SEL-387 Commissioning Test Example 1

Background:

A technician calls while performing commissioning tests. The substation phone connects you to the SEL-2020. An SEL-387 (Port 4) is connected to the high-side cts of a 69-12 kV power transformer via Winding One, and to two load side feeders via Windings Two and Three. The following information was downloaded with one feeder (Winding Two) closed and carrying load and the other feeder (Winding Three) open. An SEL-351 (Port 5) is used for high-side phase (A,B,C currents) and neutral (N current) back-up.

Answer the question, "Is the SEL-387 ready to go into service?" using the following screen captures and the SEL-387 Commissioning Worksheet.

The following settings were found using the SHOWSET command on the SEL-387.

```
=>SHO
Group 1


RID      =SEL387 98229032
TID      =PAULS VALLEY TRANSF.2
E87W1    = Y          E87W2    = Y          E87W3    = Y          E87W4    = N
EOC1     = Y          EOC2     = Y          EOC3     = Y          EOC4     = N
EOCC     = N          ESLS1    = Y          ESLS2    = N          ESLS3    = N

W1CT     = Y          W2CT     = Y          W3CT     = Y          W4CT     = Y
CTR1     = 120        CTR2     = 240        CTR3     = 240        CTR4     = 1
MVA      = OFF        ICOM     = Y
W1CTC    = 0          W2CTC    = 1          W3CTC    = 1

TAP1     = 2.01       TAP2     = 5.55       TAP3     = 5.55
O87P     = 0.3        SLP1     = 40         SLP2     = OFF
U87P     = 8.0        PCT2     = 15         PCT5     = 35
TH5P     = OFF        IHBL     = N
```

The following is a METER command on the SEL-351 transformer back-up (to get the total transformer load).

```
=>MET

SEL-351 98229034                  Date: 02/22/99    Time: 16:12:10.291
PAULS VALLEY BANK 2 BACKUP
                      A          B          C          N          G
I MAG (A)         34.529     38.369     34.708     60.291      0.436
I ANG (DEG)       57.38     -65.29     170.38      83.12       3.45

                      A          B          C          S
V MAG (KV)        41.111     41.191     41.007      0.002
V ANG (DEG)        0.00    -119.80     119.52     -64.91

                      A          B          C         3P
MW                 0.765      0.917      0.898      2.581
MVAR              -1.196     -1.287     -1.104     -3.586
PF                 0.539      0.581      0.631      0.584
                   LEAD       LEAD       LEAD       LEAD

                      I1        3I2        3I0         V1         V2        3V0
MAG               35.825      7.503      0.436     41.102      0.163      0.443
ANG    (DEG)      54.17     179.38       3.45     -0.09     147.73     -7.70

FREQ (Hz)         60.01                VDC (V)       133.7
```

Use the 3P MW and MVAR readings on the SEL-351 back-up relay to fill in the Metered Load section of the SEL-387 Commissioning Test Worksheet (Section 10 of the SEL-387 I.M.). Use these numbers to calculate expected relay load. We assume that Winding Two power must equal Winding One (power through the transformer is constant, minus losses). (we could have done a meter command on the Feeder on Winding Two to read the actual power).

Also, note the neutral current? 60 Amps. Can you provide an answer as to why the neutral current does not match the high-side ground current calculated by 3I0=Ia + Ib + Ic? (Delta high-side winding prevents ground current from being seen at the high-side CTs) Why might the neutral current be so high? (load unbalance on the feeder) Does this neutral current magnitude and angle make sense, and how might we determine this? (Calculate the unbalance from the Winding Two currents with 3I0=Ia + Ib + Ic or measure the neutral current on the feeder relay)

The following was retrieved from the SEL-387 using the MET DIF and MET SEC commands. Use this data to fill in page two of the commissioning worksheet.

```
=>MET DIF

SEL387 98229032                          Date: 02/22/99    Time: 16:16:19.530
PAULS VALLEY TRANSF.2
```

	Operate Currents			Restraint Currents		
	IOP1	IOP2	IOP3	IRT1	IRT2	IRT3
I (Mult. of Tap)	0.01	0.00	0.01	0.15	0.16	0.14

	Second Harmonic Currents			Fifth Harmonic Currents		
	I1F2	I2F2	I3F2	I1F5	I2F5	I3F5
I (Mult. of Tap)	0.00	0.00	0.00	0.00	0.00	0.00

```
=>MET SEC

SEL387 98229032                          Date: 02/22/99    Time: 16:15:00.542
PAULS VALLEY TRANSF.2
```

	Phase Currents			Sequence Currents		
Wdg1	IAW1	IBW1	ICW1	3I1W1	3I2W1	IRW1
I (A,sec)	0.29	0.31	0.29	0.89	0.05	0.01
Angle (deg)	0.00	-124.15	112.61	-3.87	116.34	81.49
Wdg2	IAW2	IBW2	ICW2	3I1W2	3I2W2	IRW2
I (A,sec)	0.82	0.78	0.89	2.47	0.17	0.23
Angle (deg)	152.66	32.65	-99.67	148.26	-33.85	-160.47
Wdg3	IAW3	IBW3	ICW3	3I1W3	3I2W3	IRW3
I (A,sec)	0.00	0.00	0.00	0.00	0.00	0.00
Angle (deg)	-35.07	-35.07	-35.07	-35.07	-35.07	-35.07
Wdg4	IAW4	IBW4	ICW4	3I1W4	3I2W4	IRW4
I (A,sec)	0.00	0.00	0.00	0.00	0.00	0.00
Angle (deg)	-35.07	144.93	-35.07	-95.07	24.93	144.93

Is the SEL-387 ready to go into service?

COMMISSIONING TEST WORKSHEET
SEL-387 Relay

SYSTEM INFORMATION

System Settings

RID (Relay identification) = _____

TID (Terminal identification) = _____

MVA (Maximum transformer rating) = _____

	Winding 1	Winding 2	Winding 3	Winding 4
Current transformer connection:	W1CT = _____	W2CT = _____	W3CT = _____	W4CT = _____
Current transformer ratio:	CTR1 = _____	CTR2 = _____	CTR3 = _____	CTR4 = _____
Connection compensation:	W1CTC = _____	W2CTC = _____	W3CTC = _____	W4CTC = _____
Nominal line-to-line voltage (kV):	VWDG1 = _____	VWDG2 = _____	VWDG3 = _____	VWDG4 = _____
Tap calculation:	TAP1 = _____	TAP2 = _____	TAP3 = _____	TAP4 = _____

Differential Settings

O87P = _____ SLP1 = _____ SLP2 = _____ IRS1 = _____ U87P = _____

Metered Load (Data taken from substation panel meters, not the SEL-387 Relay)

± Readings from meters	Winding 1	Winding 2	Winding 3	Winding 4
Megawatts:	MW1 = _____	MW2 = _____	MW3 = _____	MW4 = _____
Megavars:	MVAR1 = _____	MVAR2 = _____	MVAR3 = _____	MVAR4 = _____
MVA calculation:				
$MVAn = \sqrt{MWn^2 + MVARn^2}$	MVA1 = _____	MVA2 = _____	MVA3 = _____	MVA4 = _____

Calculated Relay Load

	Winding 1	Winding 2	Winding 3	Winding 4
Primary Amperes calculation:				
$Inpri = \frac{MVAn \cdot 1000}{\sqrt{3} \cdot VWDGn}$	I1pri = _____	I2pri = _____	I3pri = _____	I4pri = _____
Secondary Amperes calculation:				
$WnCT = Y, \quad In\,sec = \frac{Inpri}{CTRn}$	I1sec = _____	I2sec = _____	I3sec = _____	I4sec = _____
$WnCT = D, \quad In\,sec = \frac{Inpri \cdot \sqrt{3}}{CTRn}$				

COMMISSIONING TEST WORKSHEET
SEL-387 Relay

CONNECTION CHECK

Differential Connection (issue **MET DIF<ENTER>** to serial port or front panel)

Note: System load conditions should be higher than 0.1 A secondary. 0.5 A secondary is recommended for the best results.

Operate Current: IOP1 = _____ IOP2 = _____ IOP3 = _____

Restraint Current: IRT1 = _____ IRT2 = _____ IRT3 = _____

Mismatch Calculation:

$MMn = IOPn / IRTn$ MM1 = _____ MM2 = _____ MM3 = _____

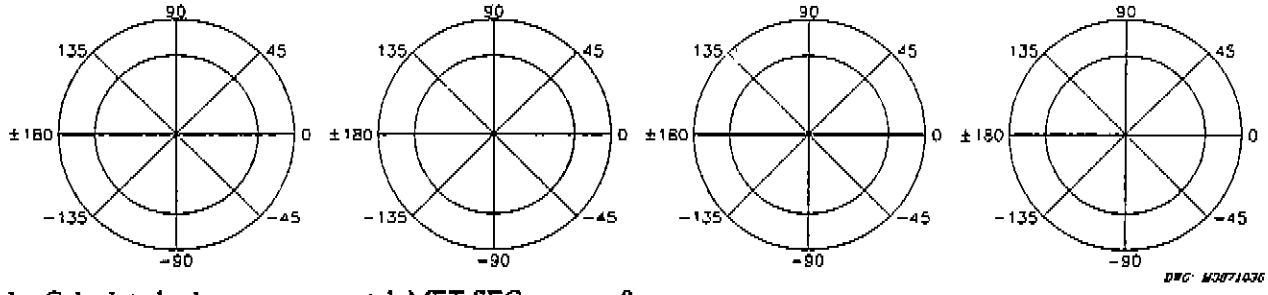
Check individual current magnitudes, phase angles, and operate and restraint currents in an event report if mismatch is not less than 0.10.

MAGNITUDE, ANGLE, AND PHASE ROTATION CHECK

(issue **MET SEC<ENTER>** to the serial port or front panel)

	Winding 1	Winding 2	Winding 3	Winding 4
A-Phase Secondary Amperes:	IAW1 = _____	IAW2 = _____	IAW3 = _____	IAW4 = _____
A-Phase Angle:	_____	_____	_____	_____
B-Phase Secondary Amperes:	IBW1 = _____	IBW2 = _____	IBW3 = _____	IBW4 = _____
B-Phase Angle:	_____	_____	_____	_____
C-Phase Secondary Amperes:	ICW1 = _____	ICW2 = _____	ICW3 = _____	ICW4 = _____
C-Phase Angle:	_____	_____	_____	_____

Winding 1 Winding 2 Winding 3 Winding 4



1. Calculated relay amperes match MET SEC amperes?
2. Phase rotation is as expected for each winding?
3. Do angular relationships among windings correspond to expected results? (Remember that secondary current values for load current flowing out of a winding will be 180° out of phase with the reference phase position for that winding. The reason is that ct polarity marks normally face away from the transformer on all windings.)

SEL-387 Commissioning Test Example 2

Background:

A technician calls while performing commissioning tests. The substation phone connects you to the SEL-2020. An SEL-387 is connected to the high-side cts of a 69-12 kV power transformer via Winding One, and to two load side feeders via Windings Two and Three. The following information was downloaded with both low-side feeders in service. An SEL-351 is used for high-side phase (A,B,C currents) and neutral (N current) back-up.

Answer the question, "Is the SEL-387 ready to go into service?" using the following screen captures and the SEL-387 Commissioning Worksheet.

The following settings were found using the SHOWSET command on the SEL-387.

```
=>SHO
Group 1

RID      =SEL387 98229031
TID      =PAULS VALLEY TRANSF. 1
E87W1    = Y         E87W2    = Y         E87W3    = Y         E87W4    = N
EOC1     = Y         EOC2     = Y         EOC3     = Y         EOC4     = N
EOCC     = N         ESLS1    = Y         ESLS2    = N         ESLS3    = N

W1CT     = Y         W2CT     = Y         W3CT     = Y         W4CT     = Y
CTR1     = 120       CTR2     = 240       CTR3     = 240       CTR4     = 1
MVA      = OFF       ICOM     = Y
W1CTC    = 0         W2CTC    = 1         W3CTC    = 1

TAP1     = 2.01      TAP2     = 5.55      TAP3     = 5.55
O87P     = 0.3       SLP1     = 40        SLP2     = OFF
U87P     = 8.0       PCT2     = 15        PCT5     = 35
TH5P     = OFF       IHBL     = N
```

The following is a METER command on the SEL-351 transformer back-up (to get the total transformer load).

```
=>METER

SEL351                              Date: 03/10/99    Time: 16:01:50.981
PAULS VALLEY BANK 1 BU
                    A          B          C          N          G
I MAG (A)       43.293     39.188     40.577     44.004      0.333
I ANG (DEG)      9.32     -111.80     133.36     -160.36     22.27

                    A          B          C          S
V MAG (KV)      41.278     41.093     41.498      0.002
V ANG (DEG)      0.00     -120.00     120.04     -63.36

                    A          B          C          3P
MW               1.763      1.594      1.639      4.996
MVAR            -0.289     -0.230     -0.388     -0.907
PF               0.987      0.990      0.973      0.984
                 LEAD       LEAD       LEAD       LEAD

                    I1        3I2        3I0        V1         V2         3V0
MAG             40.989      6.953      0.333     41.290      0.123      0.338
ANG    (DEG)    10.29      -8.87      22.27      0.02      -88.50     97.61

FREQ (Hz)       60.01                 VDC (V)      134.0
```

The following was retrieved from the SEL-387 using the MET DIF and MET SEC commands. Use this data to fill in page two of the commissioning worksheet.

```
=>MET DIFF

SEL387 98229031                          Date: 03/10/99    Time: 16:10:25.851
PAULS VALLEY TRANSF. 1
```

	Operate Currents			Restraint Currents		
	IOP1	IOP2	IOP3	IRT1	IRT2	IRT3
I (Mult. of Tap)	0.01	0.00	0.01	0.19	0.18	0.19
	Second Harmonic Currents			Fifth Harmonic Currents		
	I1F2	I2F2	I3F2	I1F5	I2F5	I3F5
I (Mult. of Tap)	0.00	0.00	0.00	0.00	0.00	0.00

```
=>MET SEC

SEL387 98229031                          Date: 03/10/99    Time: 16:10:16.927
PAULS VALLEY TRANSF. 1
```

	Phase Currents			Sequence Currents		
Wdg1	IAW1	IBW1	ICW1	3I1W1	3I2W1	IRW1
I (A,sec)	0.37	0.33	0.35	1.05	0.04	0.02
Angle (deg)	0.00	-121.21	121.68	0.17	-16.28	35.88
Wdg2	IAW2	IBW2	ICW2	3I1W2	3I2W2	IRW2
I (A,sec)	0.29	0.29	0.37	0.94	0.14	0.19
Angle (deg)	-150.66	72.14	-17.73	-150.88	178.37	7.01
Wdg3	IAW3	IBW3	ICW3	3I1W3	3I2W3	IRW3
I (A,sec)	0.82	0.83	0.82	2.47	0.03	0.01
Angle (deg)	130.55	11.22	-109.91	130.62	-57.32	62.45
Wdg4	IAW4	IBW4	ICW4	3I1W4	3I2W4	IRW4
I (A,sec)	0.00	0.00	0.00	0.01	0.00	0.01
Angle (deg)	-72.55	107.45	17.45	-117.55	62.45	62.45

Is the SEL-387 ready to go into service?

COMMISSIONING TEST WORKSHEET
SEL-387 Relay

SYSTEM INFORMATION

System Settings

RID (Relay identification) = _____

TID (Terminal identification) = _____

MVA (Maximum transformer rating) = _____

	Winding 1	Winding 2	Winding 3	Winding 4
Current transformer connection:	W1CT = _____	W2CT = _____	W3CT = _____	W4CT = _____
Current transformer ratio:	CTR1 = _____	CTR2 = _____	CTR3 = _____	CTR4 = _____
Connection compensation:	W1CTC = _____	W2CTC = _____	W3CTC = _____	W4CTC = _____
Nominal line-to-line voltage (kV):	VWDG1 = _____	VWDG2 = _____	VWDG3 = _____	VWDG4 = _____
Tap calculation:	TAP1 = _____	TAP2 = _____	TAP3 = _____	TAP4 = _____

Differential Settings

O87P = _____ SLP1 = _____ SLP2 = _____ IRS1 = _____ U87P = _____

Metered Load (Data taken from substation panel meters, not the SEL-387 Relay)

± Readings from meters	Winding 1	Winding 2	Winding 3	Winding 4
Megawatts:	MW1 = _____	MW2 = _____	MW3 = _____	MW4 = _____
Megavars:	MVAR1 = _____	MVAR2 = _____	MVAR3 = _____	MVAR4 = _____
MVA calculation:				
$MVAn = \sqrt{MWn^2 + MVARn^2}$	MVA1 = _____	MVA2 = _____	MVA3 = _____	MVA4 = _____

Calculated Relay Load

	Winding 1	Winding 2	Winding 3	Winding 4
Primary Amperes calculation:				
$Inpri = \frac{MVAn \cdot 1000}{\sqrt{3} \cdot VWDGn}$	I1pri = _____	I2pri = _____	I3pri = _____	I4pri = _____
Secondary Amperes calculation:				
$WnCT = Y, \quad In\,sec = \frac{Inpri}{CTRn}$	I1sec = _____	I2sec = _____	I3sec = _____	I4sec = _____
$WnCT = D, \quad In\,sec = \frac{Inpri \cdot \sqrt{3}}{CTRn}$				

COMMISSIONING TEST WORKSHEET
SEL-387 Relay

CONNECTION CHECK

Differential Connection (issue **MET DIF<ENTER>** to serial port or front panel)

Note: System load conditions should be higher than 0.1 A secondary. 0.5 A secondary is recommended for the best results.

Operate Current: IOP1 = _____ IOP2 = _____ IOP3 = _____

Restraint Current: IRT1 = _____ IRT2 = _____ IRT3 = _____

Mismatch Calculation:

$MM_n = IOP_n / IRT_n$ MM1 = _____ MM2 = _____ MM3 = _____

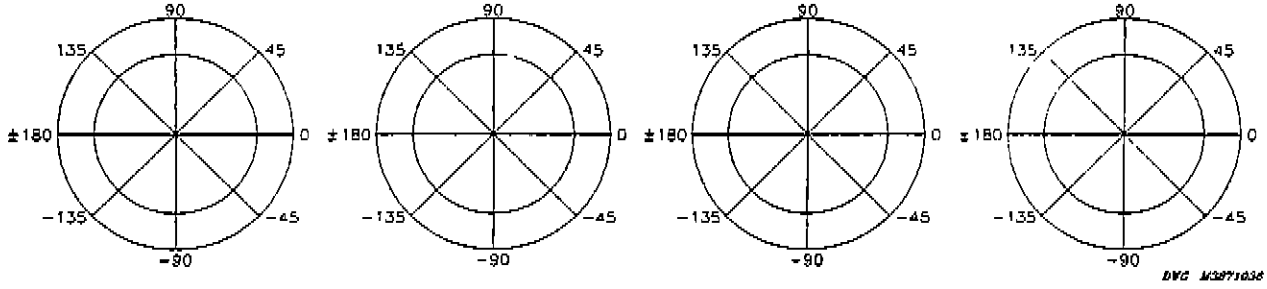
Check individual current magnitudes, phase angles, and operate and restraint currents in an event report if mismatch is not less than 0.10.

MAGNITUDE, ANGLE, AND PHASE ROTATION CHECK

(issue **MET SEC<ENTER>** to the serial port or front panel)

	Winding 1	Winding 2	Winding 3	Winding 4
A-Phase Secondary Amperes:	IAW1 = _____	IAW2 = _____	IAW3 = _____	IAW4 = _____
A-Phase Angle:	_____	_____	_____	_____
B-Phase Secondary Amperes:	IBW1 = _____	IBW2 = _____	IBW3 = _____	IBW4 = _____
B-Phase Angle:	_____	_____	_____	_____
C-Phase Secondary Amperes:	ICW1 = _____	ICW2 = _____	ICW3 = _____	ICW4 = _____
C-Phase Angle:	_____	_____	_____	_____

Winding 1 Winding 2 Winding 3 Winding 4



1. Calculated relay amperes match MET SEC amperes?
2. Phase rotation is as expected for each winding?
3. Do angular relationships among windings correspond to expected results? (Remember that secondary current values for load current flowing out of a winding will be 180° out of phase with the reference phase position for that winding. The reason is that ct polarity marks normally face away from the transformer on all windings.)

SEL-387 Commissioning Test Example 3

Background:

Use the same SEL-387 settings and load readings as in Example 1. However, use the following screen captures for MET DIFF and MET SEC readings.

Answer the question, "Is the SEL-387 ready to go into service?" using the following screen captures and the SEL-387 Commissioning Worksheet.

```
=>>MET DIFF

SEL387 S/N                                Date: 03/14/99    Time: 03:43:47.775
PAULS VALLEY TRANSF. 2

                        Operate Currents            Restraint Currents

                    IOP1      IOP2      IOP3      IRT1      IRT2      IRT3

I (Mult. of Tap)    0.04      0.03      0.04      0.16      0.17      0.16

                    Second Harmonic Currents      Fifth Harmonic  Currents

                    I1F2      I2F2      I3F2      I1F5      I2F5      I3F5

I (Mult. of Tap)    0.00      0.00      0.00      0.00      0.00      0.00


=>>MET SEC

SEL387 S/N                                Date: 03/14/99    Time: 03:43:55.026
PAULS VALLEY TRANSF. 2

                    Phase Currents                    Sequence Currents

Wdg1                IAW1      IBW1      ICW1          3I1W1     3I2W1     IRW1
I (A,sec)           0.29      0.30      0.29          0.88      0.02      0.02
Angle (deg)         0.00   -119.25    118.91         -0.09    126.48    -75.51

Wdg2                IAW2      IBW2      ICW2          3I1W2     3I2W2     IRW2
I (A,sec)           1.02      1.01      1.02          3.05      0.01      0.01
Angle (deg)       149.74     29.59    -90.30        149.68     49.64    -93.95

Wdg3                IAW3      IBW3      ICW3          3I1W3     3I2W3     IRW3
I (A,sec)           0.00      0.00      0.00          0.00      0.00      0.00
Angle (deg)       176.05    176.05    176.05        176.05    176.05    176.05

Wdg4                N/A       INEU      N/A           3I1W4     3I2W4     IRW4
I (A,sec)           0.00      0.00      0.00          0.00      0.00      0.00
Angle (deg)       176.05    176.05     -3.95       -123.95    116.05     -3.95


=>>
```

COMMISSIONING TEST WORKSHEET
SEL-387 Relay

SYSTEM INFORMATION

System Settings

RID (Relay identification) = _____

TID (Terminal identification) = _____

MVA (Maximum transformer rating) = _____

	Winding 1	Winding 2	Winding 3	Winding 4
Current transformer connection	W1CT = _____	W2CT = _____	W3CT = _____	W4CT = _____
Current transformer ratio	CTR1 = _____	CTR2 = _____	CTR3 = _____	CTR4 = _____
Compensation	W1ANG = _____	W2ANG = _____	W3ANG = _____	W4ANG = _____
Nominal line-to-line voltage (kV)	VWDG1 = _____	VWDG2 = _____	VWDG3 = _____	VWDG4 = _____
Tap calculation	TAP1 = _____	TAP2 = _____	TAP3 = _____	TAP4 = _____

Differential Settings

O87P = _____ SLP1 = _____ SLP2 = _____ IRS1 = _____ U87P = _____

Metered Load (Data taken from substation panel meters, not the SEL-387 Relay)

± Readings from meters	Winding 1	Winding 2	Winding 3	Winding 4
Megawatts	MW1 = _____	MW2 = _____	MW3 = _____	MW4 = _____
Megavars	MVAR1 = _____	MVAR2 = _____	MVAR3 = _____	MVAR4 = _____
MVA calculation $MVAn = \sqrt{MWn^2 + MVARn^2}$	MVA1 = _____	MVA2 = _____	MVA3 = _____	MVA4 = _____

Calculated Relay Load

	Winding 1	Winding 2	Winding 3	Winding 4
Primary Amperes calculation. $Inpri = \frac{MVAn \cdot 1000}{\sqrt{3} \cdot VWDGn}$	I1pri = _____	I2pri = _____	I3pri = _____	I4pri = _____
Secondary Amperes calculation $WnCT = Y, \quad Insec = \frac{Inpri}{CTRn}$	I1sec = _____	I2sec = _____	I3sec = _____	I4sec = _____
$WnCT = D, \quad Insec = \frac{Inpri \cdot \sqrt{3}}{CTRn}$				

COMMISSIONING TEST WORKSHEET
SEL-387 Relay

CONNECTION CHECK

Differential Connection (issue **MET DIF<ENTER>** to serial port or front panel)

Note: System load conditions should be higher than 0.1 A secondary. 0.5 A secondary is recommended for the best results.

Operate Current: IOP1 = _____ IOP2 = _____ IOP3 = _____

Restraint Current: IRT1 = _____ IRT2 = _____ IRT3 = _____

Mismatch Calculation:

$MMn = IOPn / IRTn$ MM1 = _____ MM2 = _____ MM3 = _____

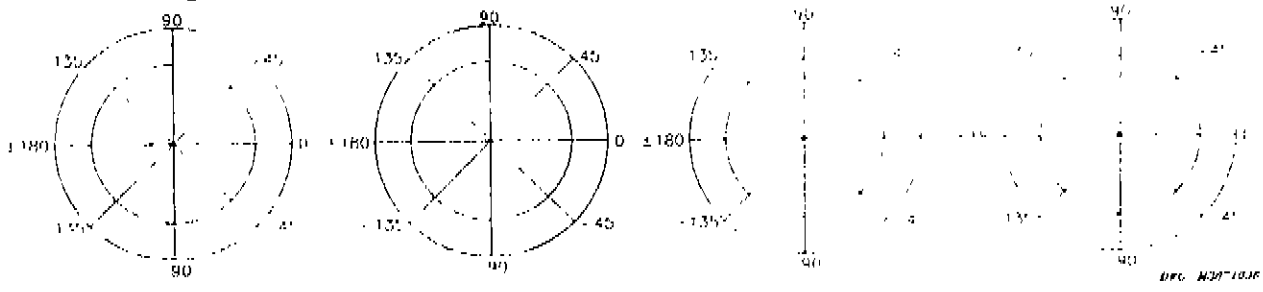
Check individual current magnitudes, phase angles, and operate and restraint currents in an event report if mismatch is not less than 0.10.

MAGNITUDE, ANGLE, AND PHASE ROTATION CHECK

(issue **MET SEC<ENTER>** to the serial port or front panel)

	Winding 1	Winding 2	Winding 3	Winding 4
A-Phase Secondary Amperes:	IAW1 = _____	IAW2 = _____	IAW3 = _____	IAW4 = _____
A-Phase Angle:	_____	_____	_____	_____
B-Phase Secondary Amperes:	IBW1 = _____	IBW2 = _____	IBW3 = _____	IBW4 = _____
B-Phase Angle:	_____	_____	_____	_____
C-Phase Secondary Amperes:	ICW1 = _____	ICW2 = _____	ICW3 = _____	ICW4 = _____
C-Phase Angle:	_____	_____	_____	_____

Winding 1 Winding 2 Winding 3 Winding 4



1 Calculated relay amperes match MET SEC amperes?

2 Phase rotation is as expected for each winding?

3 Do angular relationships among windings correspond to expected results? (Remember that secondary current values for load current flowing out of a winding will be 180° out of phase with the reference phase position for that winding. The reason is that ct polarity marks normally face away from the transformer on all windings.)

SEL-387 Commissioning Test Example 4

Background:

Use the same SEL-387 settings and load readings as in Example 1. However, use the following screen captures for MET DIFF and MET SEC readings.

Answer the question, "Is the SEL-387 ready to go into service?" using the following screen captures and the SEL-387 Commissioning Worksheet.

```
=>>MET DIFF

SEL387 S/N                              Date: 03/14/99    Time: 04:09:35.133
PAULS VALLEY TRANSF. 2

                        Operate Currents            Restraint Currents

                    IOP1      IOP2      IOP3      IRT1      IRT2      IRT3

I (Mult. of Tap)    0.19      0.18      0.08      0.18      0.12      0.12

                    Second Harmonic Currents      Fifth Harmonic  Currents

                    I1F2      I2F2      I3F2      I1F5      I2F5      I3F5

I (Mult. of Tap)    0.00      0.00      0.00      0.00      0.00      0.00


=>>MET SEC

SEL387 S/N                              Date: 03/14/99    Time: 04:09:38.509
PAULS VALLEY TRANSF. 2

                    Phase Currents                  Sequence Currents

Wdg1              IAW1      IBW1      ICW1          3I1W1     3I2W1     IRW1
I (A,sec)         0.43      0.30      0.29           1.02      0.13      0.15
Angle (deg)       0.00   -119.76    118.38          -0.39      6.82     -3.34

Wdg2              IAW2      IBW2      ICW2          3I1W2     3I2W2     IRW2
I (A,sec)         0.84      0.85      0.85           1.69      0.84      1.69
Angle (deg)     149.03    -90.92   -150.88          88.96    148.99   -150.78

Wdg3              IAW3      IBW3      ICW3          3I1W3     3I2W3     IRW3
I (A,sec)         0.00      0.00      0.00           0.00      0.00      0.00
Angle (deg)     -95.31    -95.31    -95.31         -95.31    -95.31    -95.31

Wdg4               N/A      INEU       N/A          3I1W4     3I2W4     IRW4
I (A,sec)         0.00      0.00      0.00           0.00      0.00      0.00
Angle (deg)     -95.31    -95.31     84.69         -35.31   -155.31     84.69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COMMISSIONING TEST WORKSHEET
SEL-387 Relay

SYSTEM INFORMATION

System Settings

RID (Relay identification) = _____

TID (Terminal identification) = _____

MVA (Maximum transformer rating) = _____

	Winding 1	Winding 2	Winding 3	Winding 4
Current transformer connection:	W1CT = _____	W2CT = _____	W3CT = _____	W4CT = _____
Current transformer ratio	CTR1 = _____	CTR2 = _____	CTR3 = _____	CTR4 = _____
Nominal line to line voltage (kV).	VWDG1 = _____	VWDG2 = _____	VWDG3 = _____	VWDG4 = _____
Tap calculation	TAP1 = _____	TAP2 = _____	TAP3 = _____	TAP4 = _____

Differential Settings

O87P = _____ SLP1 = _____ SLP2 = _____ IRS1 = _____ U87P = _____

Metered Load (Data taken from substation panel meters, not the SEL-387 Relay)

± Readings from meters	Winding 1	Winding 2	Winding 3	Winding 4
Megawatts:	MW1 = _____	MW2 = _____	MW3 = _____	MW4 = _____
Megavars:	MVAR1 = _____	MVAR2 = _____	MVAR3 = _____	MVAR4 = _____
MVA calculation $MVAn = \sqrt{MWn^2 + MVARn^2}$	MVA1 = _____	MVA2 = _____	MVA3 = _____	MVA4 = _____

Calculated Relay Load

	Winding 1	Winding 2	Winding 3	Winding 4
Primary Amperes calculation. $Inpri = \frac{MVAn \cdot 1000}{\sqrt{3} \cdot VWDGn}$	I1pri = _____	I2pri = _____	I3pri = _____	I4pri = _____
Secondary Amperes calculation: $WnCT = Y \quad Insec = \frac{Inpri}{CTRn}$	I1sec = _____	I2sec = _____	I3sec = _____	I4sec = _____
$WnCT = D \quad Insec = \frac{Inpri \cdot \sqrt{3}}{CTRn}$				

COMMISSIONING TEST WORKSHEET
SEL-387 Relay

CONNECTION CHECK

Differential Connection (issue **MET DIF<ENTER>** to serial port or front panel)

Note: System load conditions should be higher than 0.1 A secondary. 0.5 A secondary is recommended for the best results.

Operate Current: IOP1 = _____ IOP2 = _____ IOP3 = _____

Restraint Current: IRT1 = _____ IRT2 = _____ IRT3 = _____

Mismatch Calculation:

$MMn = IOPn / IRTn$ MM1 = _____ MM2 = _____ MM3 = _____

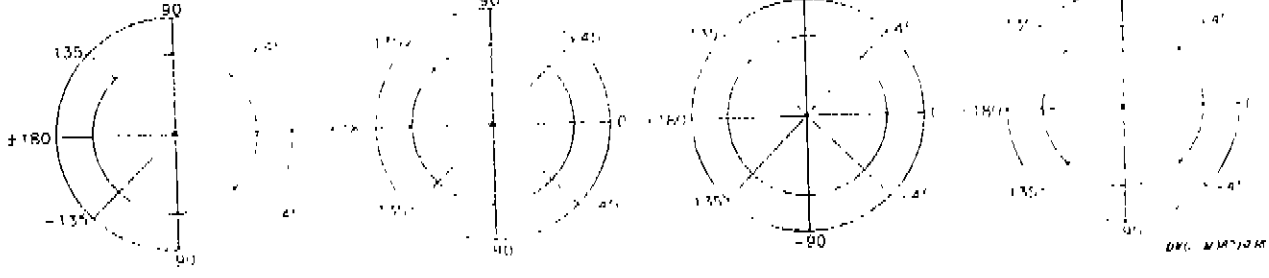
Check individual current magnitudes, phase angles, and operate and restraint currents in an event report if mismatch is not [illegible]

MAGNITUDE, ANGLE, AND PHASE ROTATION CHECK

(issue MET SEC<ENTER> to the serial port or front panel)

	Winding 1	Winding 2	Winding 3	Winding 4
A-Phase Secondary Amperes	IAW1 = _____	IAW2 = _____	IAW3 = _____	IAW4 = _____
A-Phase Angle	_____	_____	_____	_____
B-Phase Secondary Amperes	IBW1 = _____	IBW2 = _____	IBW3 = _____	IBW4 = _____
B-Phase Angle	_____	_____	_____	_____
C-Phase Secondary Amperes	ICW1 = _____	ICW2 = _____	ICW3 = _____	ICW4 = _____
C-Phase Angle	_____	_____	_____	_____

Winding 1 Winding 2 Winding 3 Winding 4



1. Calculated relay amperes match MET SEC amperes?
2. Phase rotation is as expected for each winding?
3. Do angular relationships among windings correspond to expected results? (Remember that secondary current values for load current flowing out of a winding will be 180° out of phase with the reference phase position for that winding. The reason is that ct polarity marks normally face away from the transformer on all windings.)