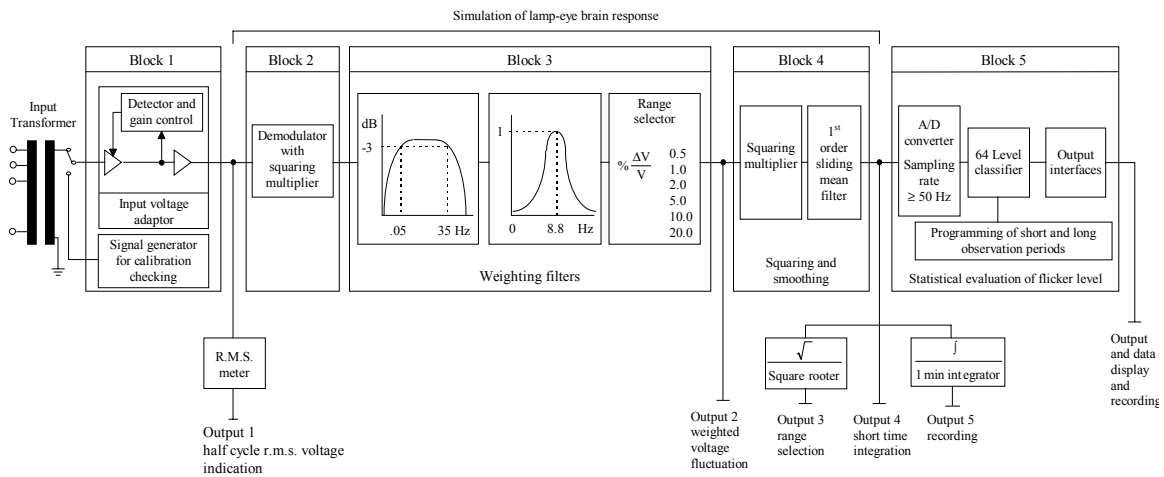


**Using EMTP
to Develop
IEC868 Compliant
Flicker Meter**

Mark Halpin
Jeff Smith

*Mississippi State
University*

Diagram of IEC868 Flicker Meter



Block 1

Input Voltage Adaptor

- Scales the mean rms input to internal reference value
- Uses TACS S-Blocks and Fortran expressions

EMTP File Excerpt

```
C *****
/TACS
C INPUT VOLTAGE FROM AC NETWORK
90CDP10A          60.0
C
C BEGIN FLICKER METER
C *****
C RMS = INPUT LINE-TO-NEUTRAL RMS (NORMAL OPERATING VOLTAGE)
88RMS           =7199.55
C INPUT VOLTAGE FROM AC NETWORK SCALED TO 120V RMS
88X1            =CDP10A*120.0/RMS
C *****
C **** INPUT VOLTAGE ADAPTOR ****
98BLOC1A66+X1                                60.0
  2BLOC1B  +BLOC1A
            1.0
            1.0      35.725  319.0689
88BLOC1C    =1-(BLOC1B-120.0)/BLOC1A
88BLOC1D    =X1*BLOC1C
C *****
```

Block 2

Demodulator

- Demodulates the input signal
- Uses TACS Fortran expressions

EMTP File Excerpt

```
C *****  
C **** DEMODULATOR ****  
88BLOCK2 =BLOC1D*BLOC1D  
C *****
```

Block 3

Weighting Filters

- 1st filter eliminates dc offset and twice the mains from Block 2
- 2nd filter weights the input signal
- Uses TACS S-Blocks

EMTP File Excerpt

```
C *****
C **** 1ST ORDER HiPass
C2345678901234567890123456789012345678901234567890
  1BLOC3A  +BLOCK2
1.0
0.31415926      1.0
C **** 6TH Order LoPass
C2345678901234567890123456789012345678901234567890
  2BLOC3B  +BLOC3A
48361.0678
48361.0678  113.8346      1.0
  2BLOC3C  +BLOC3B
48361.0678
48361.0678  311.0018      1.0
  2BLOC3D  +BLOC3C
48361.0678
48361.0678  424.8364      1.0
C **** WEIGHTING FILTERS FOR 120V LAMPS ****
C2345678901234567890123456789012345678901234567890
  4BLOC3E  +BLOC3D
          1642632.7 88925.79
57275263. 7985560.4 191411.87 3138.838 18.47194
C *****
```

Block 4

Squaring and Smoothing

- Squaring multiplier and low pass filter
- Uses TACS S-Blocks and Fortran expressions

EMTP File Excerpt

```
C *****
C **** Squaring Multiplier
88BLOC4A  =BLOC3E*BLOC3E
C **** Sliding Mean Filter
C2345678901234567890123456789012345678901234567890
  1BLOC4B  +BLOC4A
          1.0
          1.0          0.3
C
C **** Normalization
88868OUT  =BLOC4B/2690.0
C END FLICKER METER
C *****
```

Time Constant

- *Time Constant of meter is large*
Allow 3 minutes of simulation time before measuring output.

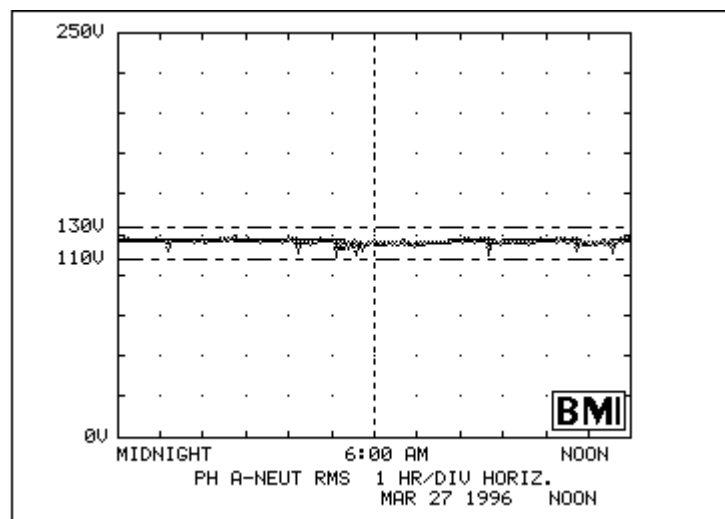
Meter Output

- *Instantaneous flicker level*
Output of “1” results in observable voltage flicker measured by the meter.
- *Can be used to obtain P_{ST} and P_{LT}*

Example System

- Weak distribution feeder (12.47kV)
- Spot load at end of feeder
 - 2 500 hp induction motors
 - 2 350 hp induction motors
- Spot load undergoes frequent motor starts

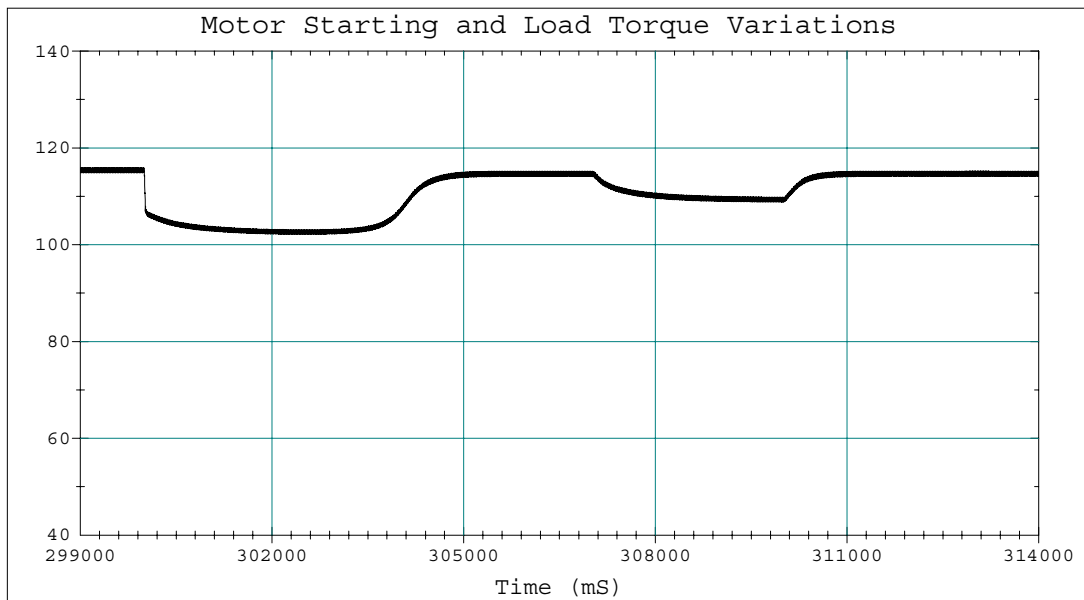
Measured RMS Voltage



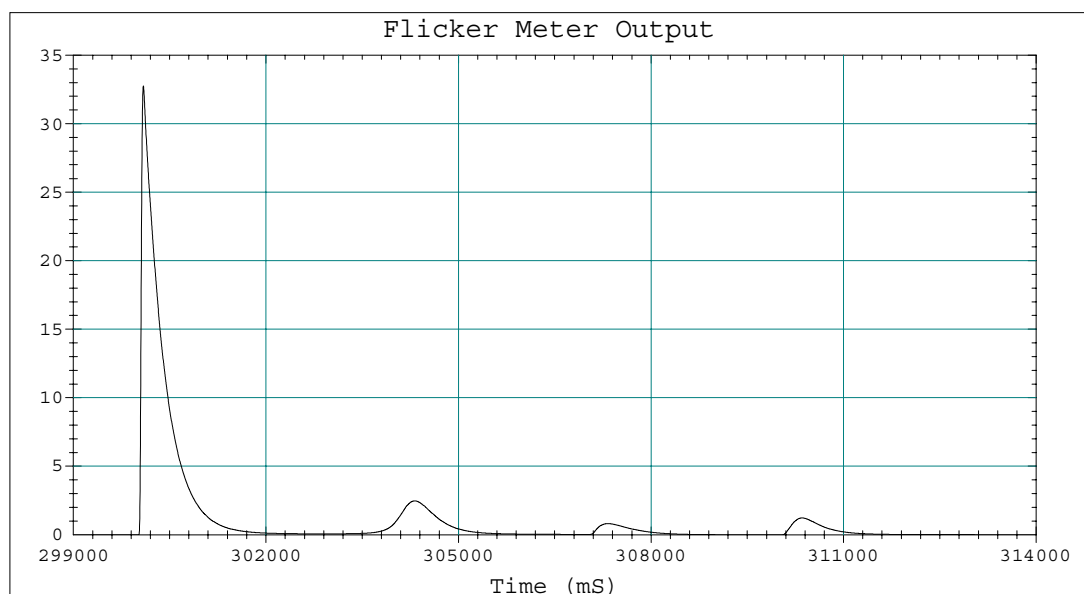
(Nominal Voltage = 120V)

EMTP Simulation Results

RMS Voltage



Flicker Meter Output



Concluding Remarks

- Scale input to $120V_{LN}$ RMS
- 3 minute time delay
- Weighting filters are based on 120V lamps