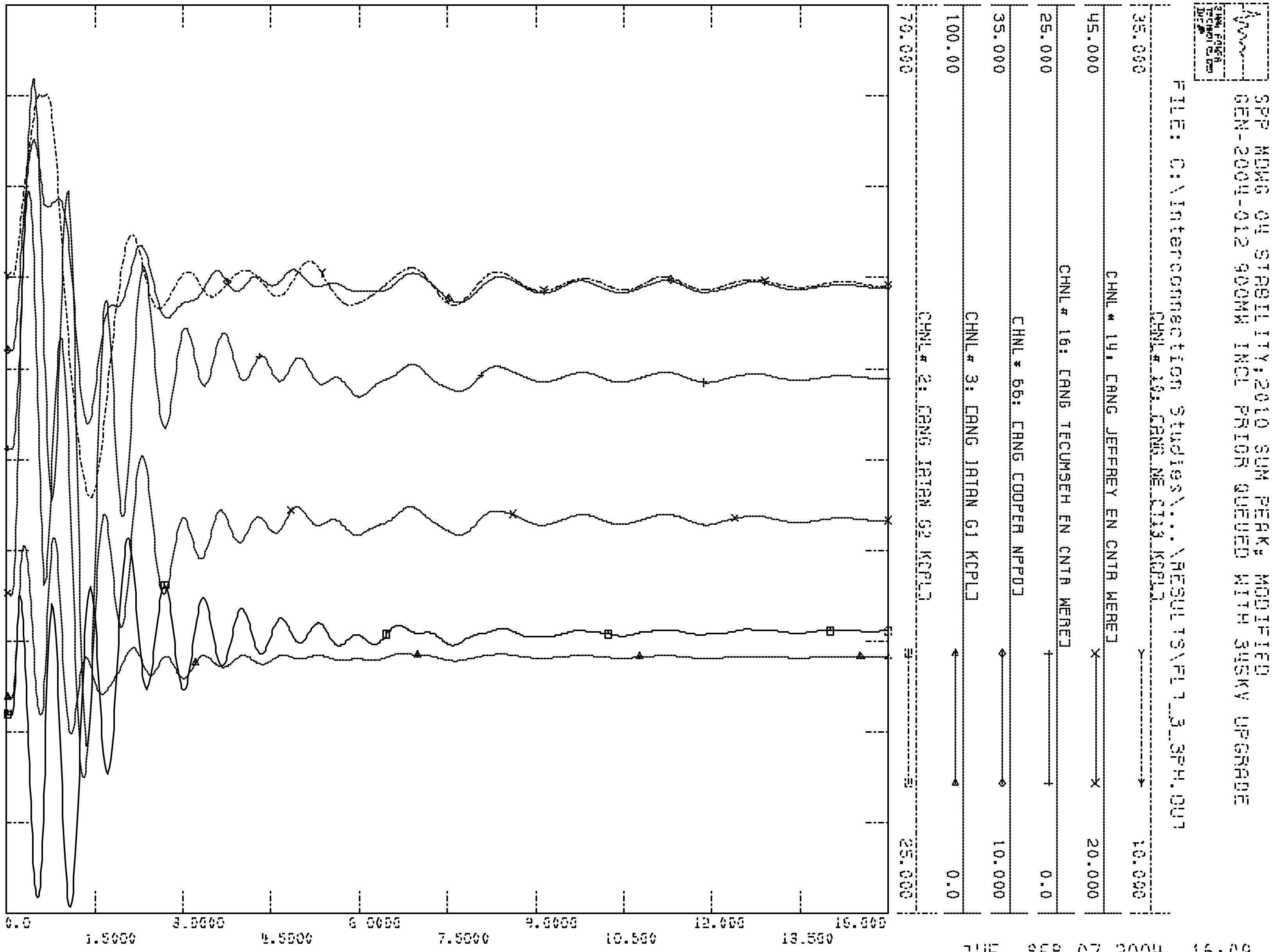


FLT_2_3PH_MACHINE ANGLES



FLT_3_1PH_MACHINE ANGLES



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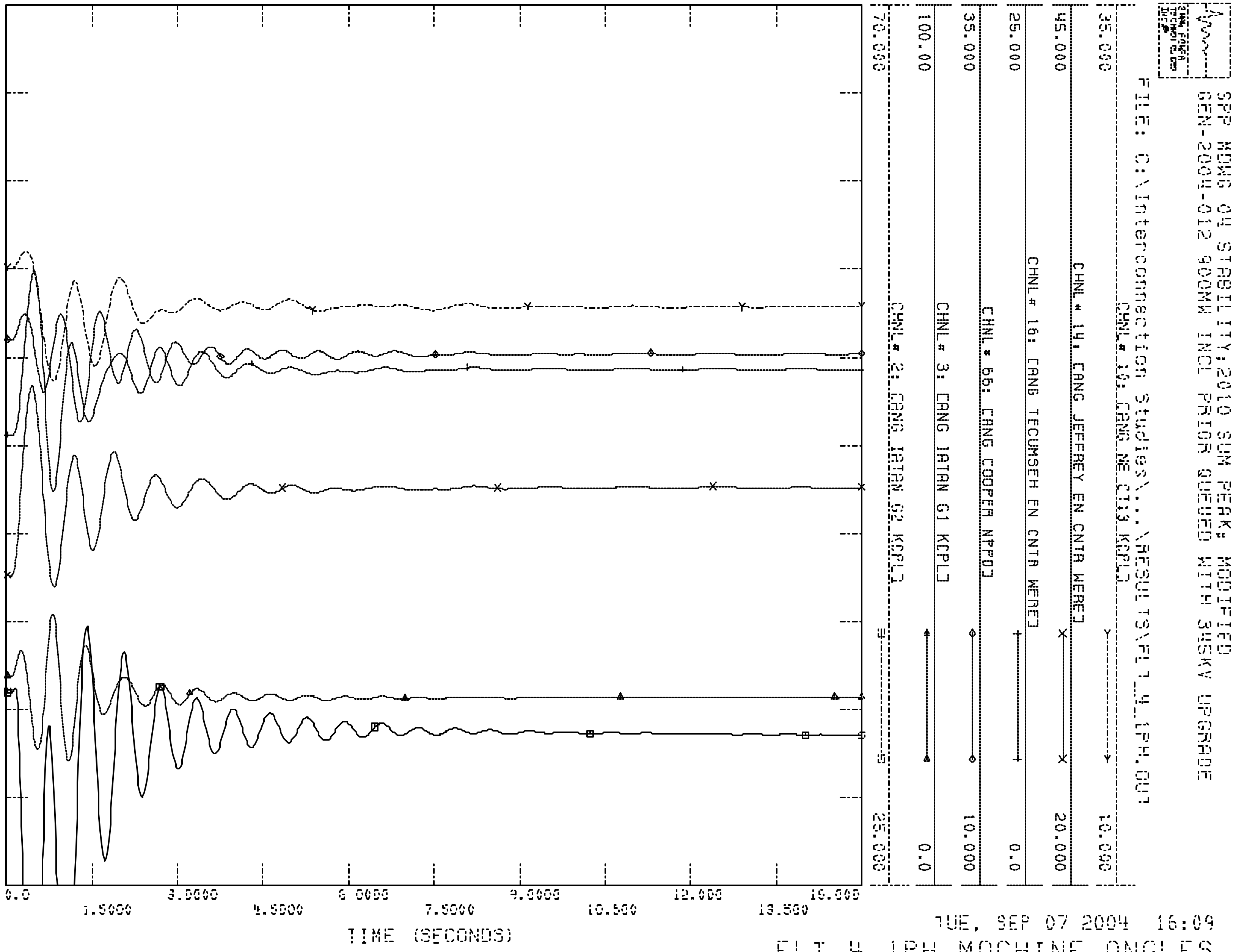

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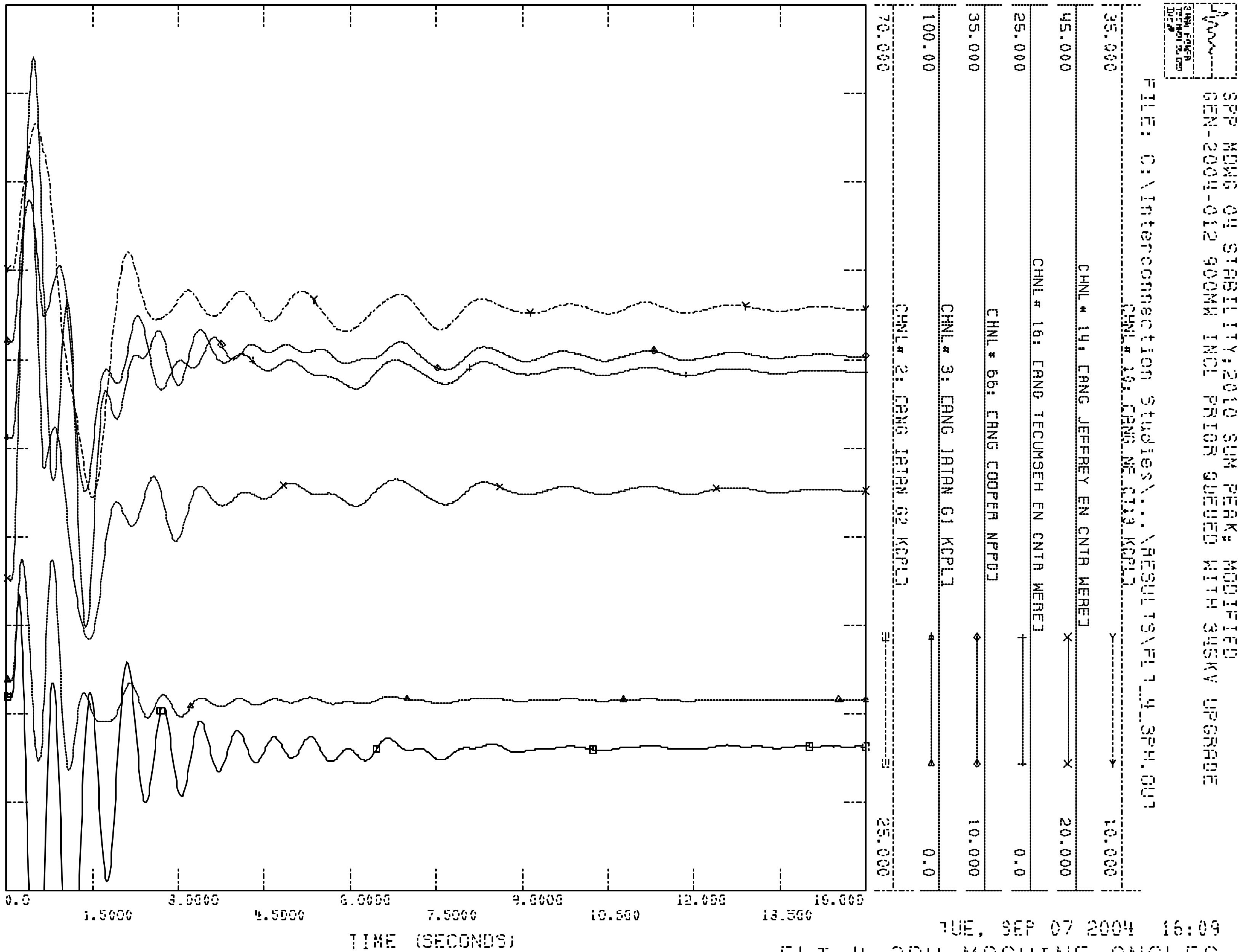

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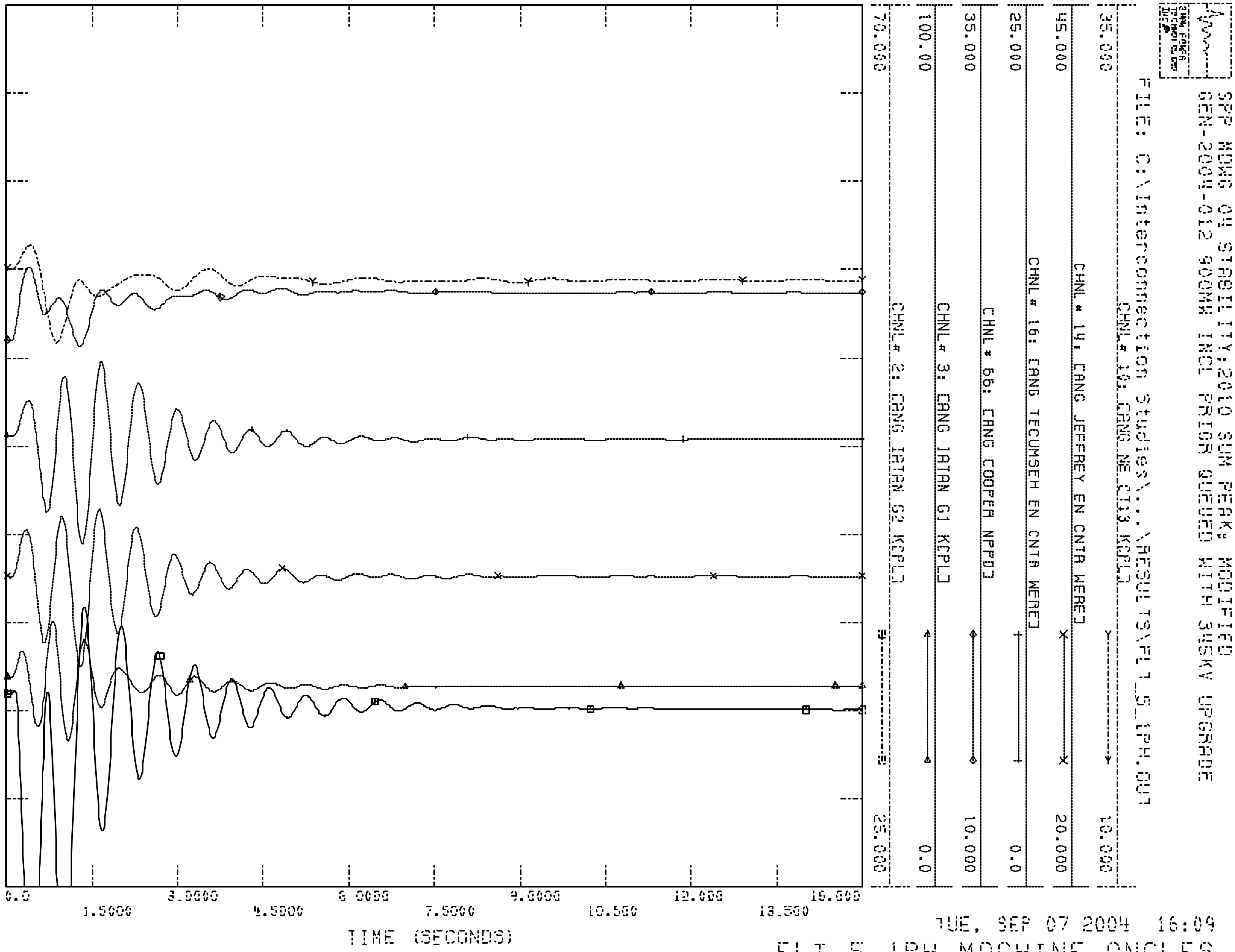

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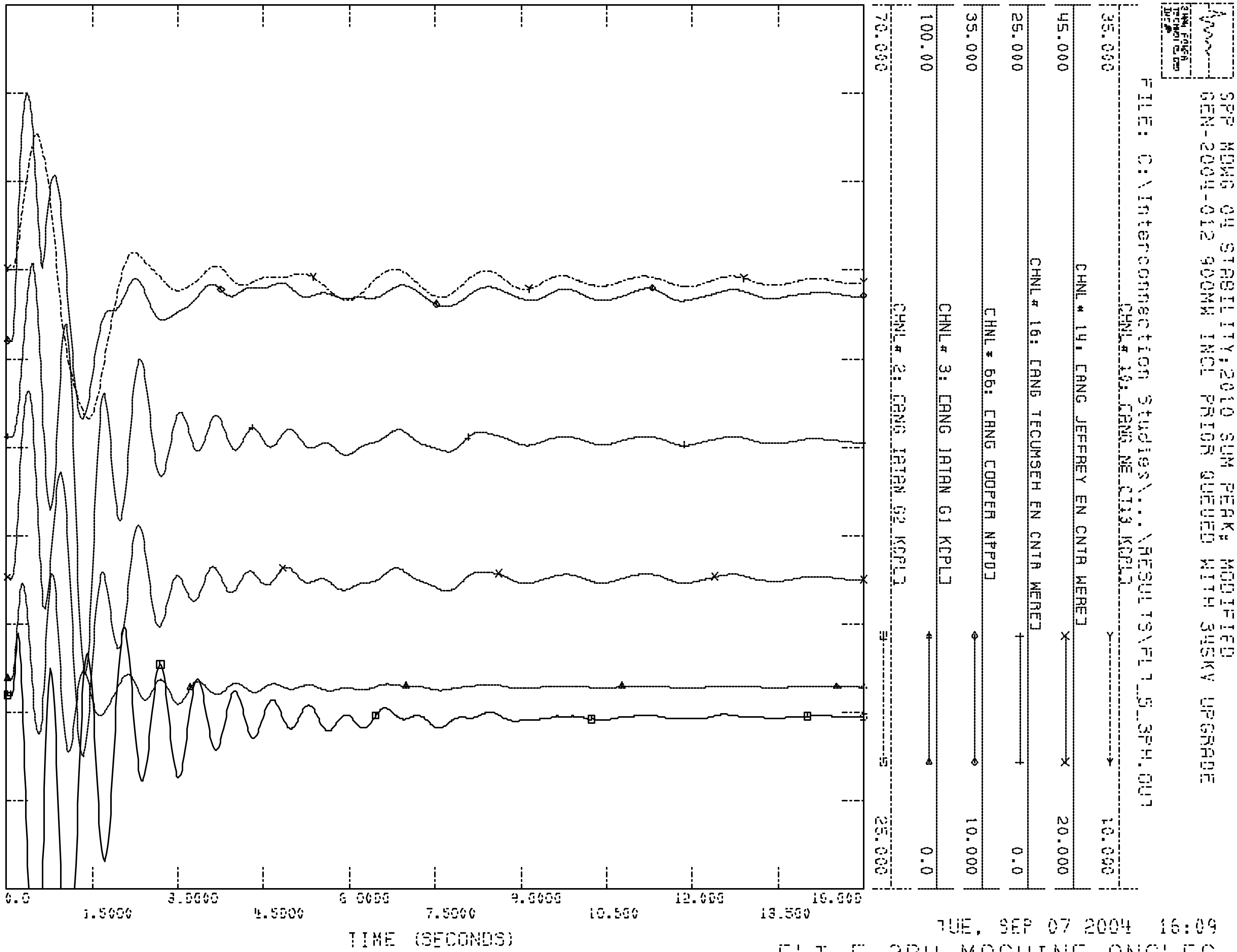
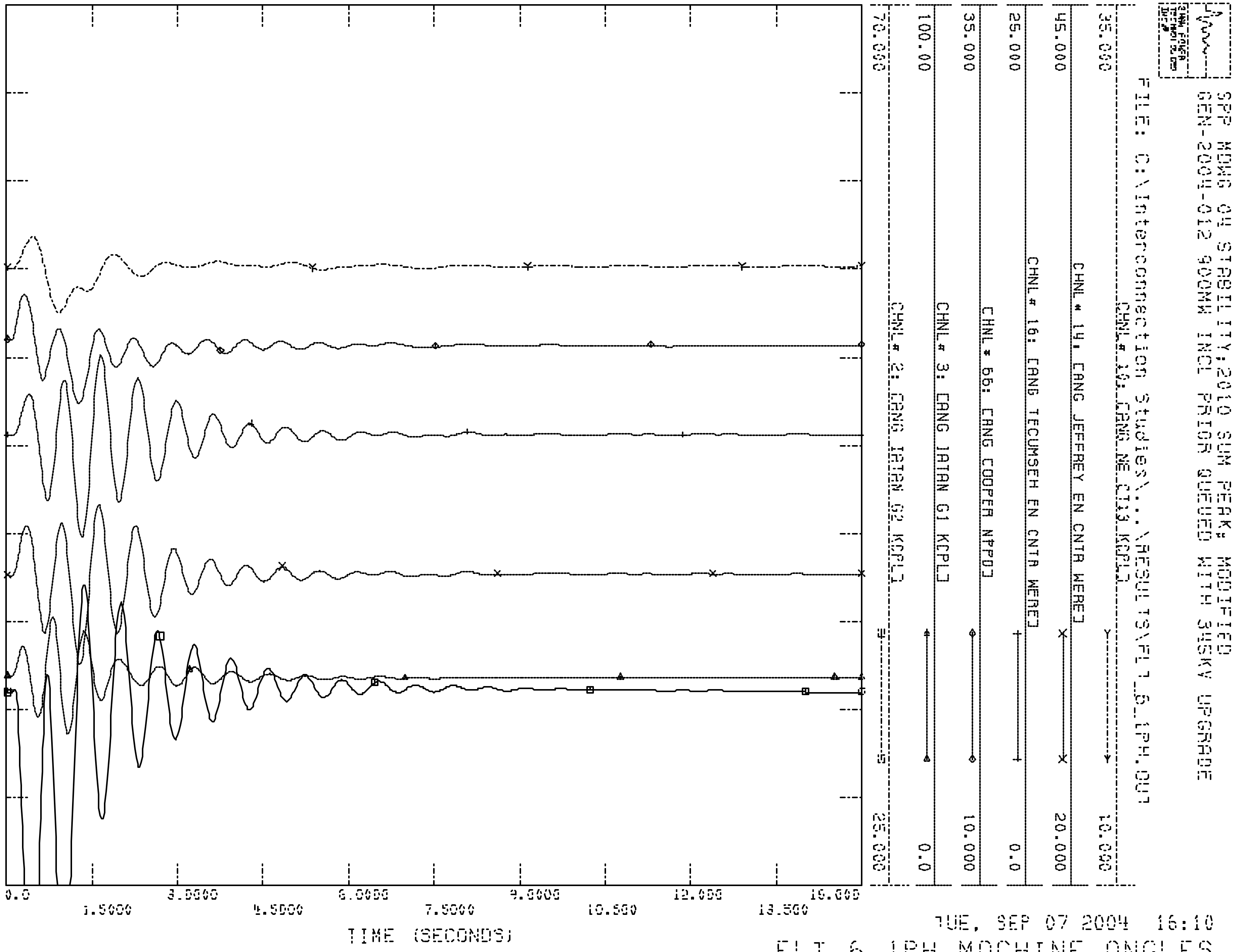


TUE, SEP 07 2004 16:09

FLT_5_3PH_MACHINE ANGLES



TUE, SEP 07 2004 16:10

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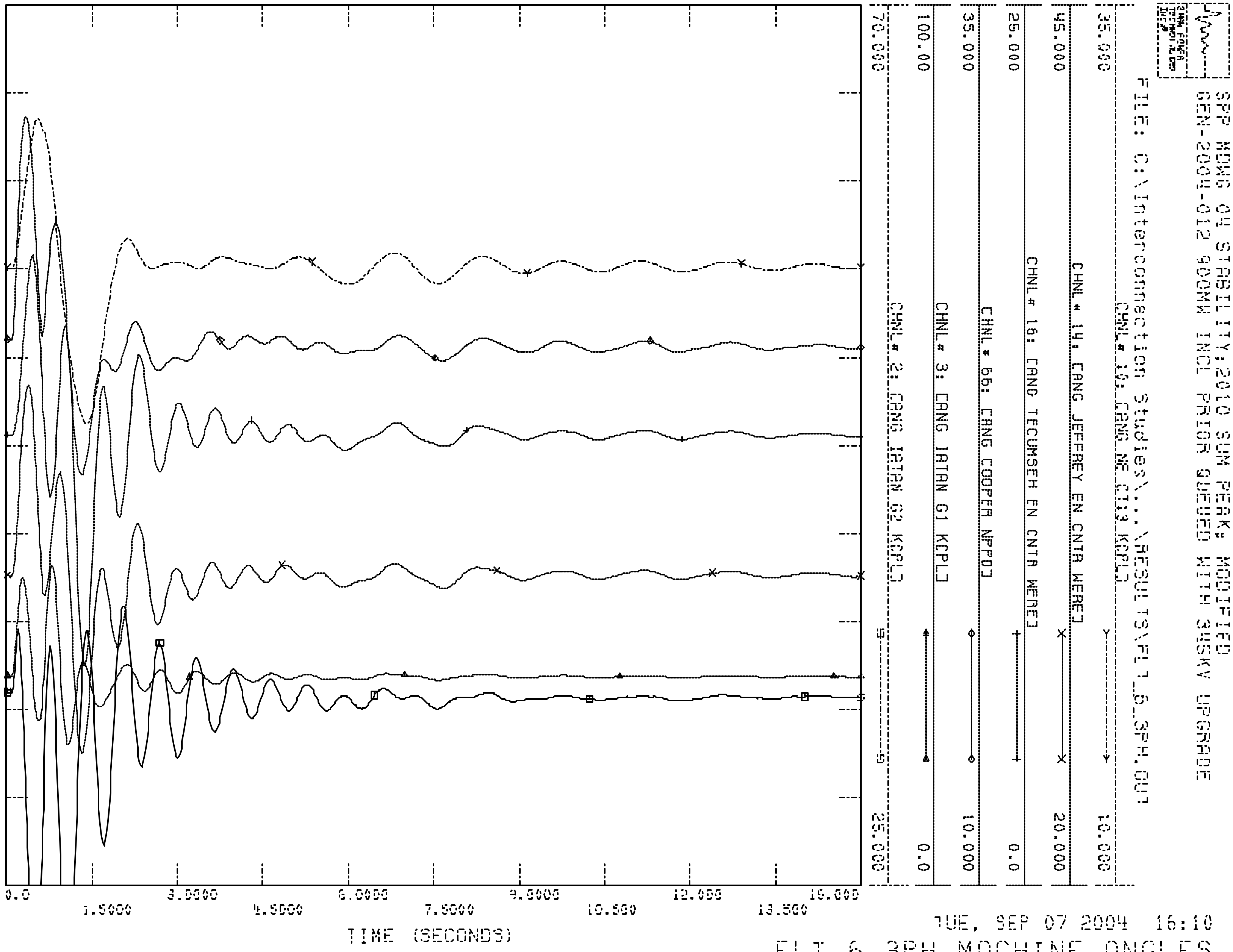

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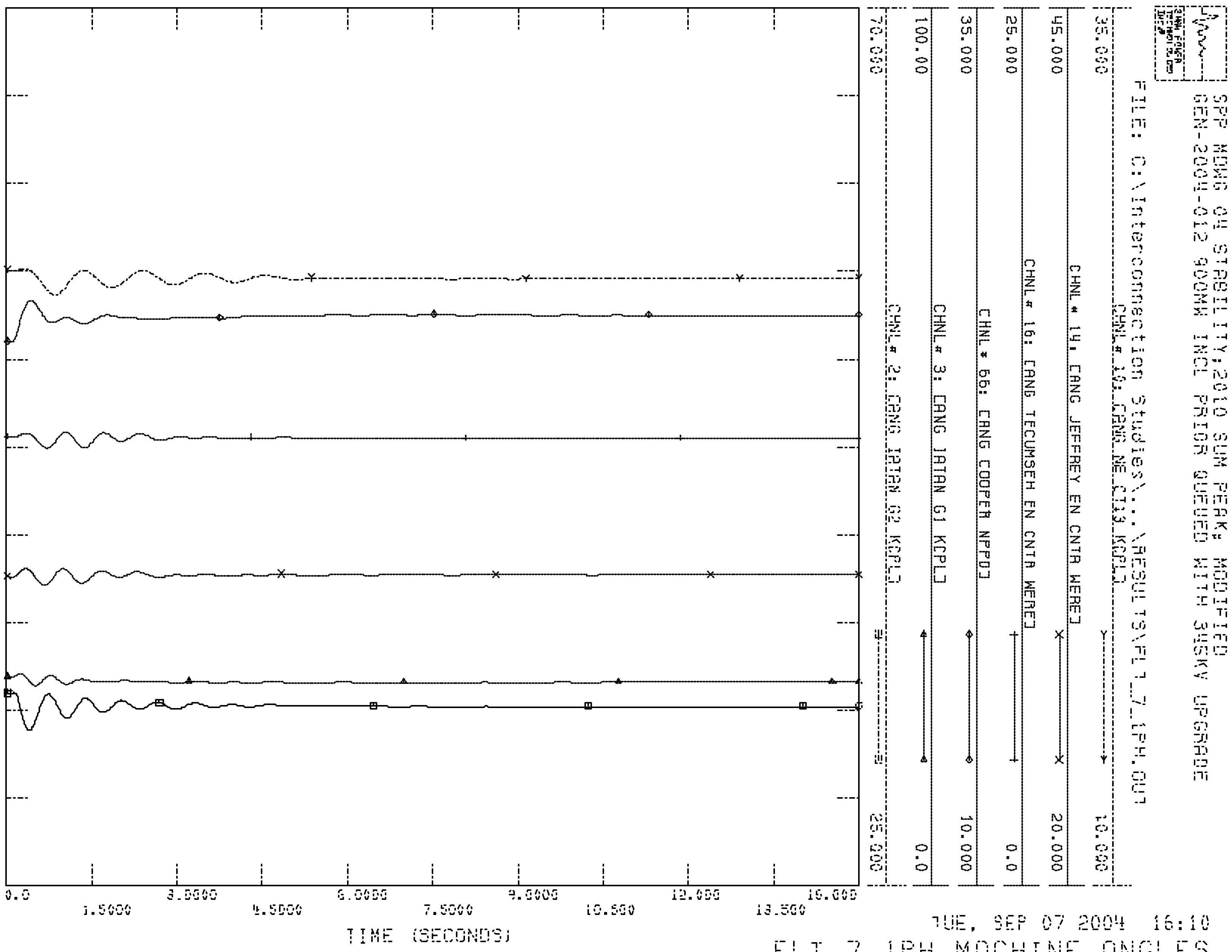
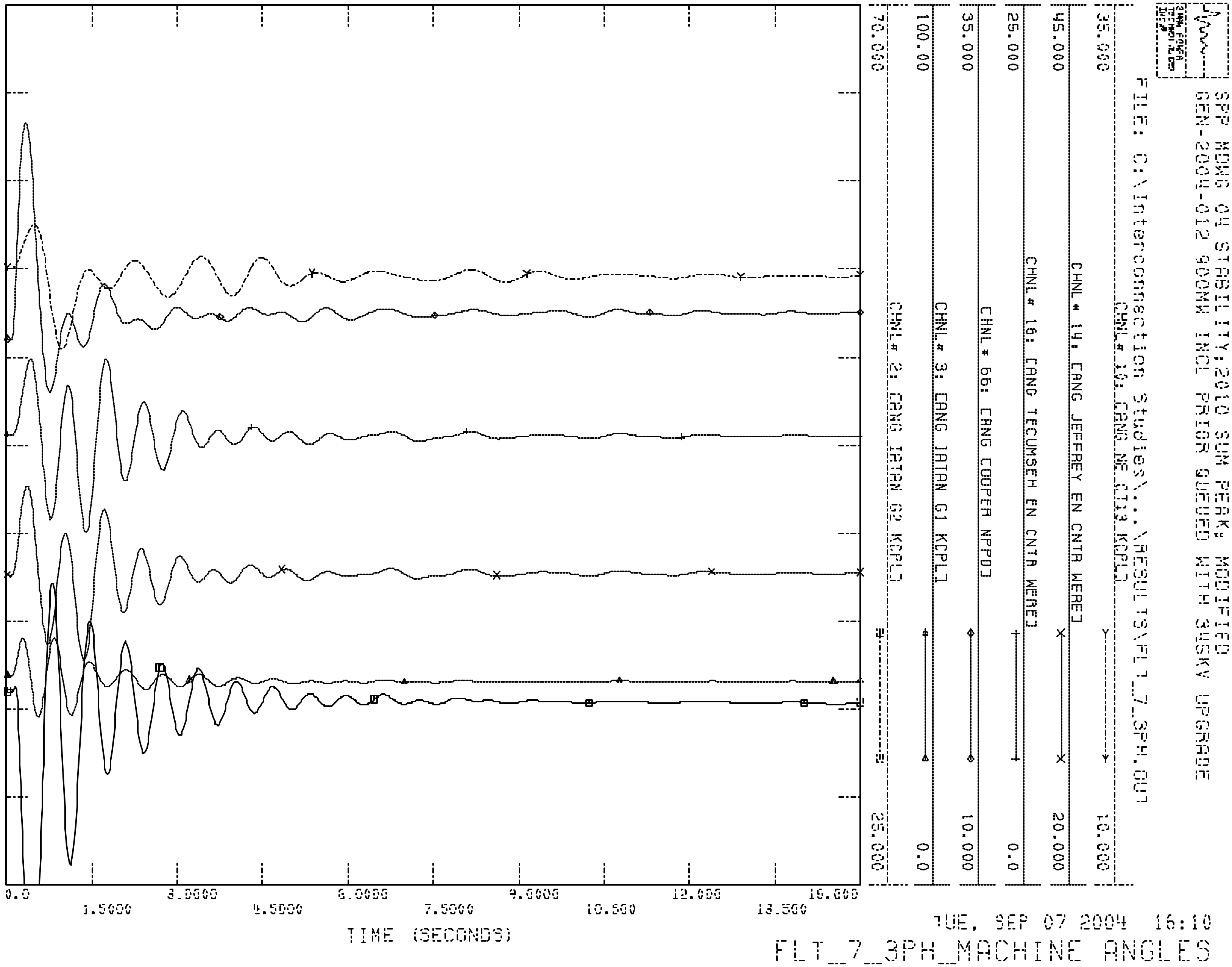
FLT_6_3PH_MACHINE ANGLES



TUE, SEP 07 2004 16:10

FLT_7_1PH_MACHINE ANGLES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW INCL PRIOR QUEUED WITH 345KV UPGRADE
FILE: C:\Interconnection Studies\...\RESULTS\FLT_7_3PH.OUT
35.000
CHNL# 10: [ANG NE CT13 KCPL]
10.000
45.000
CHNL# 14: [ANG JEFFREY EN CNTR WERE]
20.000
25.000
CHNL# 16: [ANG TECUMSEH EN CNTR WERE]
0.0
35.000
CHNL# 66: [ANG COOPER NPPD]
10.000
100.00
CHNL# 3: [ANG IATAN G1 KCPL]
0.0
70.000
CHNL# 2: [ANG IATAN G2 KCPL]
25.000
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
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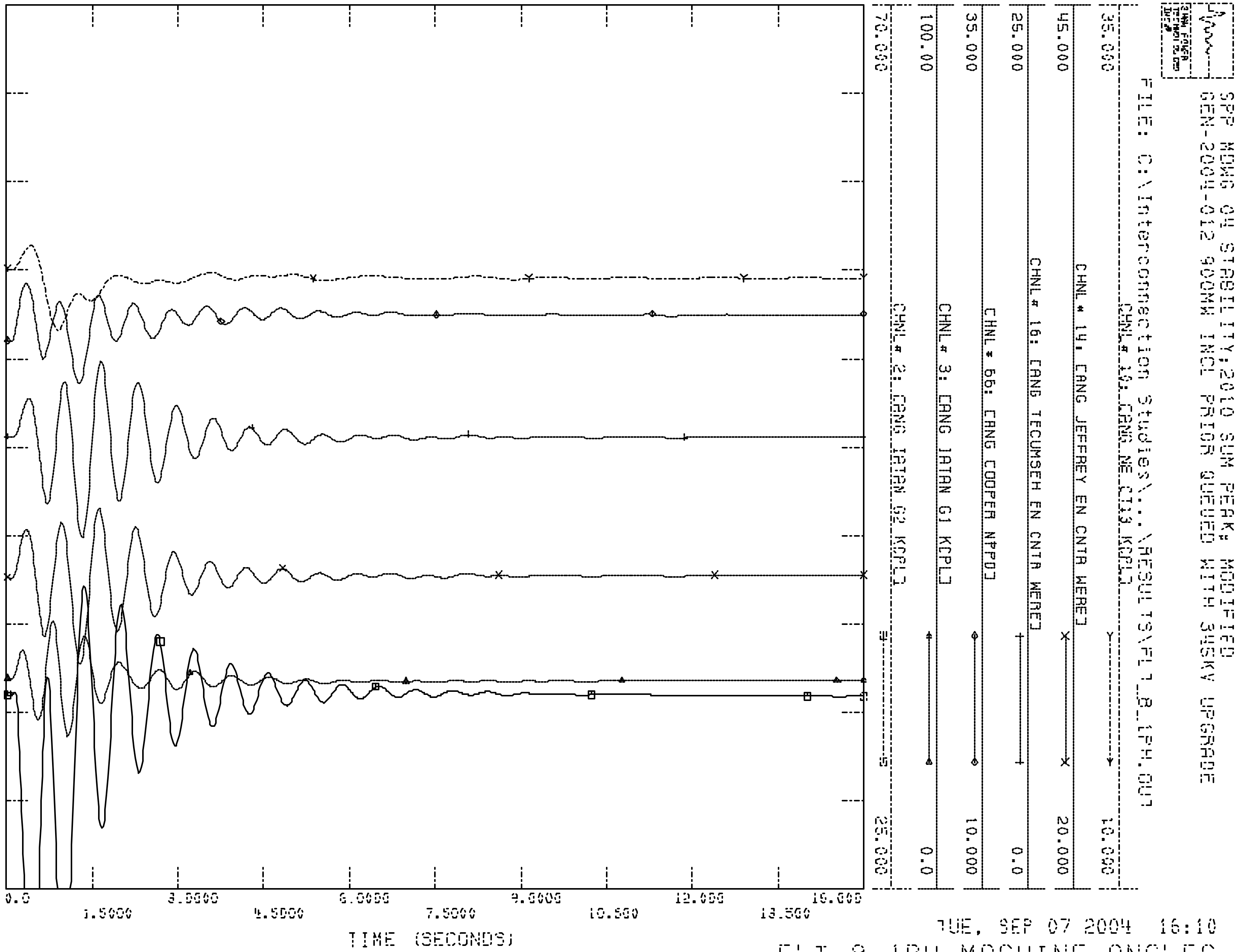
TIME (SECONDS)
TUE, SEP 07 2004 16:10
FLT_7_3PH_MACHINE ANGLES



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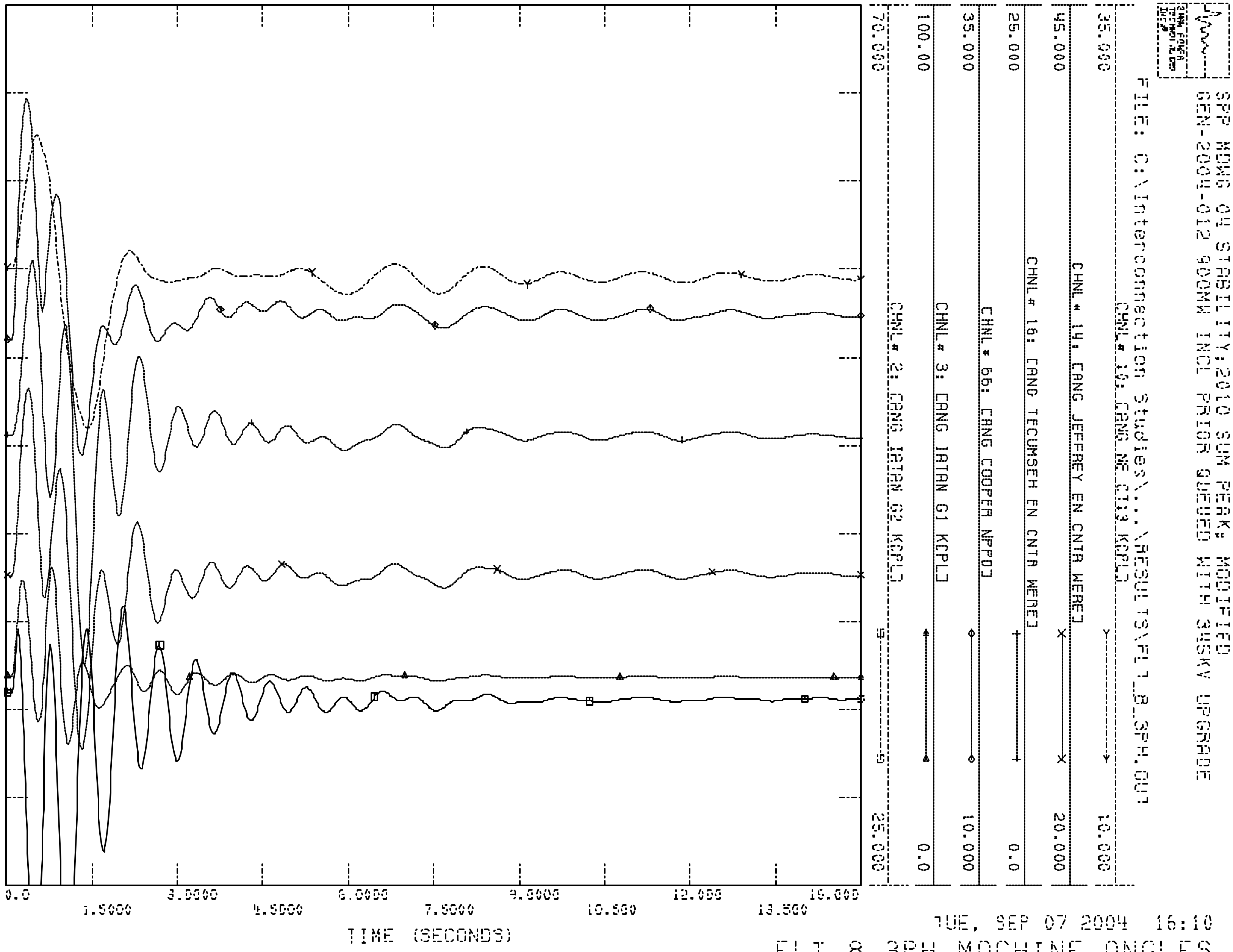
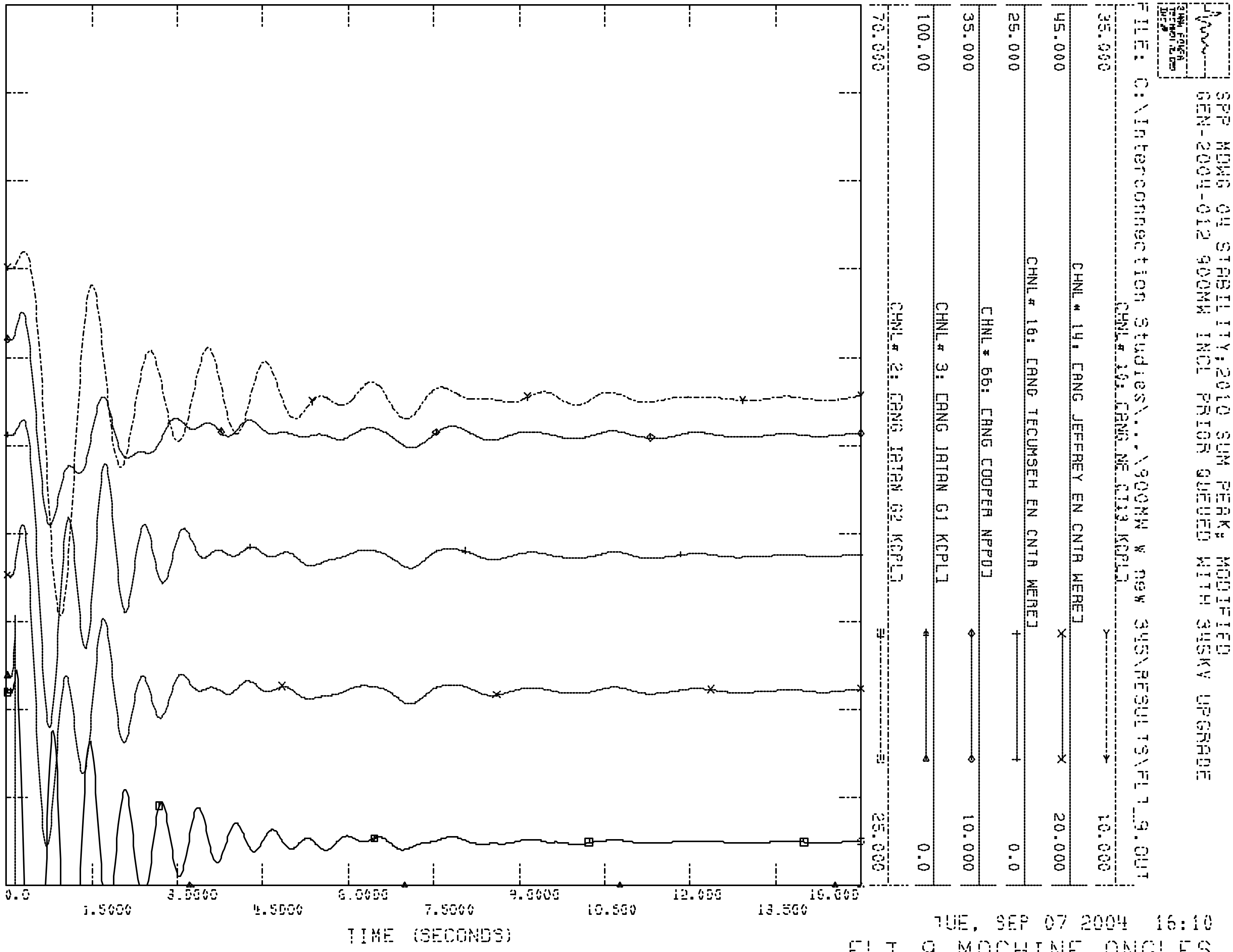


TUE, SEP 07 2004 16:10

FLT_8_3PH_MACHINE ANGLES



TUE, SEP 07 2004 16:10

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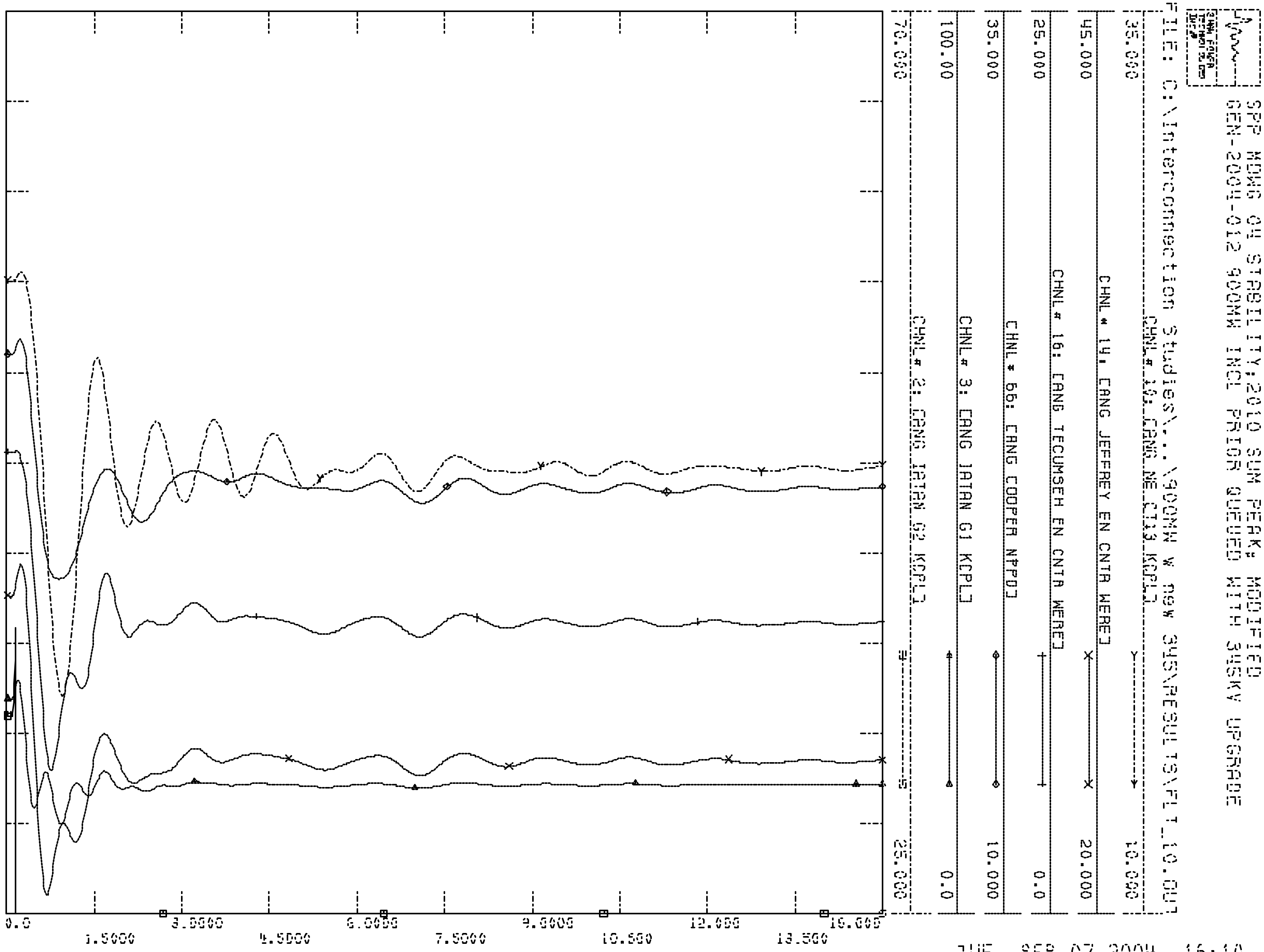
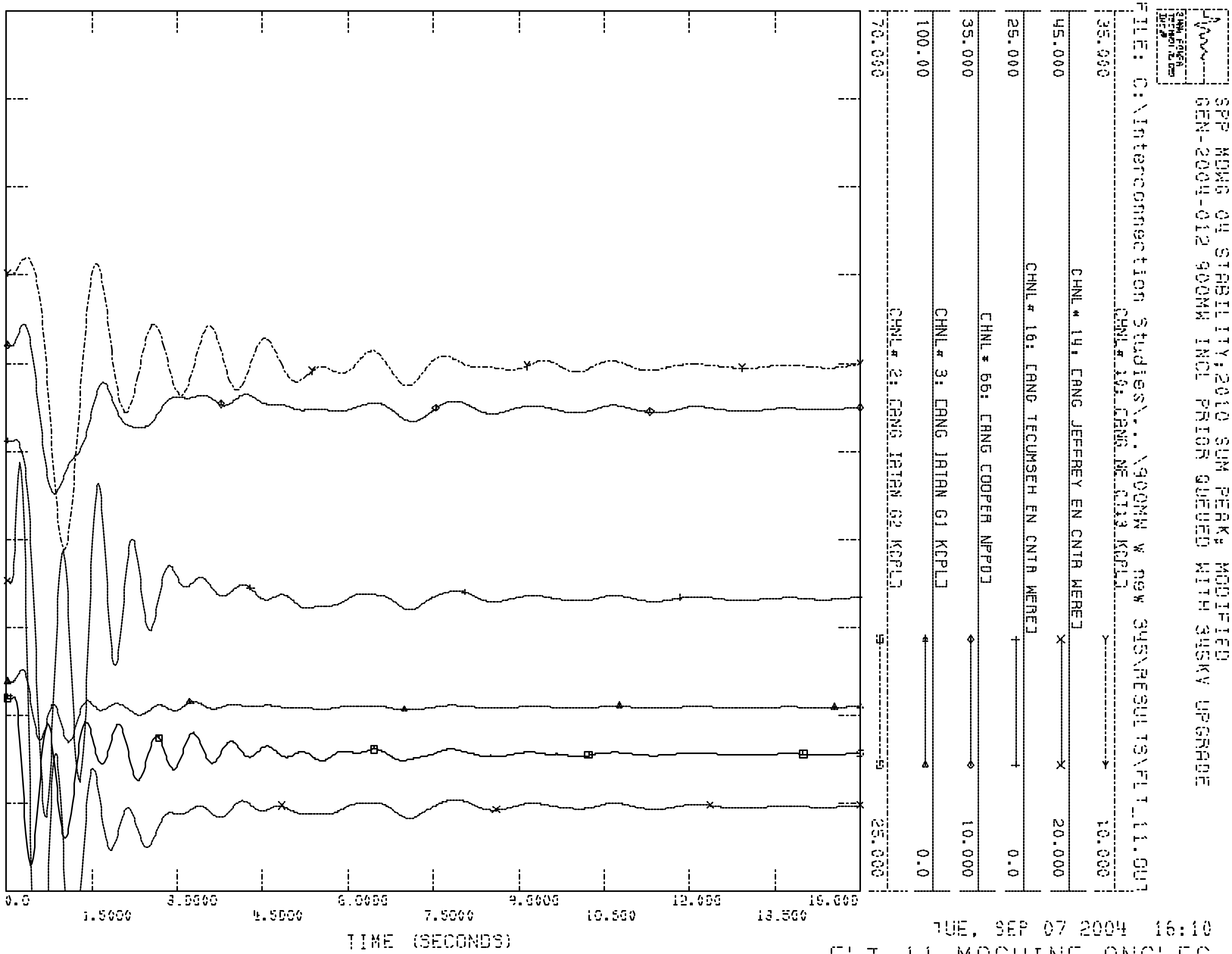
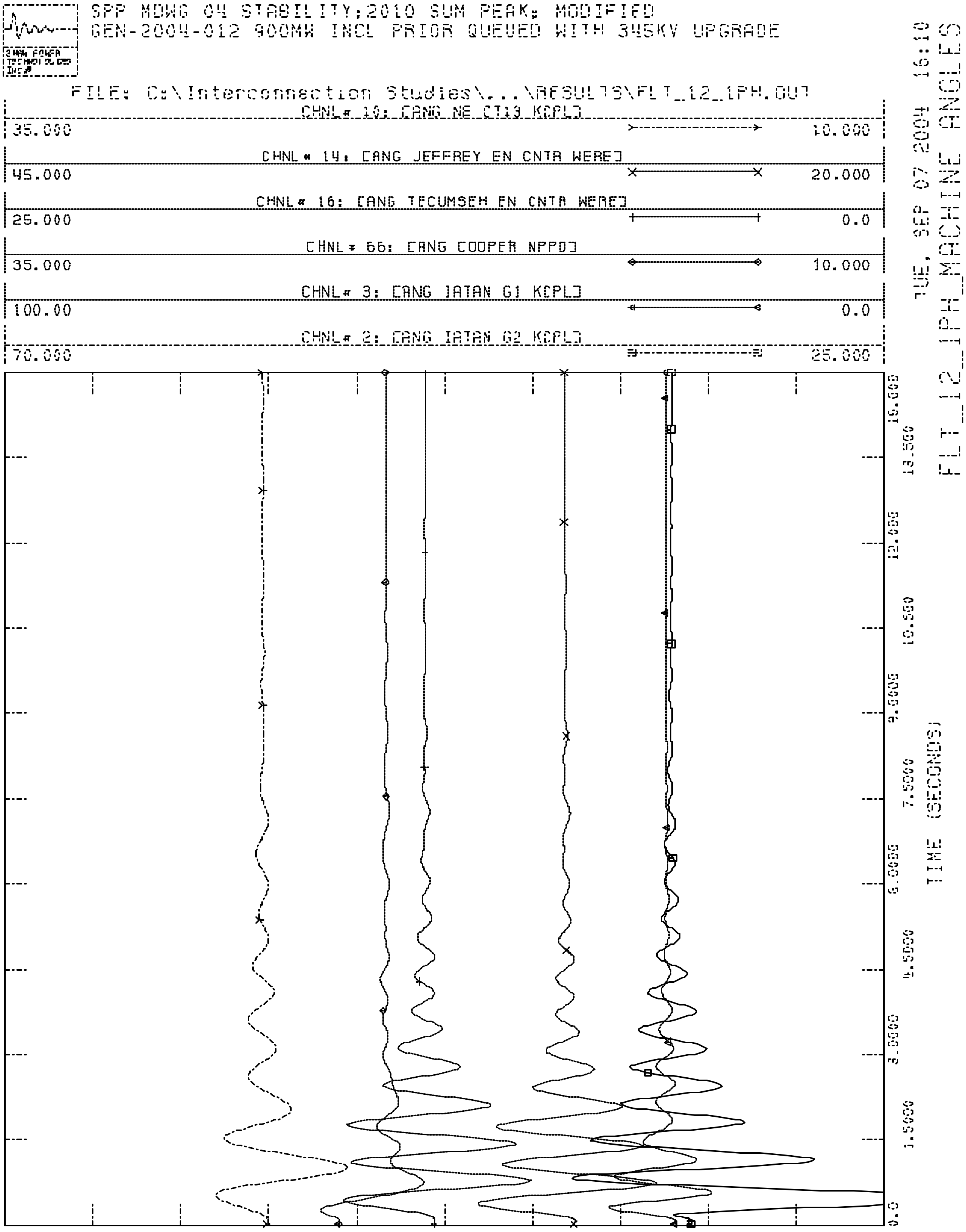


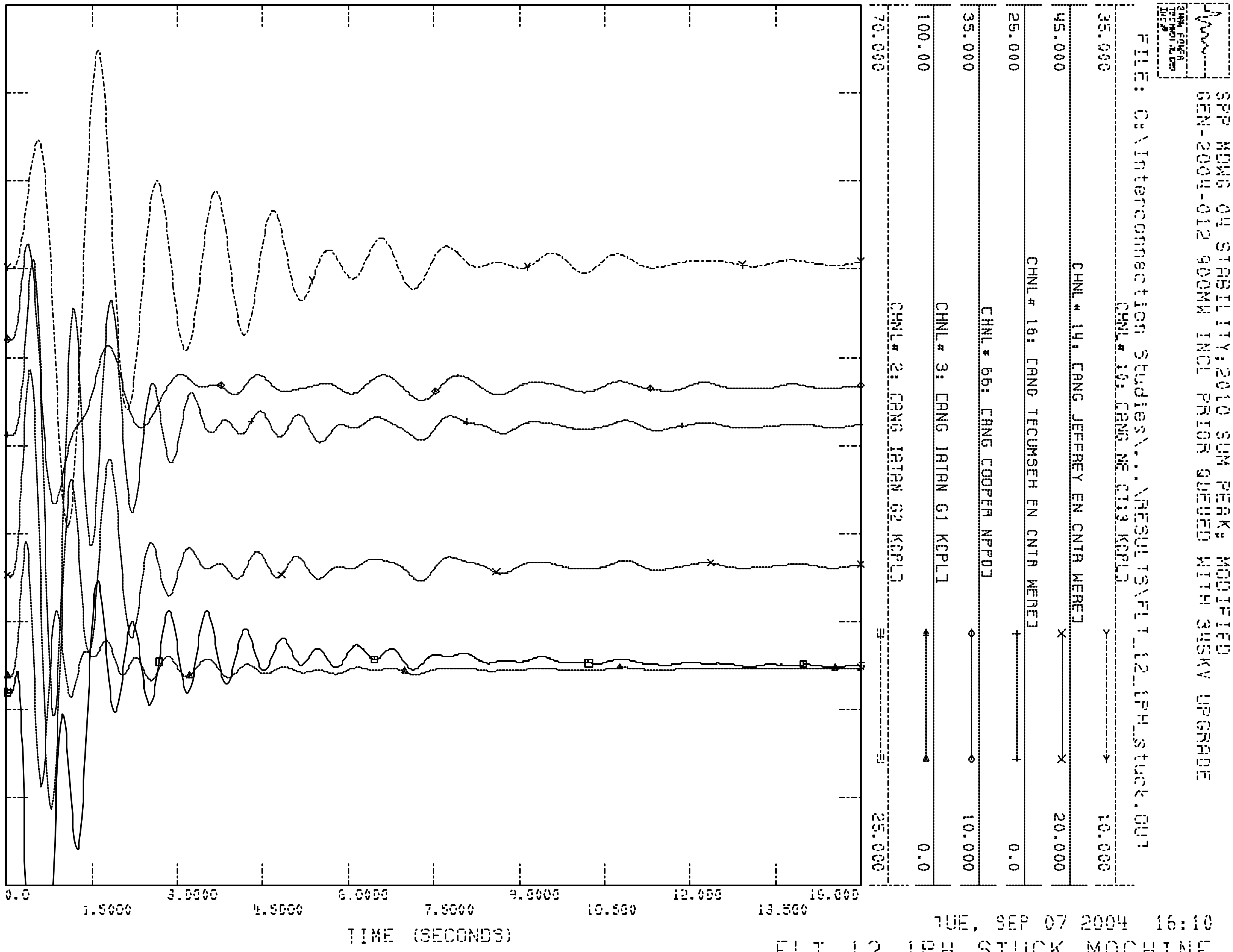
TUE, SEP 07 2004 16:10

FLT_10_MACHINE ANGLES



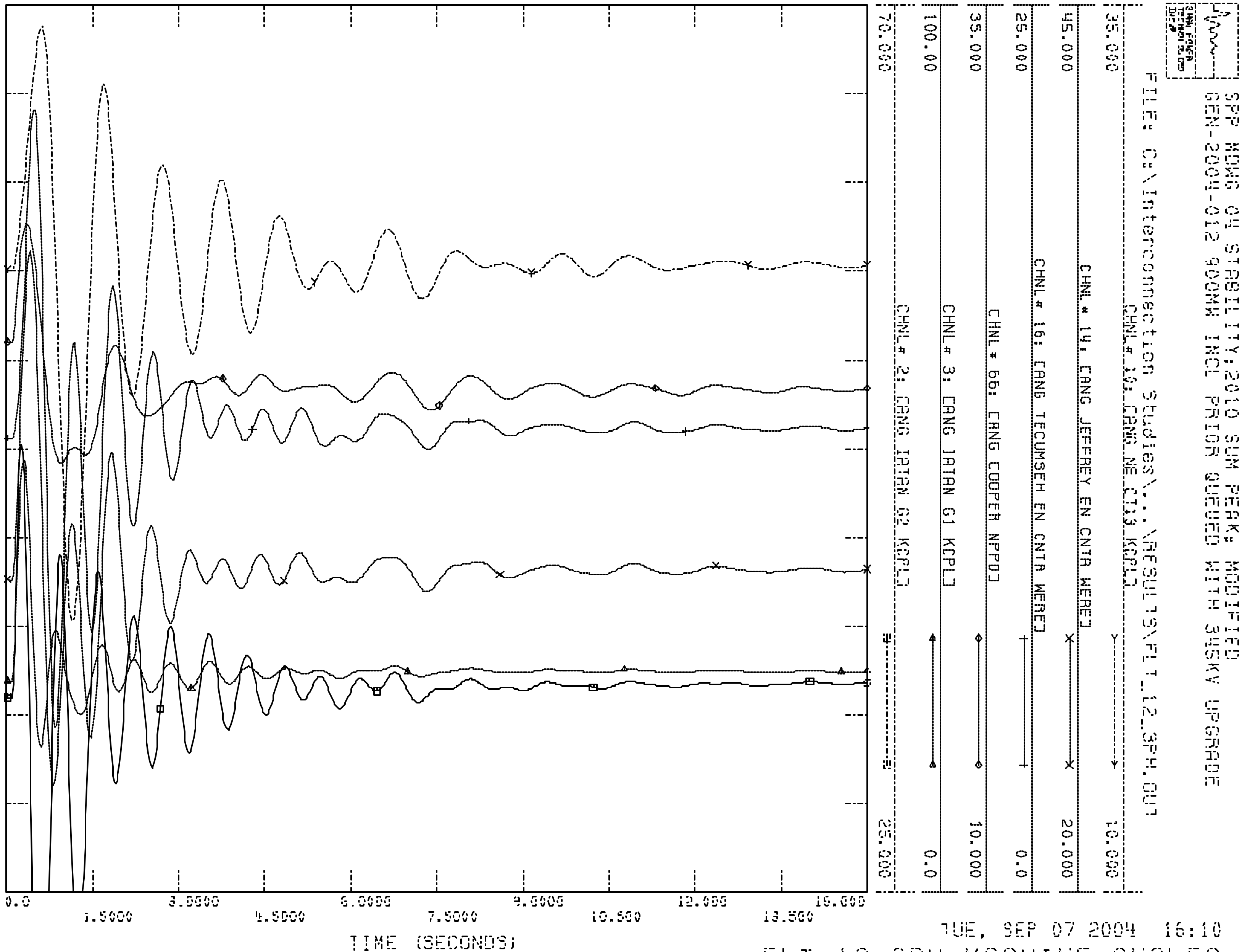
FLT_11_MACHINE ANGLES


SHAW POWER TECHNOLOGIES INC.®
SPP MDWG 04 STABILITY;2010 SUM PEAK; MODIFIED
GEN-2004-012 900MW INCL PRIOR QUEUED WITH 345KV UPGRADE
FILE: C:\Interconnection Studies\...\RESULTS\FLT_12_1PH.OUT
CHNL# 10: [ANG NE CT13 KCPL]
35.000
10.000
CHNL# 14: [ANG JEFFREY EN CNTR WERE]
45.000
20.000
CHNL# 16: [ANG TECUMSEH EN CNTR WERE]
25.000
0.0
CHNL# 66: [ANG COOPER NPPD]
35.000
10.000
CHNL# 3: [ANG IATAN G1 KCPL]
100.00
0.0
CHNL# 2: [ANG IATAN G2 KCPL]
70.000
25.000
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, SEP 07 2004 16:10
FLT_12_1PH_MACHINE ANGLES



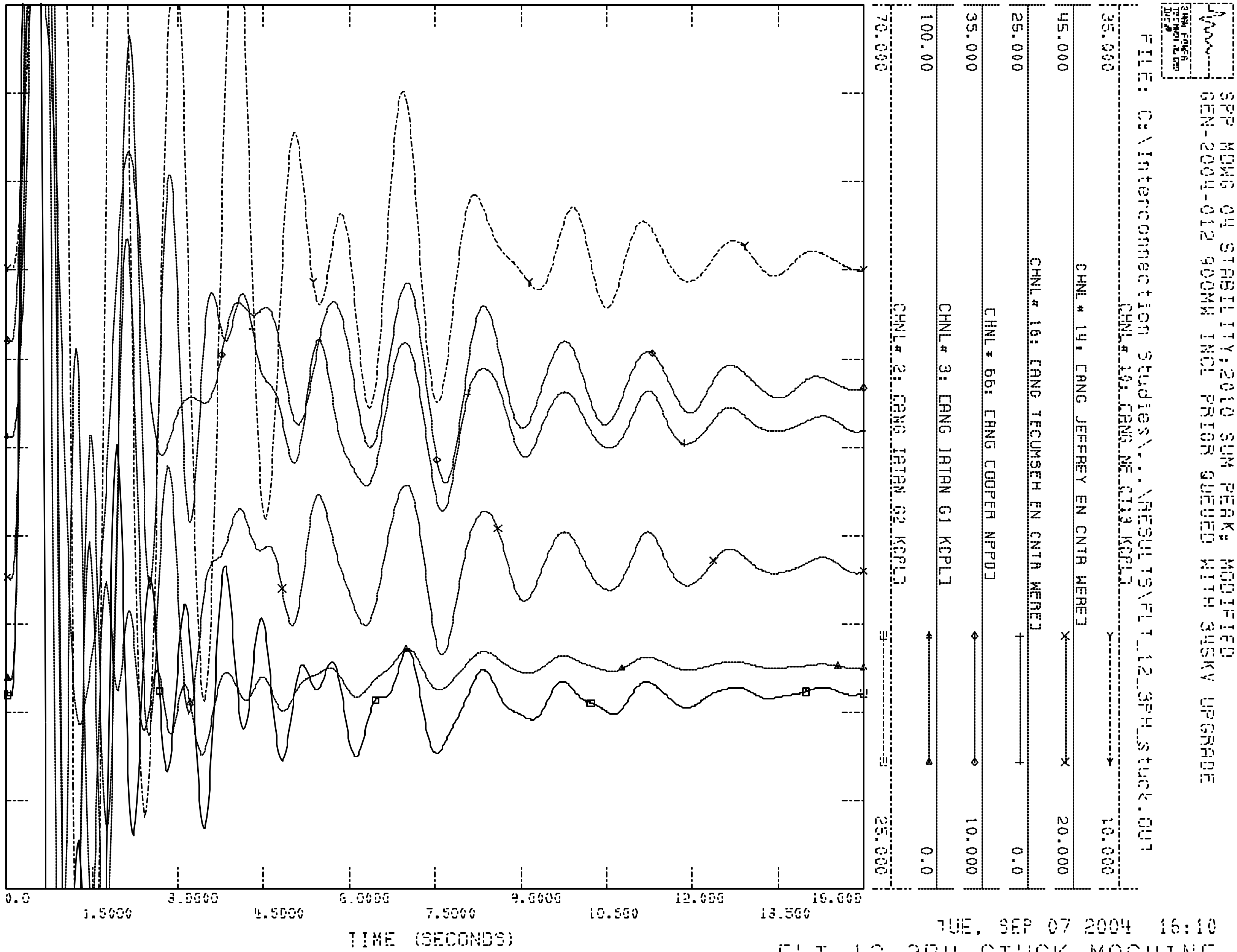
TUE, SEP 07 2004 16:10

FLT_12_1PH_STUCK_MACHINE



TUE, SEP 07 2004 16:10

FLT_12_3PH_MACHINE ANGLES



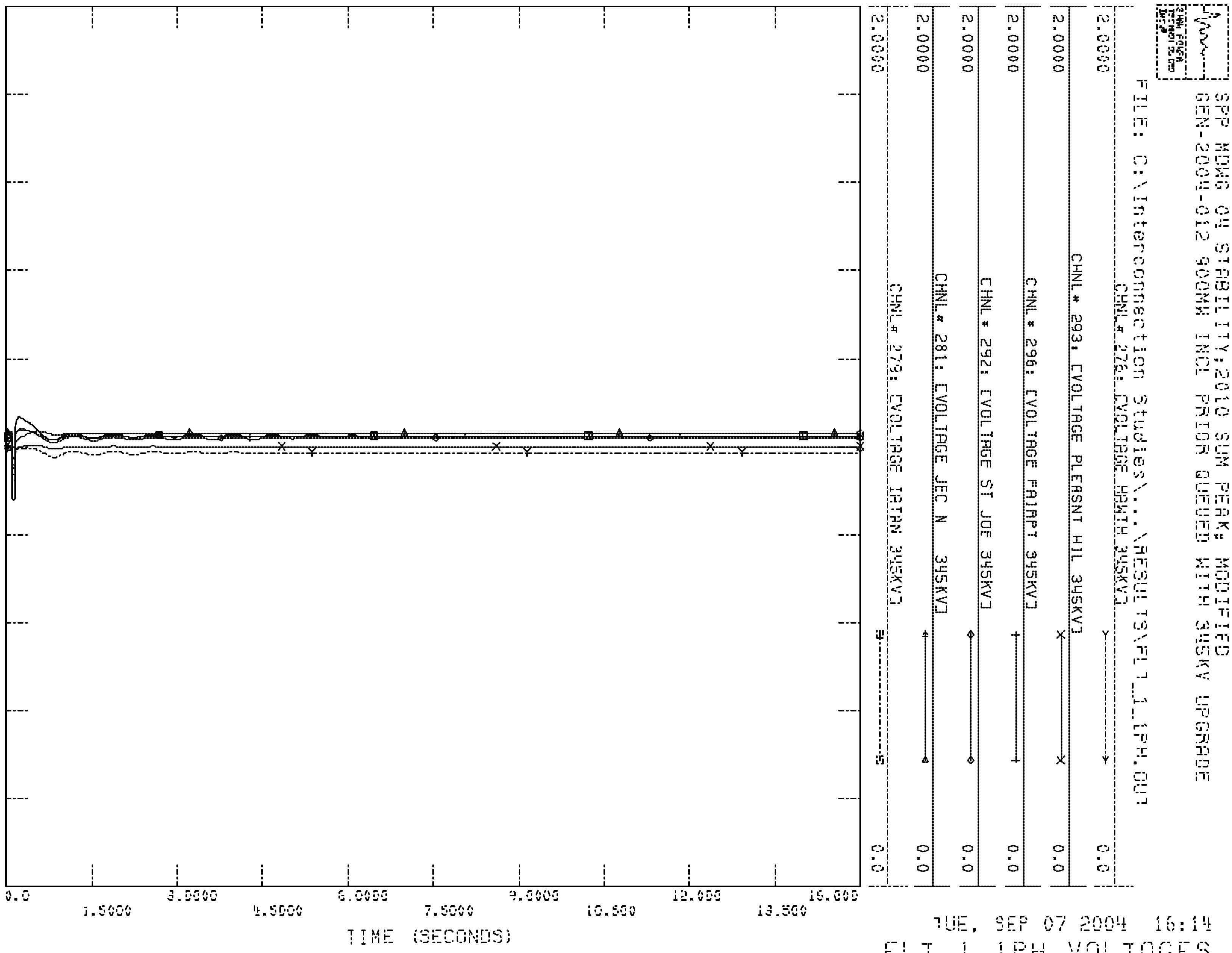
FLT_12_3PH_STUCK_MACHINE

Appendix C-2

Plots of Fault Simulations

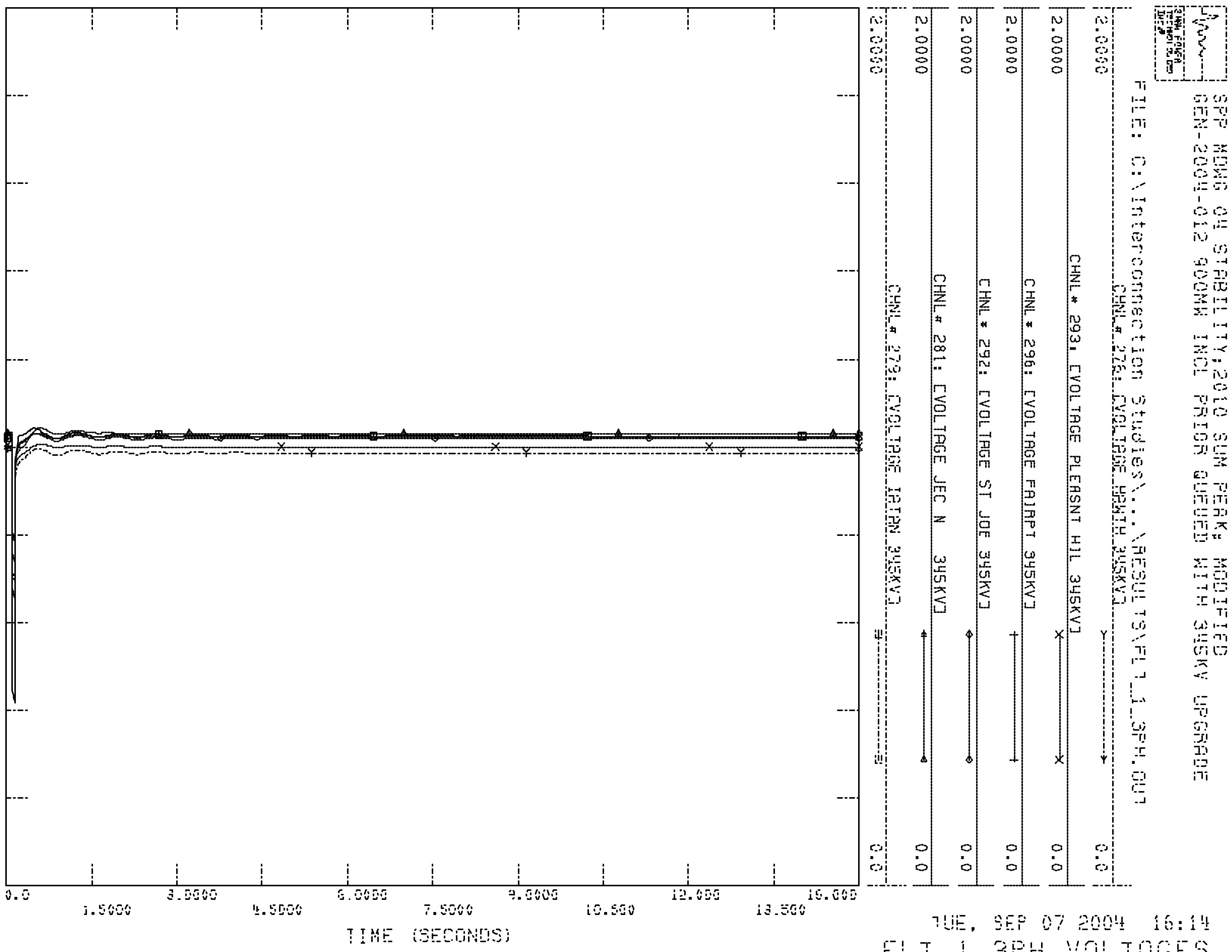
Plots of selected bus voltage response during faults

Scenario:
2010 Summer Peak
900MW
[Customer Plant at 900MW – Iatan-Nashua 345kV]



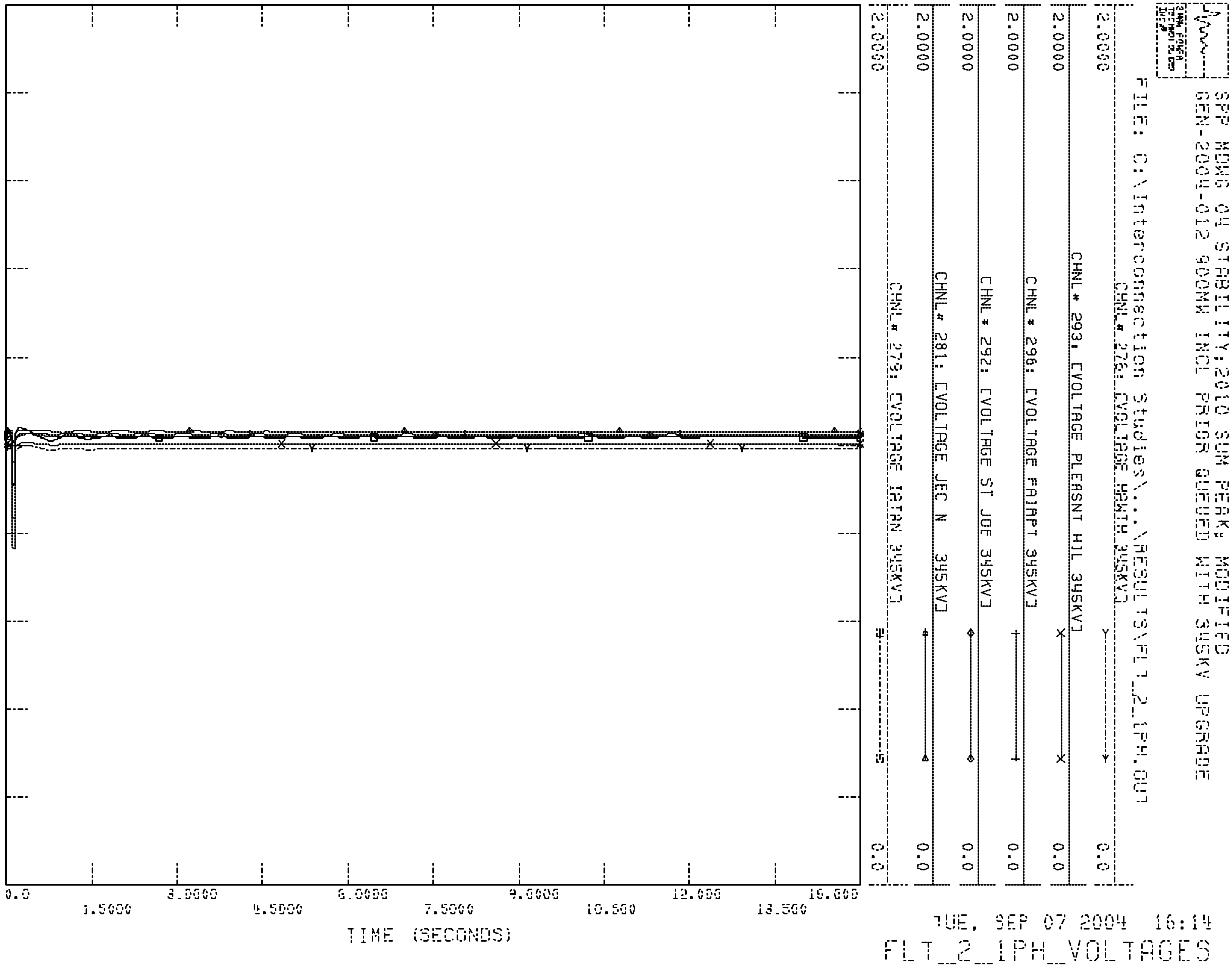
TUE, SEP 07 2004 16:14

FLT_1_1PH_VOLTAGES



TUE, SEP 07 2004 16:14

FLT_1_3PH_VOLTAGES



SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW INCL PRIOR QUEUED WITH 345KV UPGRADE
FILE: C:\Interconnection Studies\...\RESULTS\FLT_2_1PH.OUT
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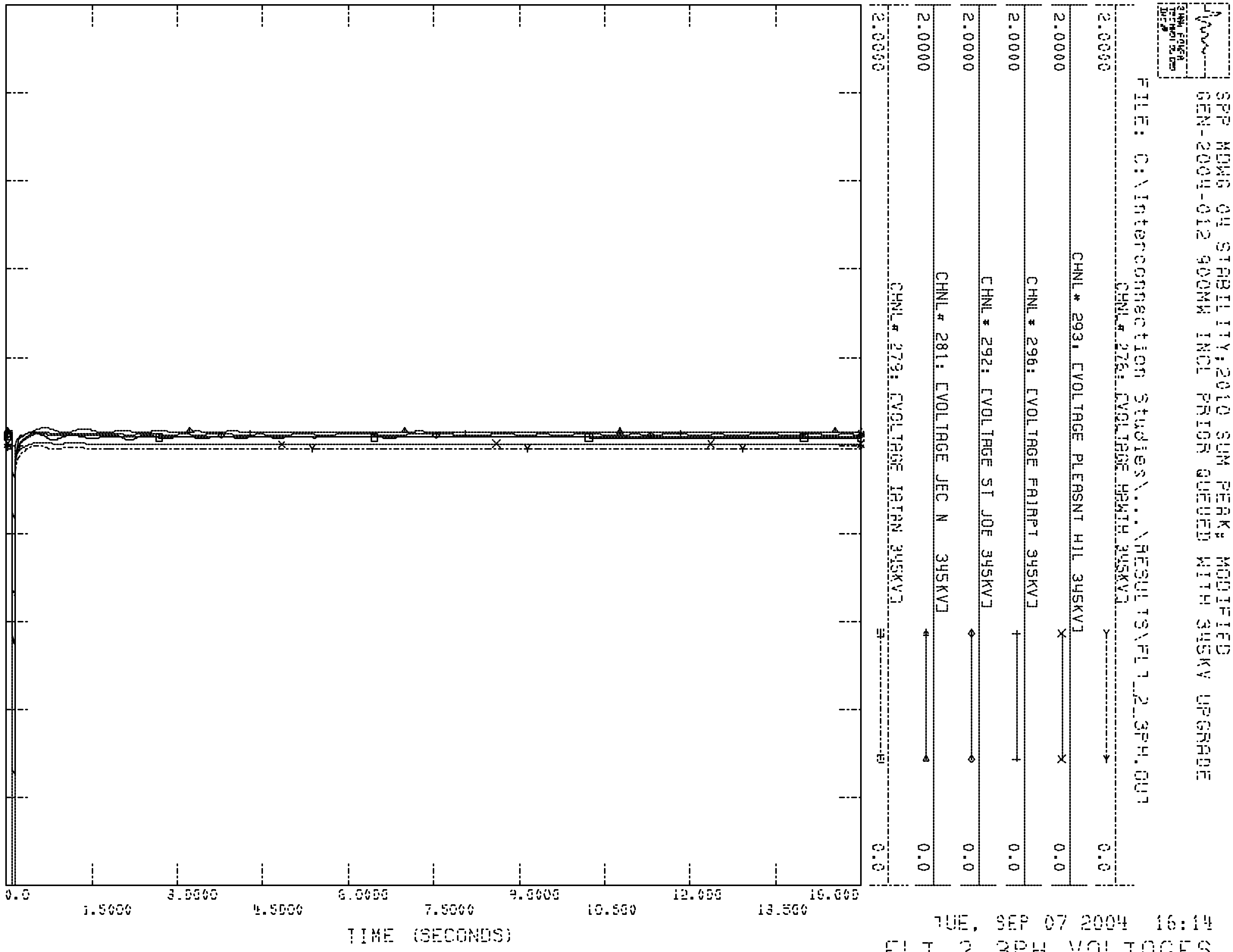
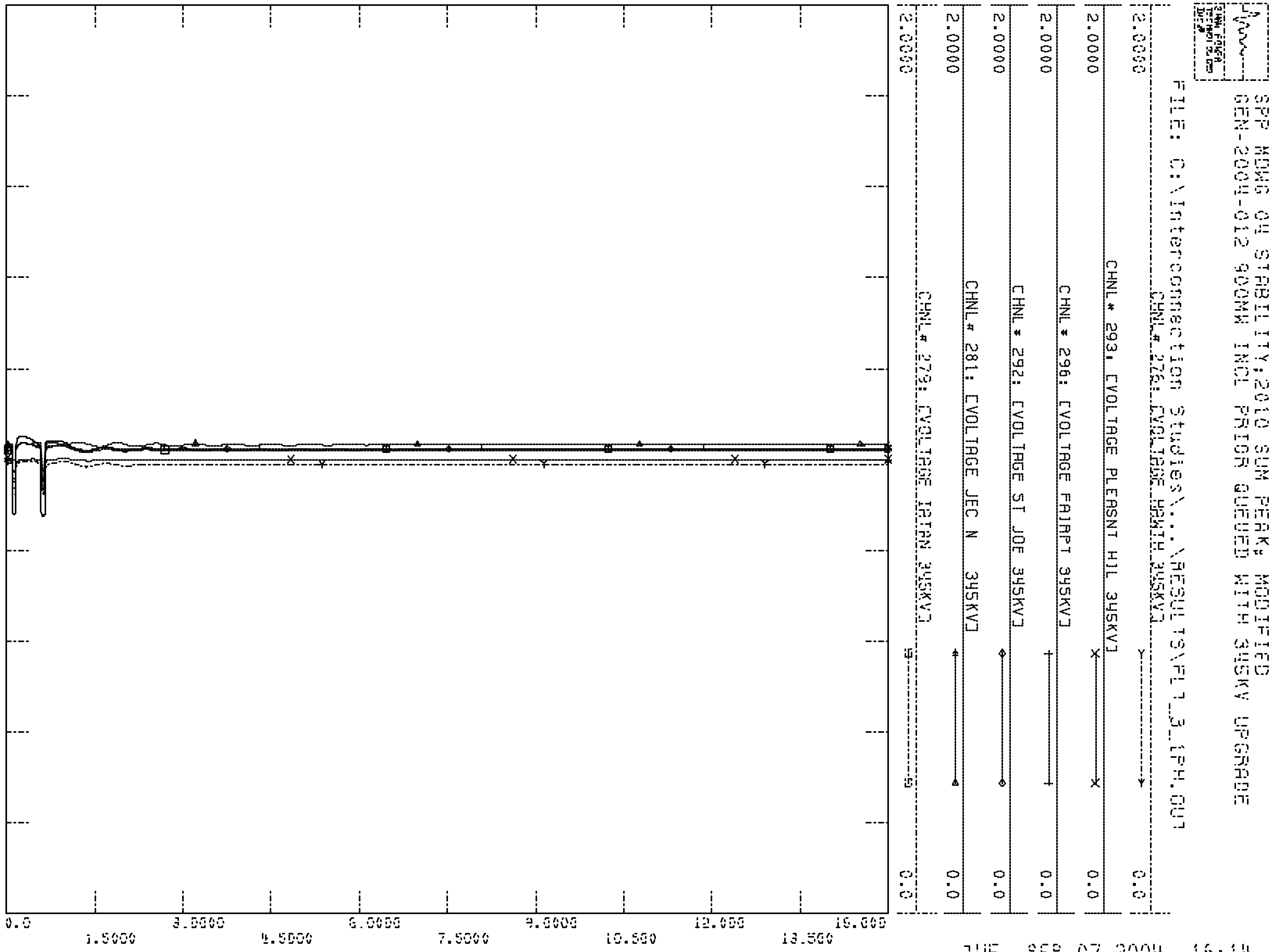
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE IATAN 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, SEP 07 2004 16:14
FLT_2_1PH_VOLTAGES



TUE, SEP 07 2004 16:14

FLT_2_3PH_VOLTAGES



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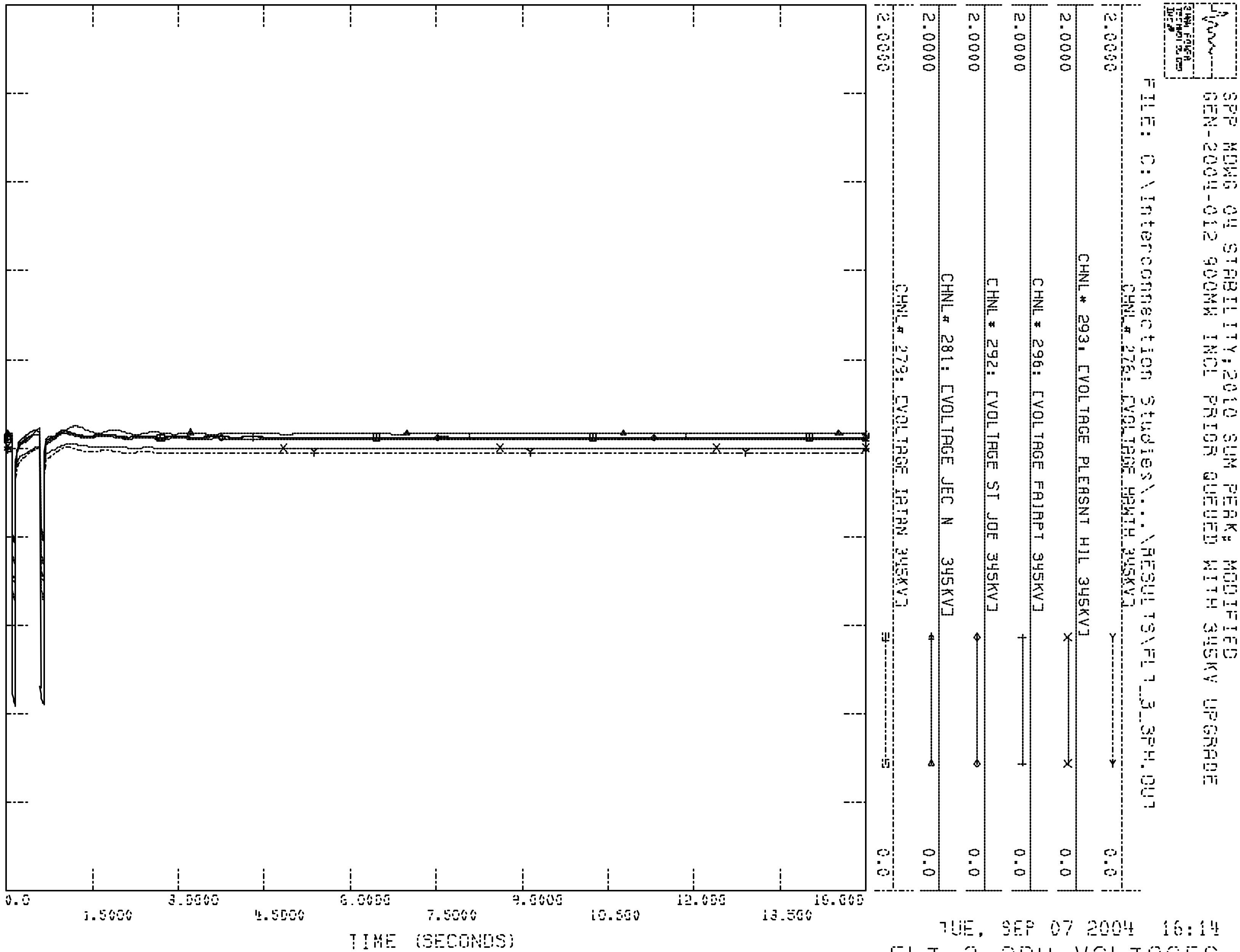
FLT_3_1PH_VOLTAGES



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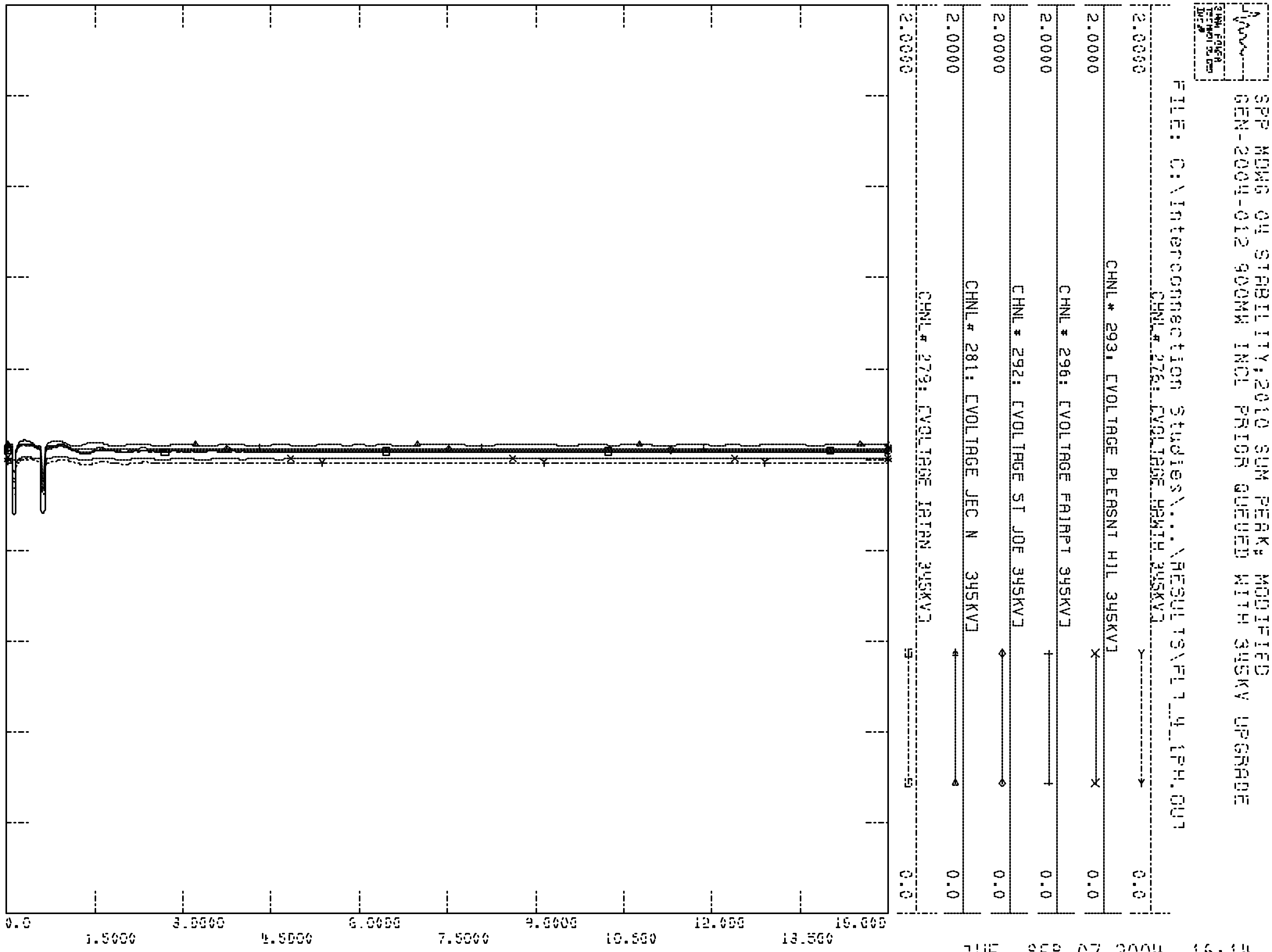
FLT_3_3PH_VOLTAGES



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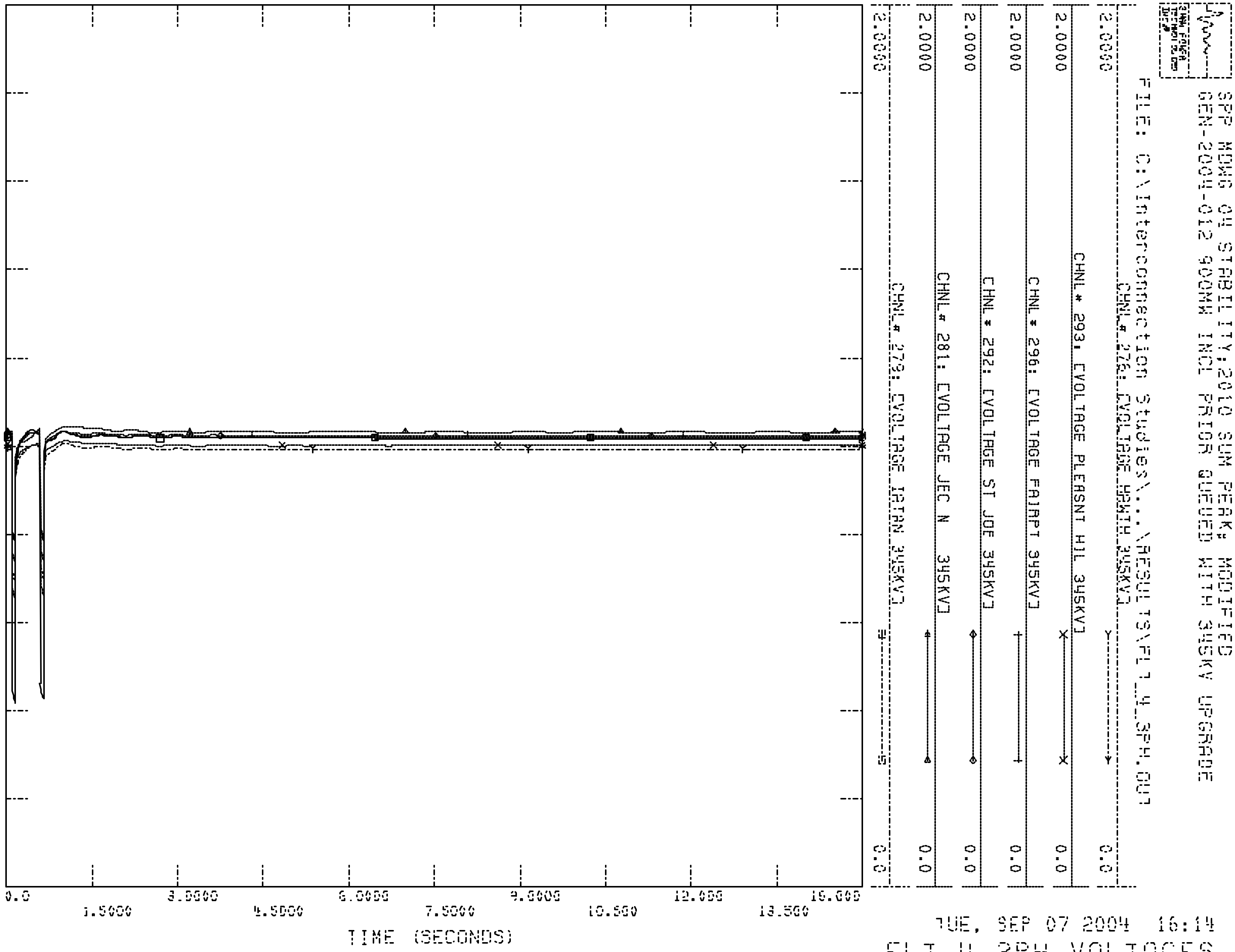
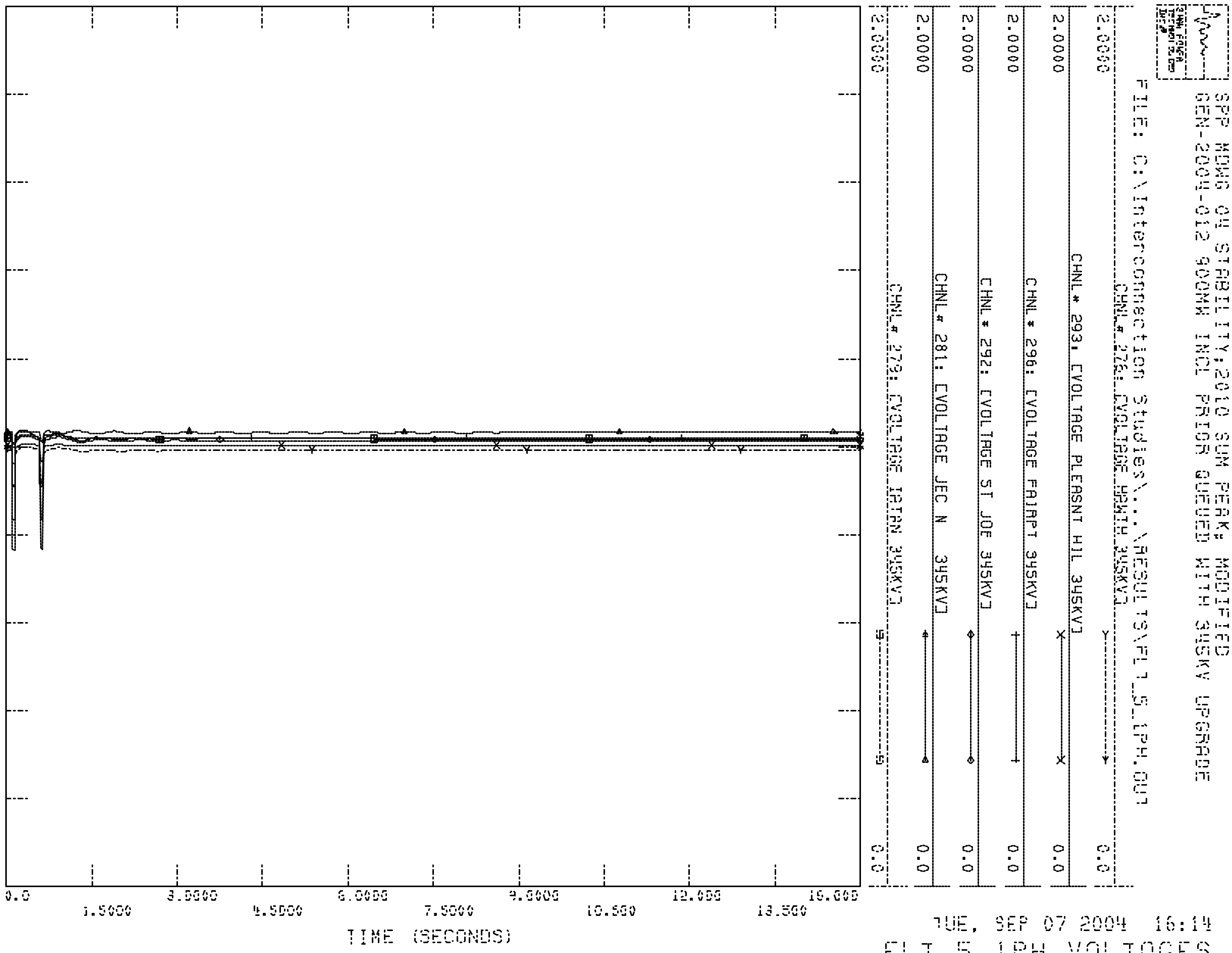


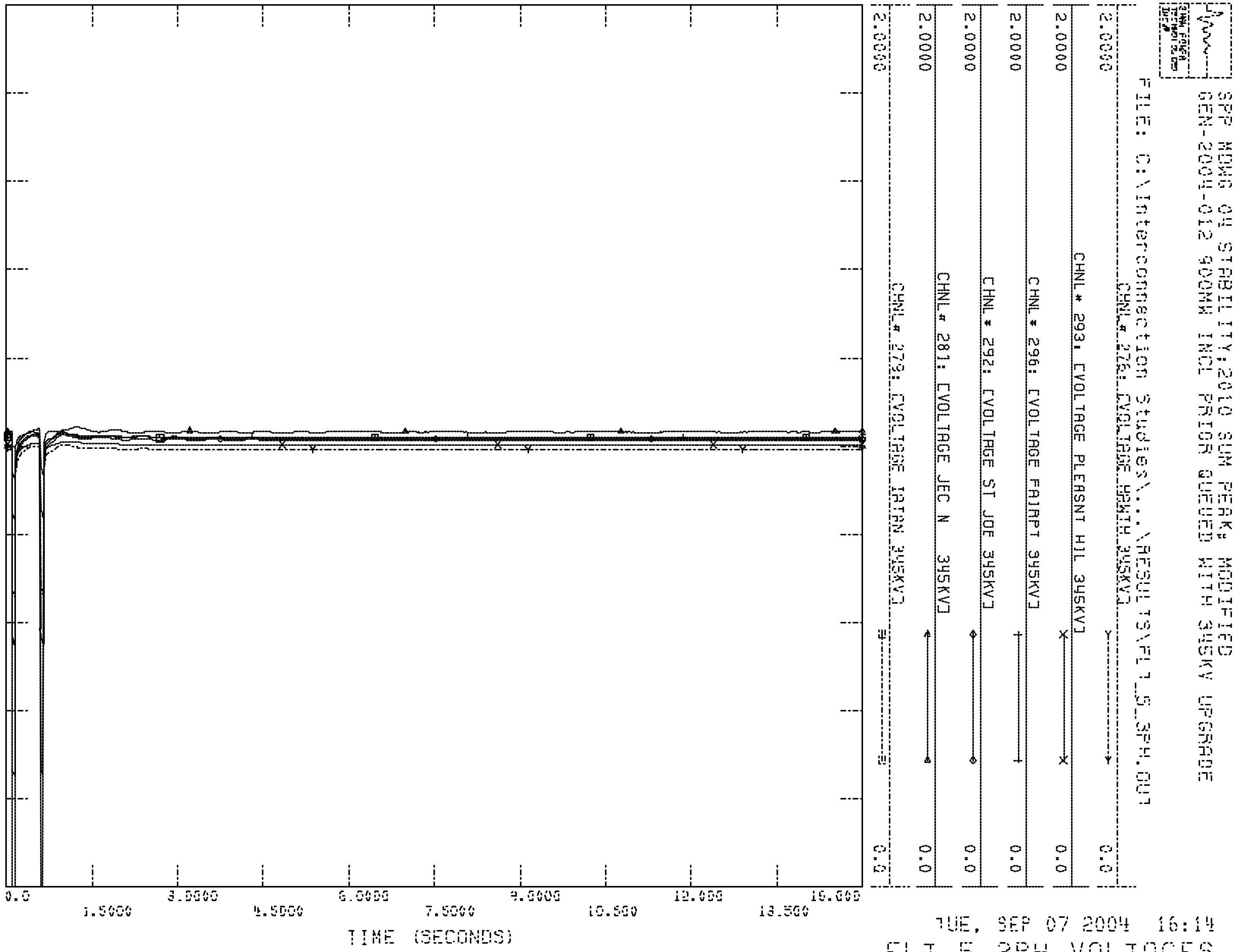
TUE, SEP 07 2004 16:14

FLT_4_3PH_VOLTAGES



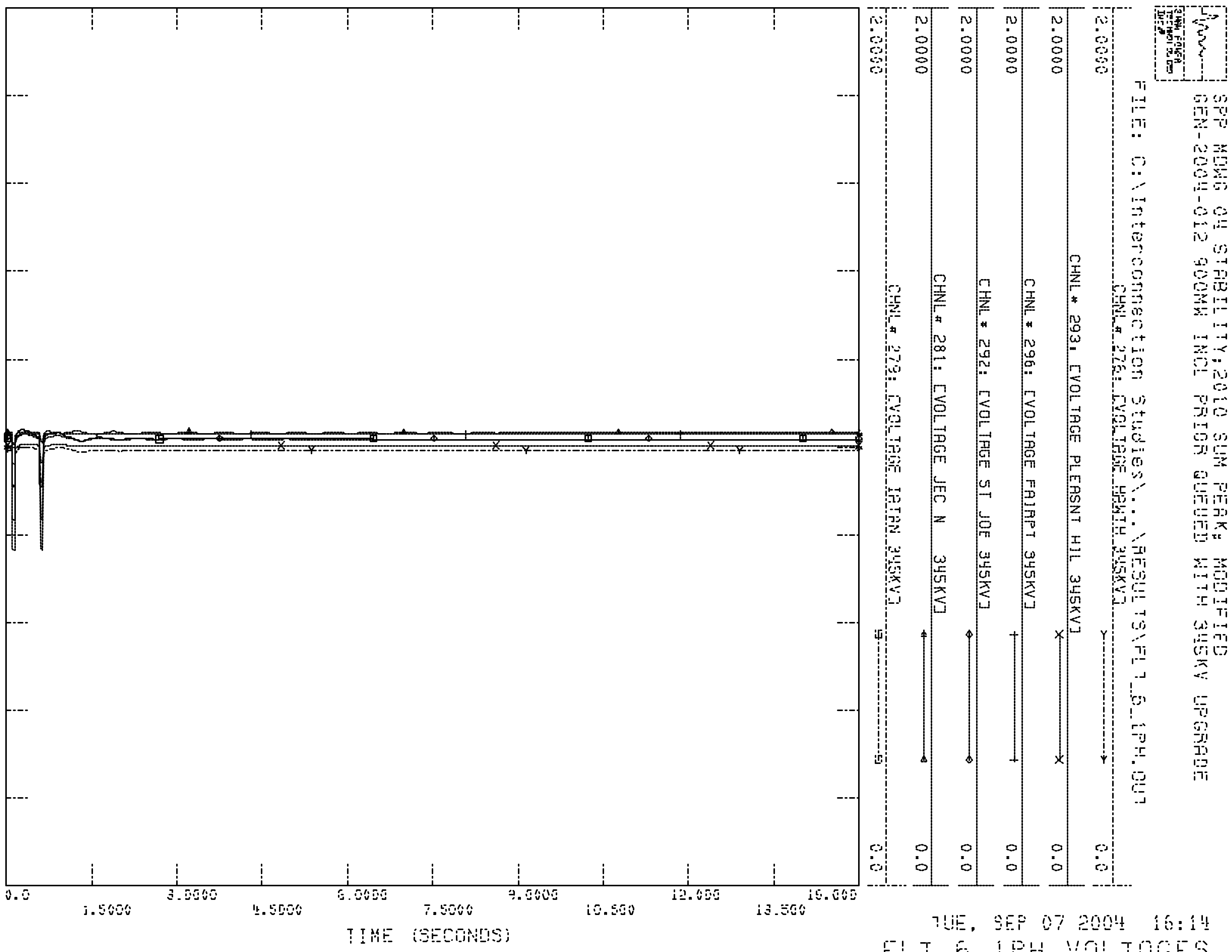
TUE, SEP 07 2004 16:14

FLT_5_1PH_VOLTAGES



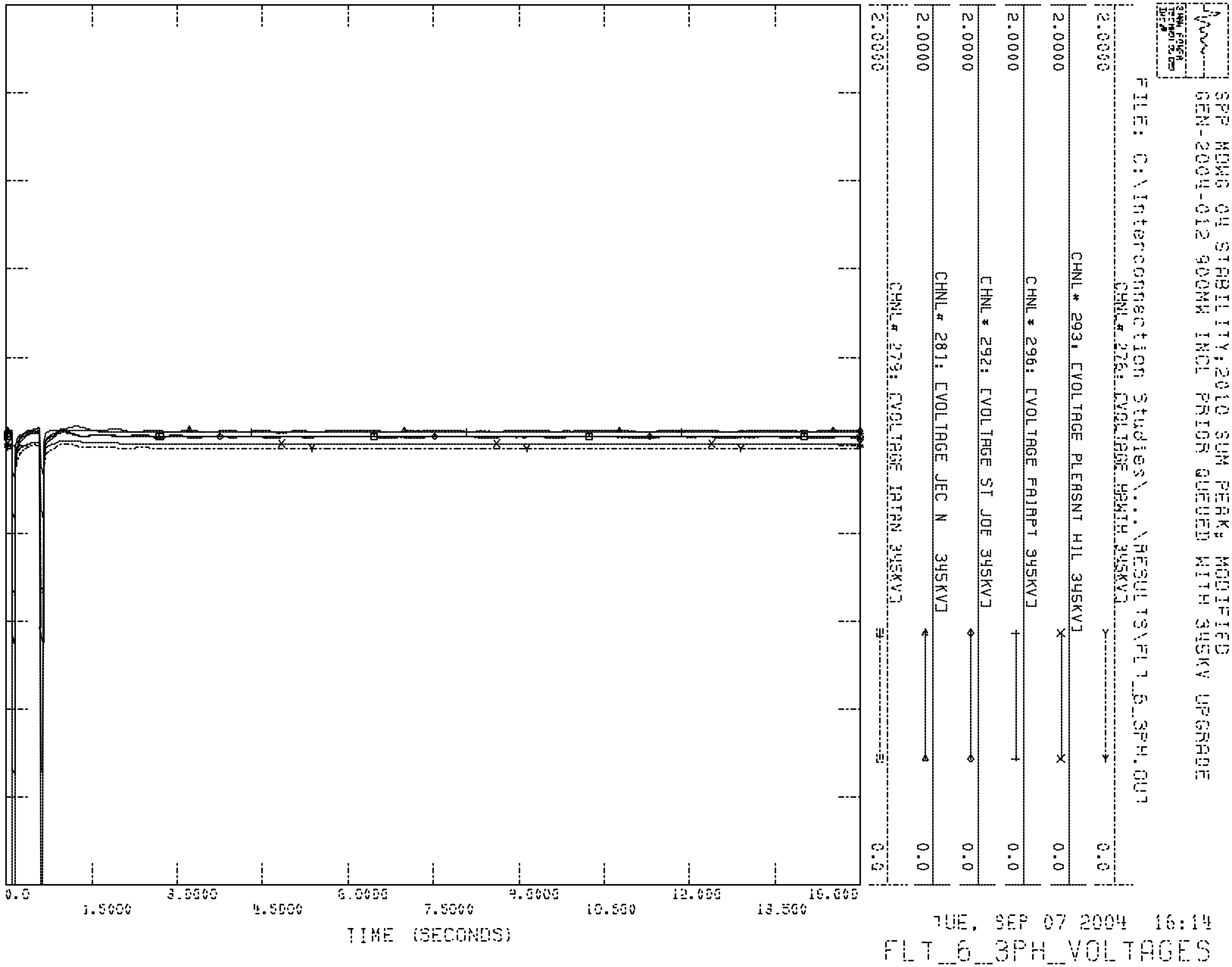
TUE, SEP 07 2004 16:14

FLT_5_3PH_VOLTAGES



TUE, SEP 07 2004 16:14

FLT_6_1PH_VOLTAGES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW INCL PRIOR QUEUED WITH 345KV UPGRADE
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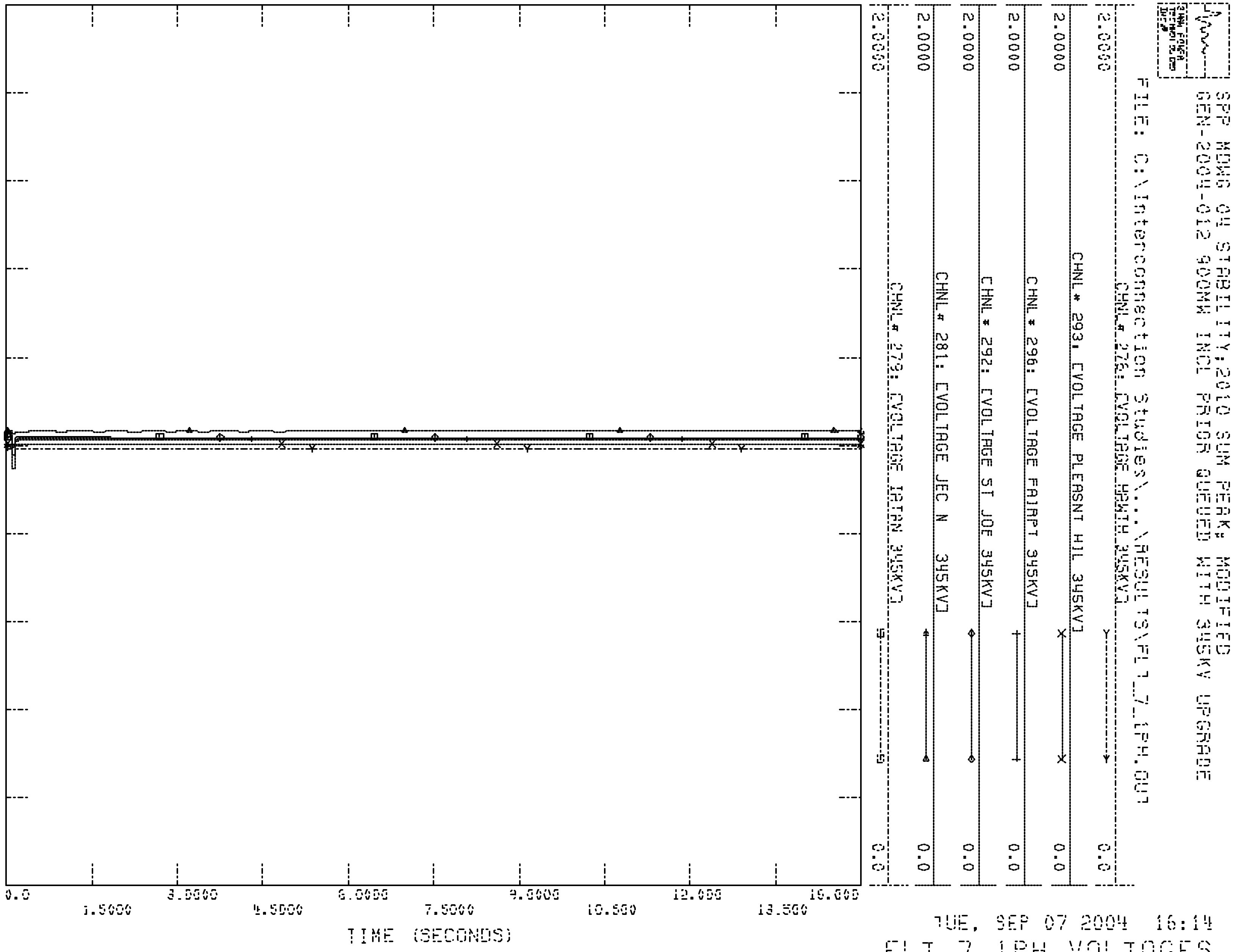
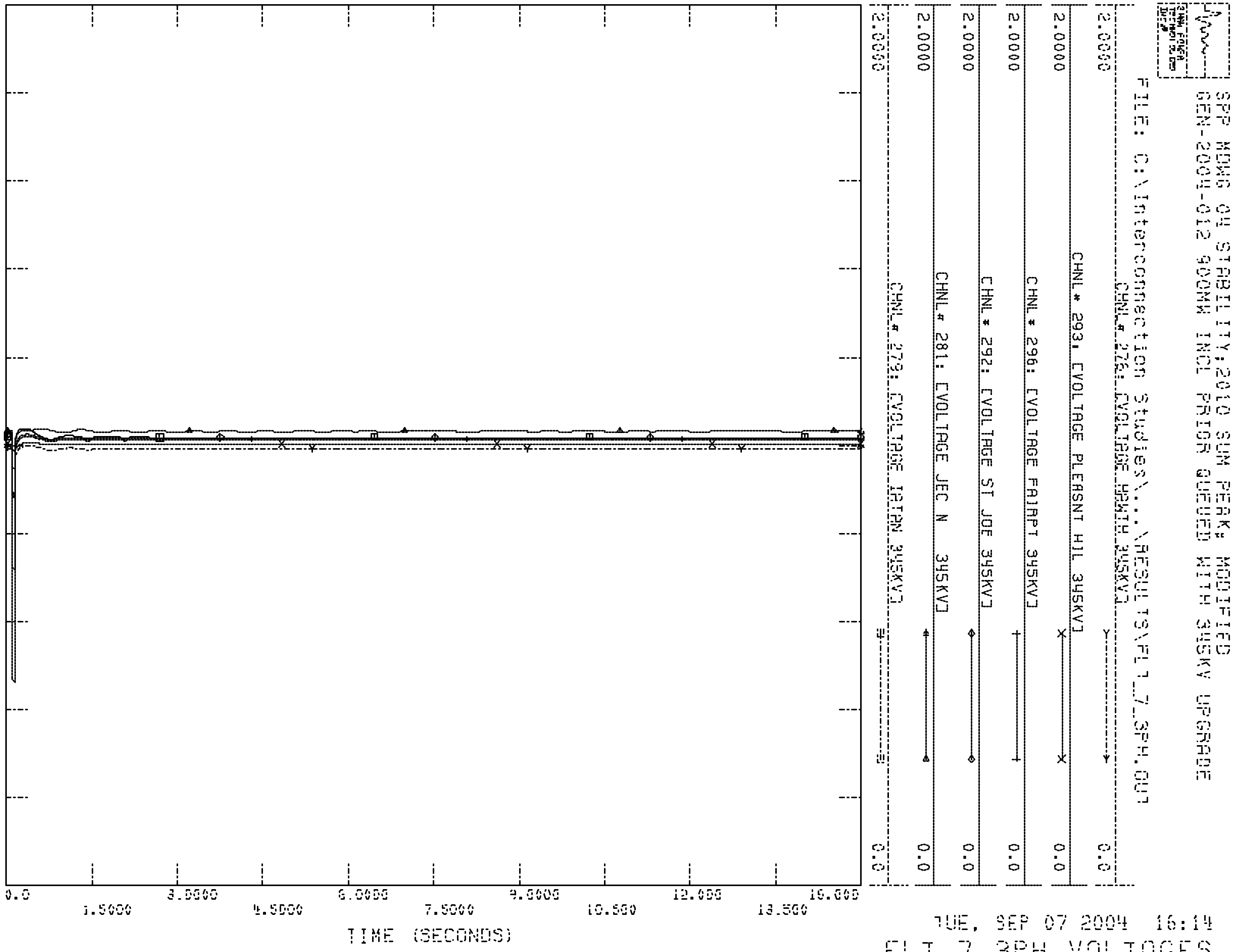
CHNL# 276: [VOLTAGE HAWTH 345KV]
2.0000
0.0
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE IATAN 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
13.500
15.000
TIME (SECONDS)
TUE, SEP 07 2004 16:14
FLT_6_3PH_VOLTAGES



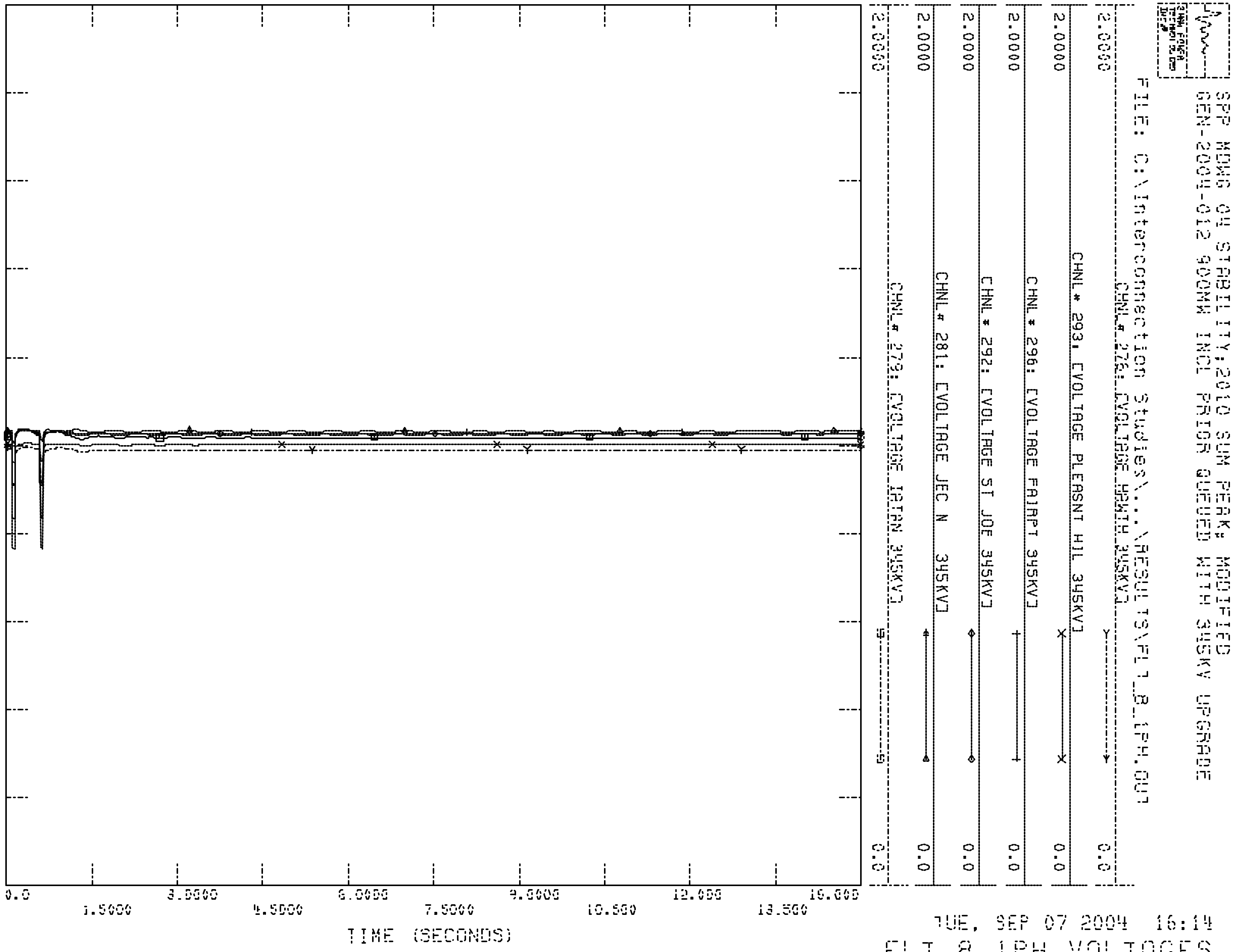
TUE, SEP 07 2004 16:14

FLT_7_1PH_VOLTAGES



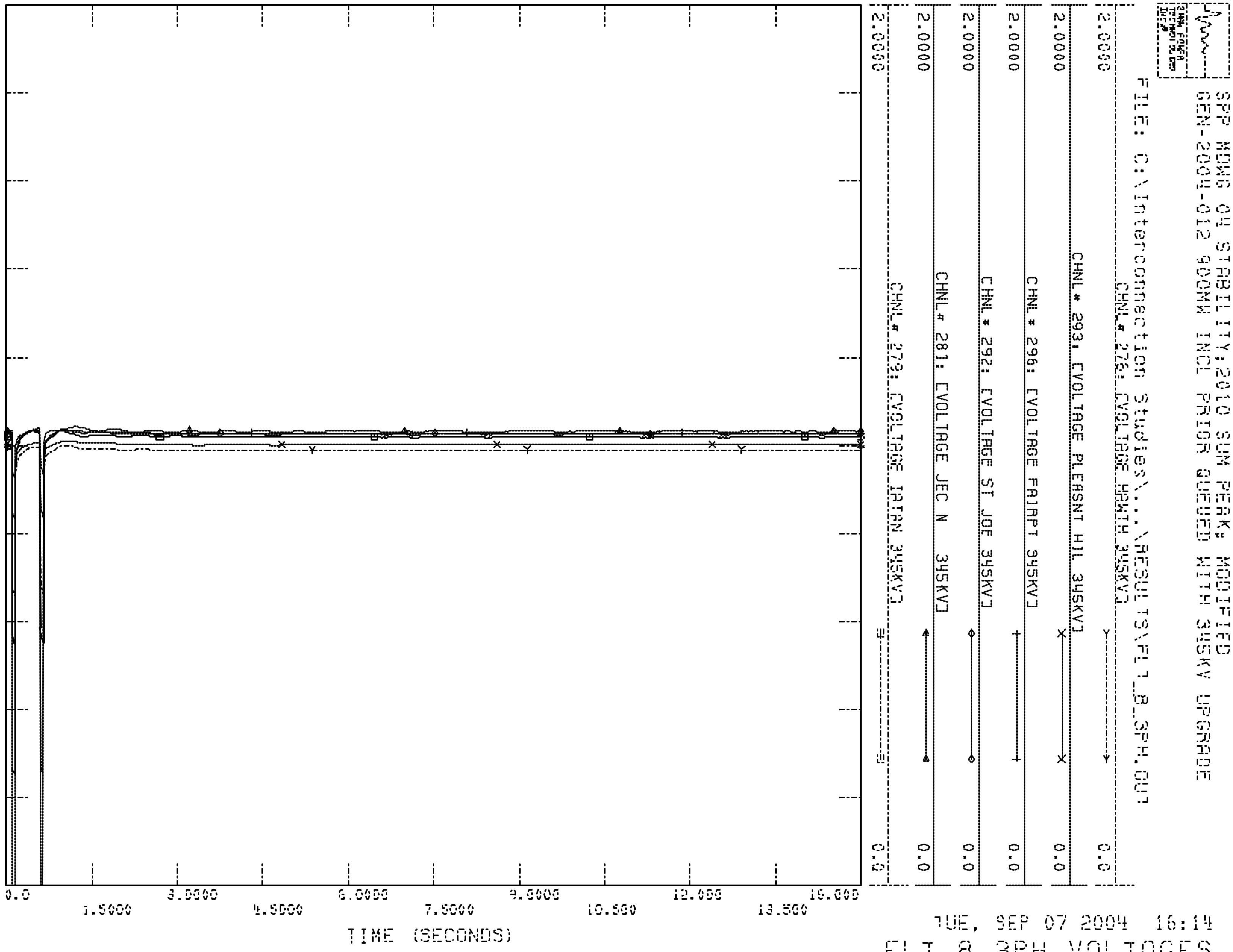
TUE, SEP 07 2004 16:14

FLT_7_3PH_VOLTAGES



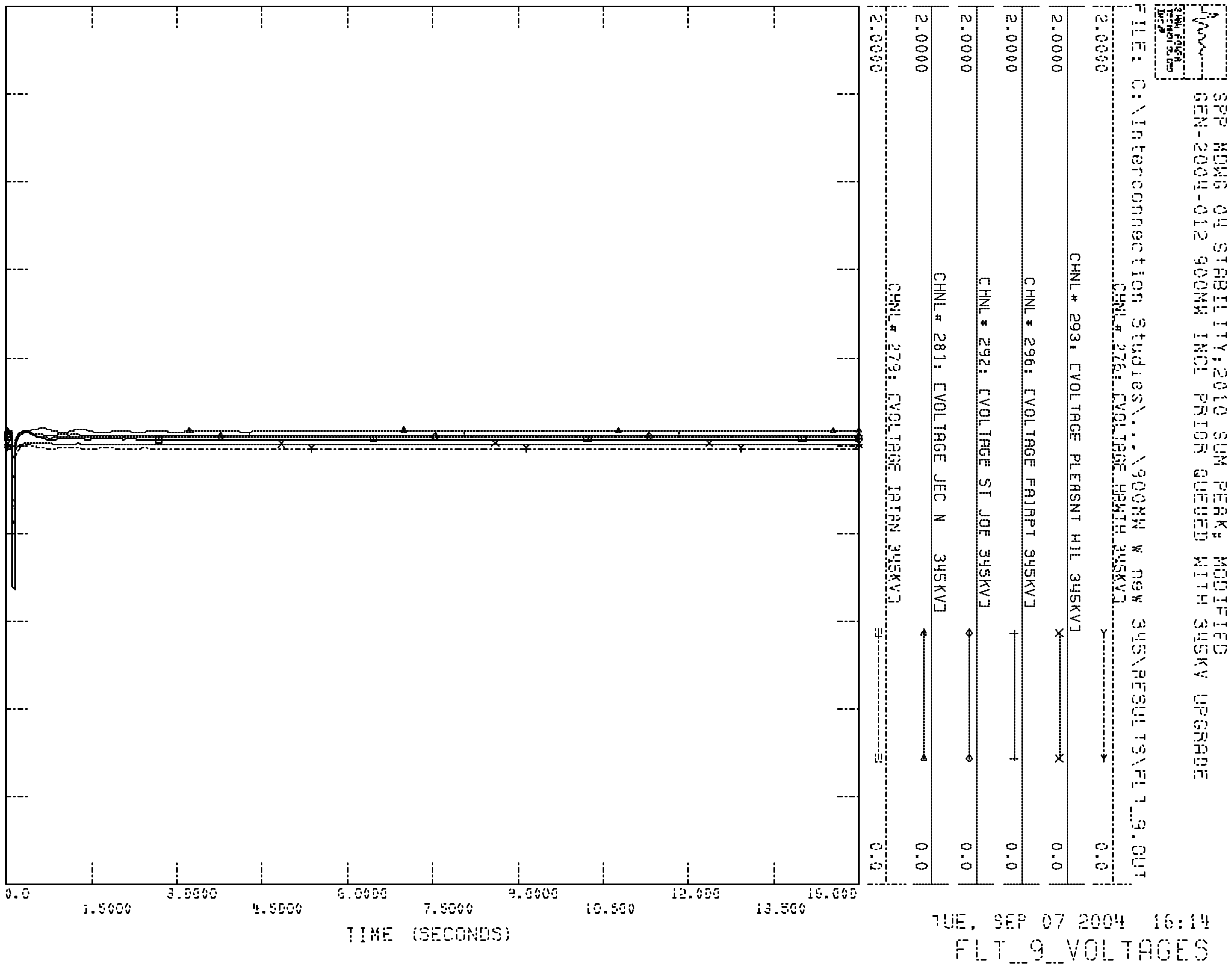
TUE, SEP 07 2004 16:14

FLT_8_1PH_VOLTAGES



TUE, SEP 07 2004 16:14

FLT_8_3PH_VOLTAGES


SPP MDWG 04 STABILITY,2010 SUM PEAK, MODIFIED
GEN-2004-012 900MW INCL PRIOR QUEUED WITH 345KV UPGRADE
FILE: C:\Interconnection Studies\...\900MW w new 345\RESULTS\FLT_9.OUT
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0.0
CHNL# 293: [VOLTAGE PLEASNT HIL 345KV]
2.0000
0.0
CHNL# 296: [VOLTAGE FAIRPT 345KV]
2.0000
0.0
CHNL# 292: [VOLTAGE ST JOE 345KV]
2.0000
0.0
CHNL# 281: [VOLTAGE JEC N 345KV]
2.0000
0.0
CHNL# 279: [VOLTAGE IATAN 345KV]
2.0000
0.0
0.0
1.5000
3.0000
4.5000
6.0000
7.5000
9.0000
10.500
12.000
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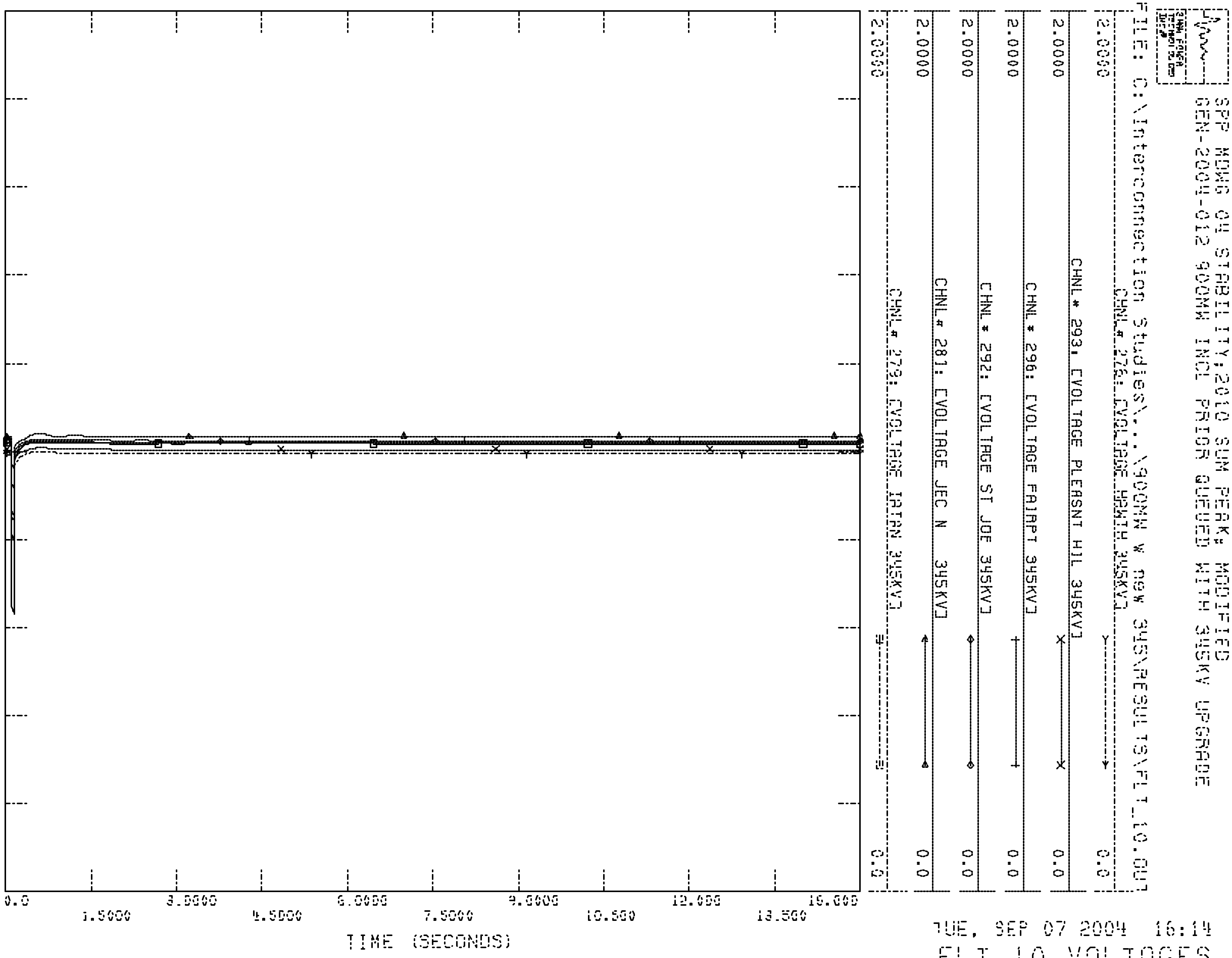
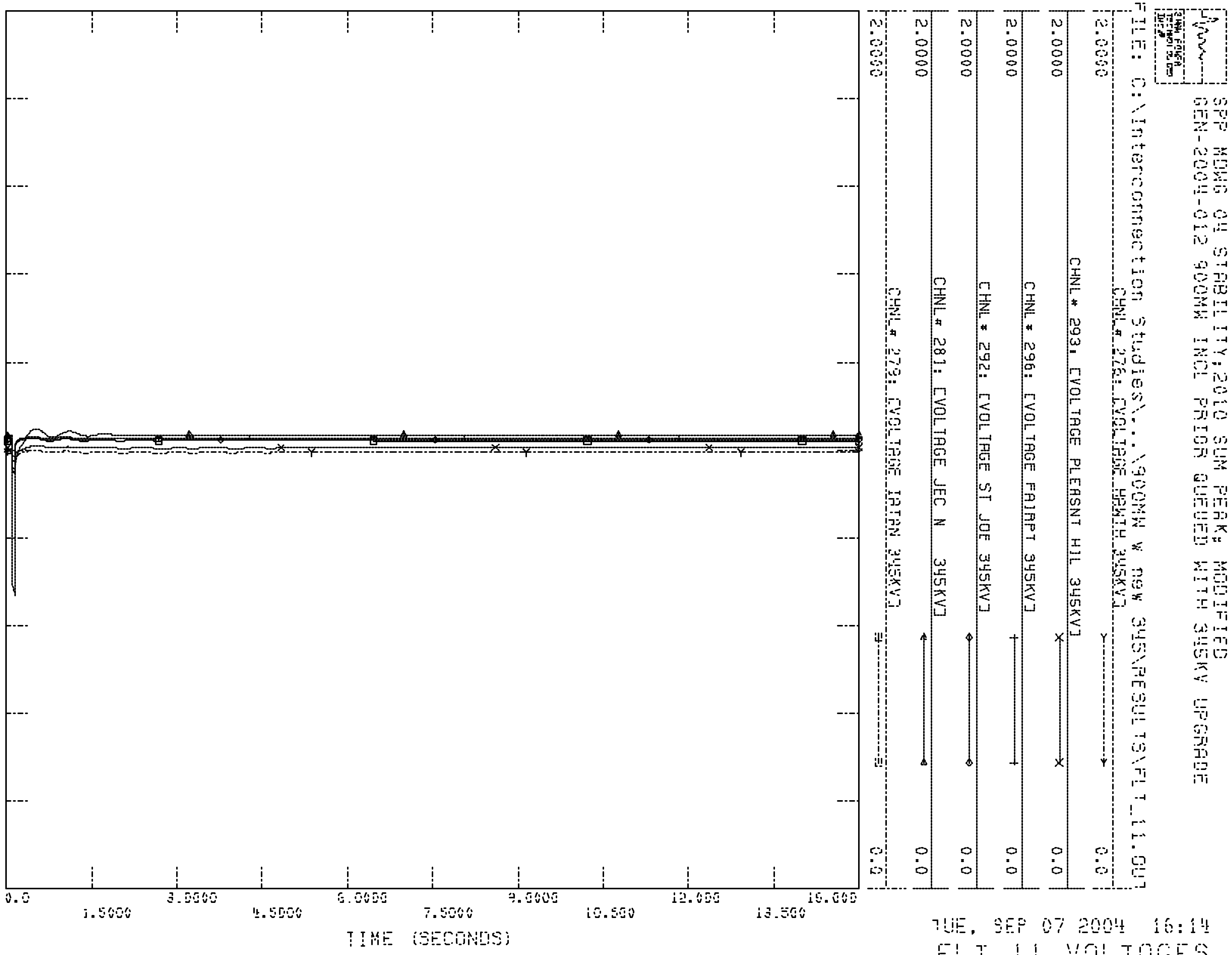
TIME (SECONDS)
TUE, SEP 07 2004 16:14
FLT_9_VOLTAGES



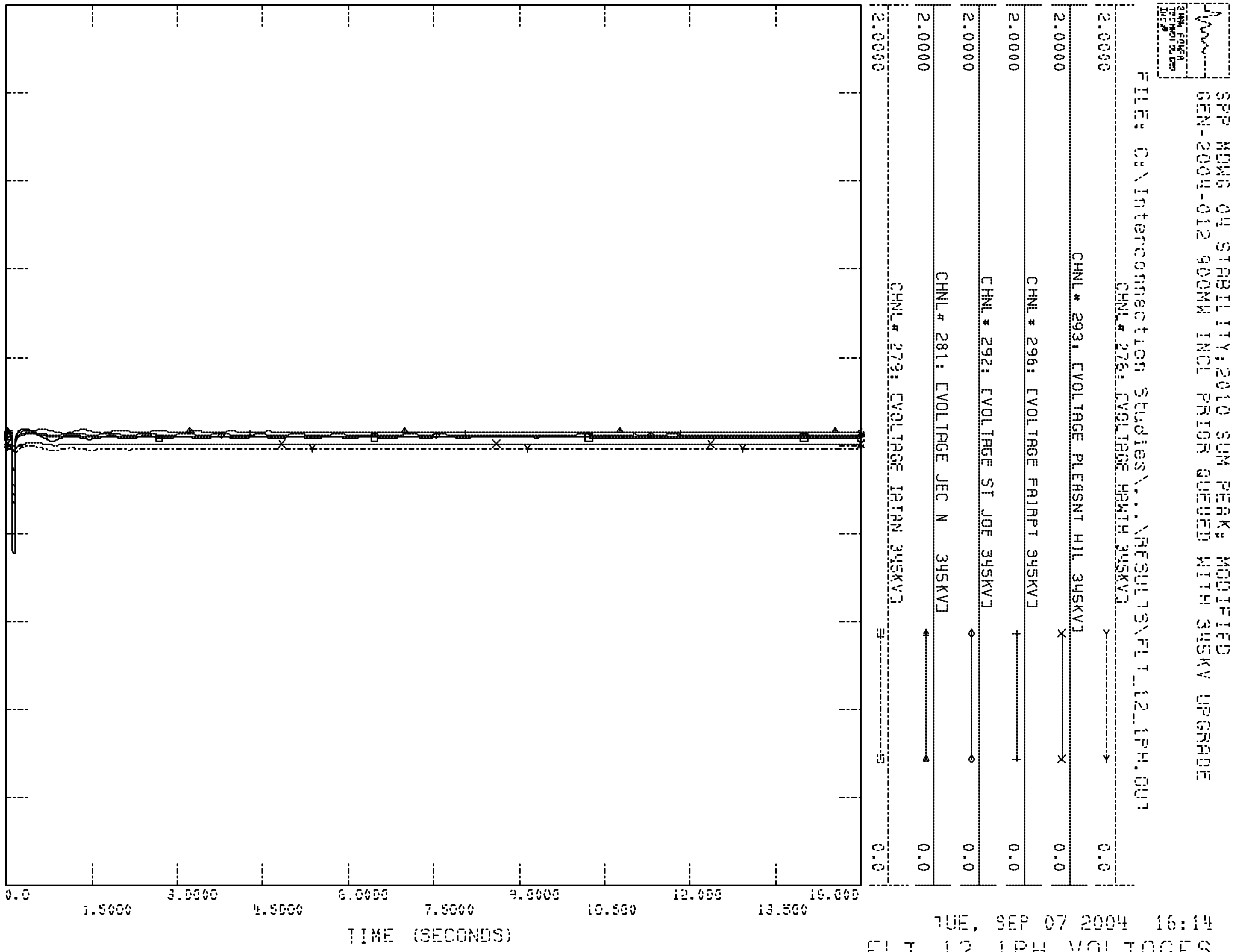
TUE, SEP 07 2004 16:14

FLT_10_VOLTAGES



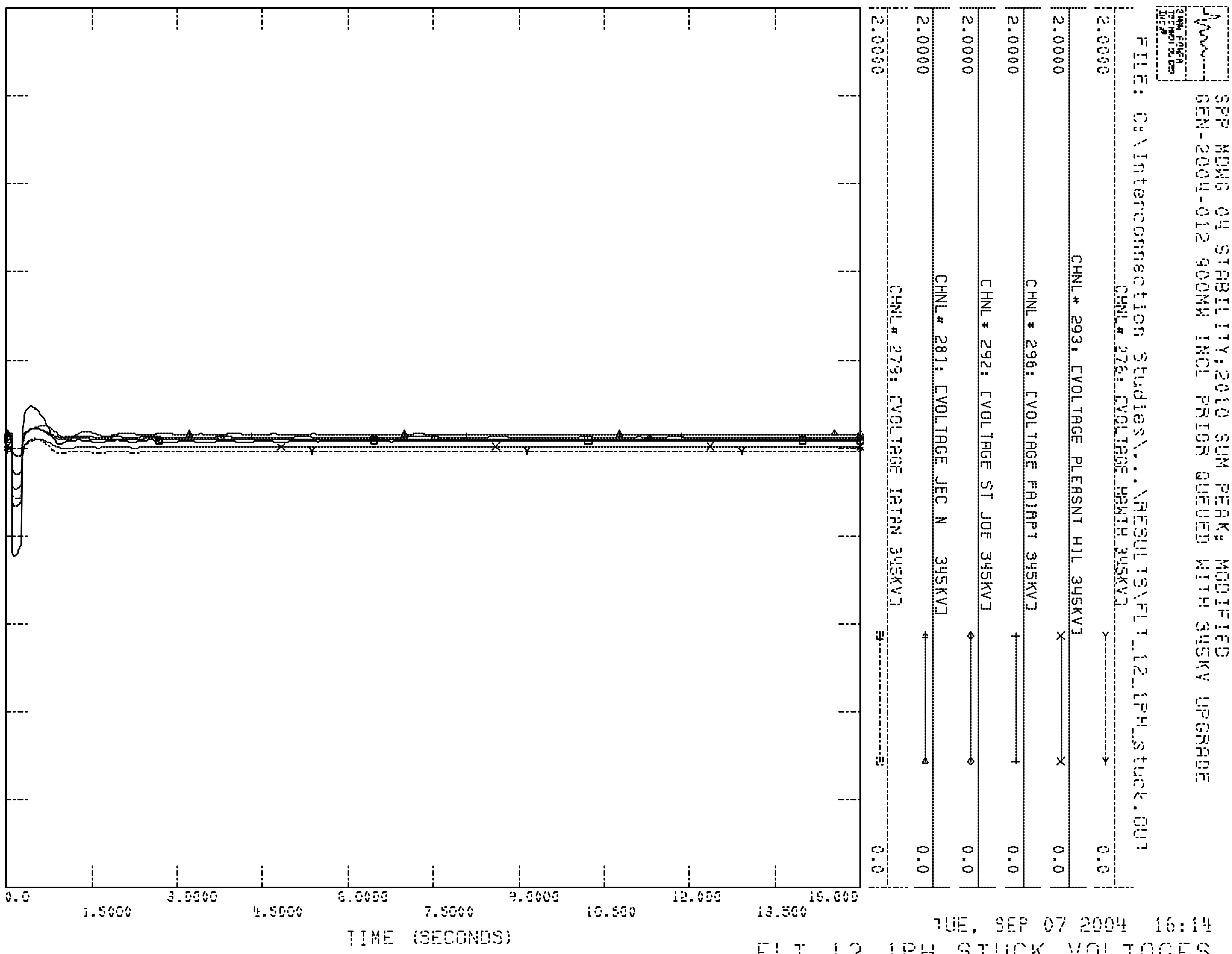
TUE, SEP 07 2004 16:14

FLT_11_VOLTAGES



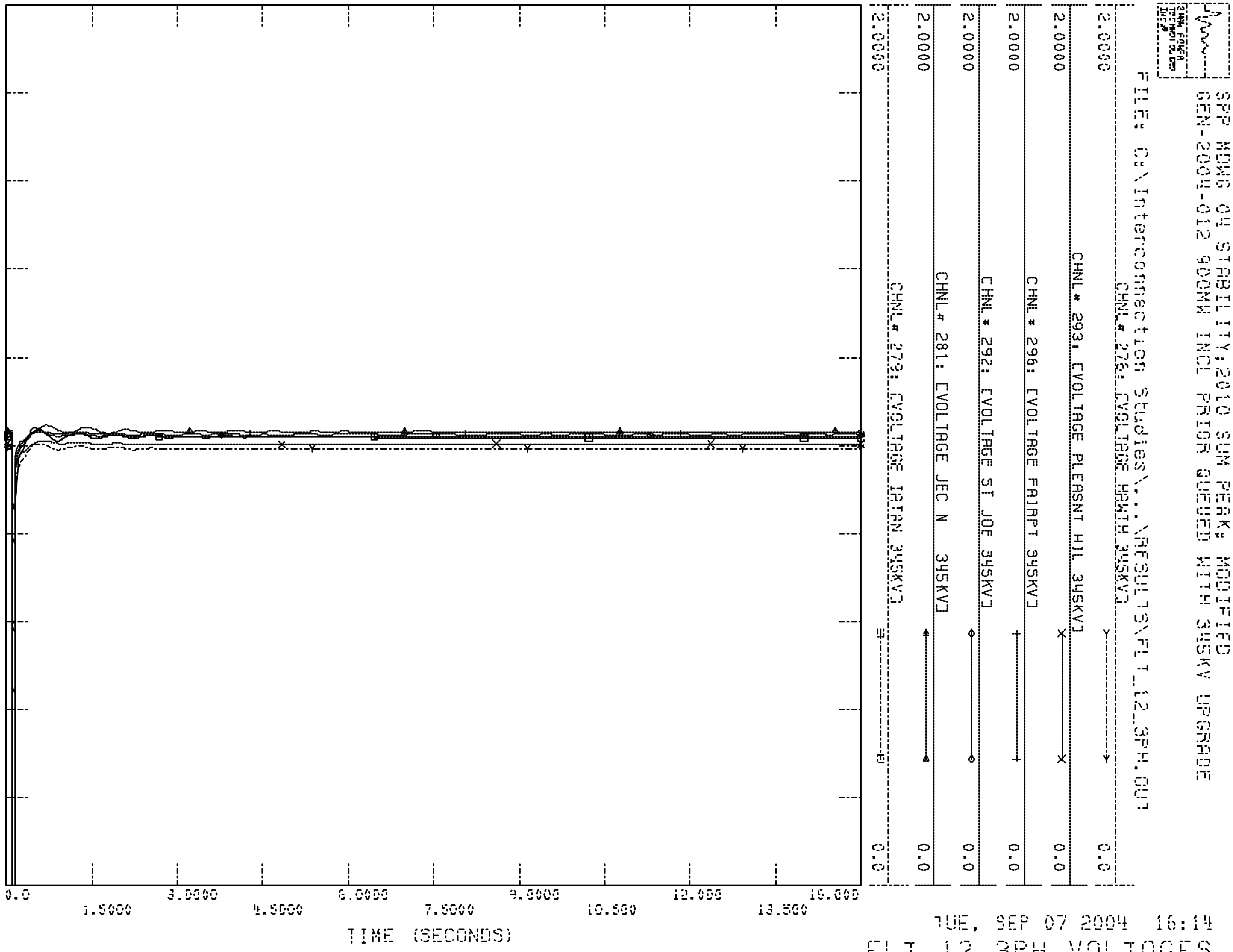
TUE, SEP 07 2004 16:14

FLT_12_1PH_VOLTAGES



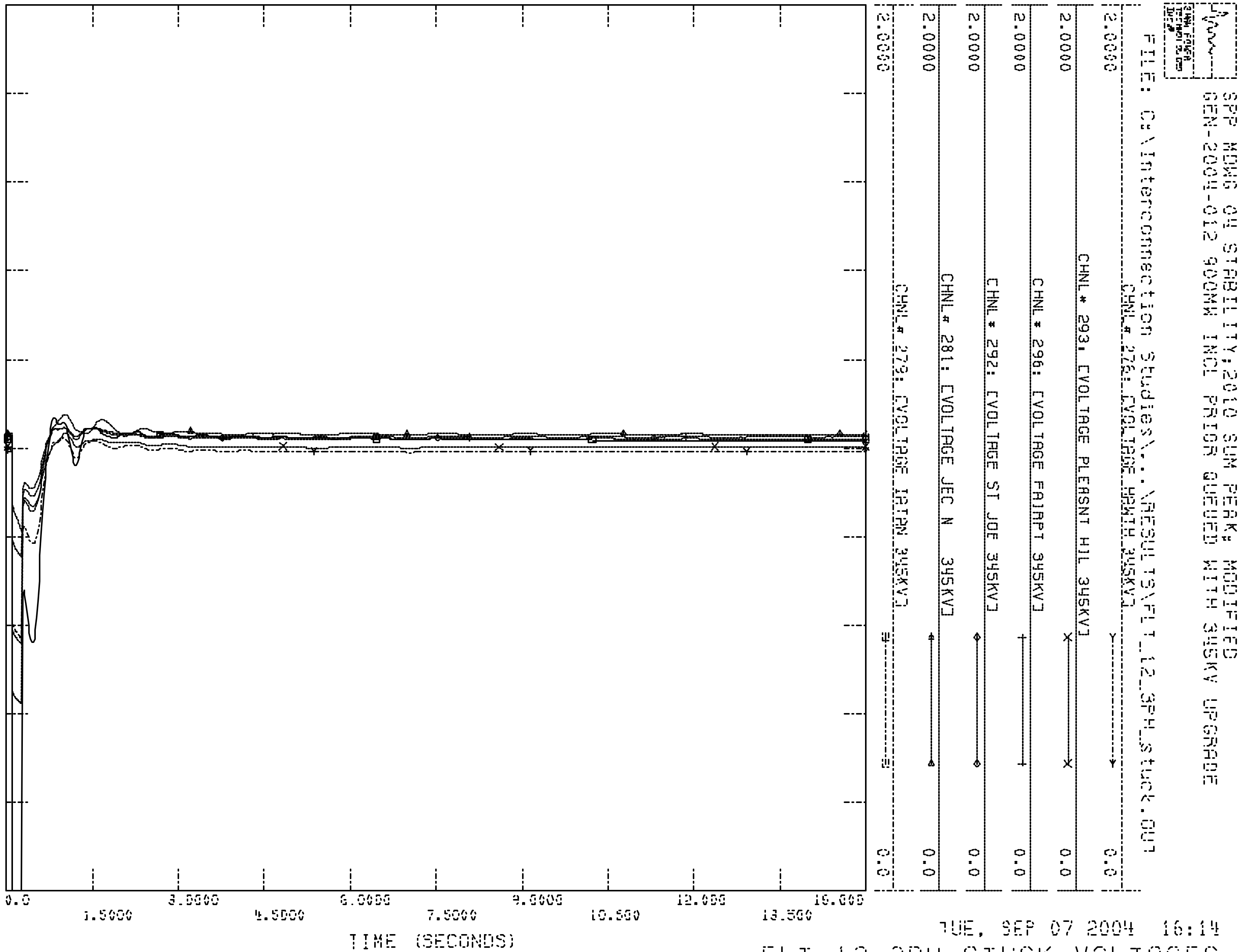
TUE, SEP 07 2004 16:14

FLT_12_1PH_STUCK_VOLTAGES



TUE, SEP 07 2004 16:14

FLT_12_3PH_VOLTAGES



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FLT_12_3PH_STUCK_VOLTAGES