

## Scratch-Dig Paper

### SURFACE QUALITY

The optical industry has adopted the military specification Mil-0-13830A as the most commonly used standard for a rating of surface imperfections. The imperfections are specified as scratches and digs by the typical designation of "20 -10", "60 - 40", or "80 - 50". The two numbers refer to graded sets of surface quality standards maintained at the Frankford Arsenal. The number before the hyphen is the scratch number and the second number after the hyphen is the dig number:

20	-	10
Scratch		Dig
Number		Number

### SCRATCHES

For reference purposes only, the scratch number defines the maximum width of scratches in tenths of microns. 1 micron = 0.001 mm. Coating scratches (scratches which do not break the surface of the glass) are evaluated separately but in the same ways as glass scratches.

Scratch Number	Maximum	Width
mm	Inches	
80	0.008	0.00031
60	0.006	0.00024
40	0.004	0.00016
20	0.002	0.00008
10	0.001	0.00004
5	0.0005	0.00002

The accumulated length (the sum of the lengths) of all maximum size scratches shall not exceed 1/4 of the diameter of the clear aperture of the lens.

### INTEGRATING SCRATCHES

1. Find the accumulated length of each size scratch (LW)
2. Divide each LW by the average diameter of the clear aperture or the part LW
3. Multiply LW by the corresponding scratch number  $W \times \frac{LW}{D} = NW$
4. Find the sum of the different NW.  $NS = \sum NW$

If a maximum size scratch exists then NS must be  $\leq 1/2$  maximum scratch number. If a maximum size scratch does not exist, then NS must be  $\leq$  maximum scratch number.

EXAMPLE #1: S.Q. = 80-50

Size - 4" x 2"

Diameter of circle of equal area = 2.55"

$$80 \times \frac{0.5}{2.55} = 15.7 = N80$$

Qty

1	1/2"	#80 scratch				
2	1/2"	#60	$60 \times \frac{1}{2.55} =$	23.5	=	N60 scratch
1	1/2"	#40	$40 \times \frac{0.5}{2.55} =$	7.8	=	N40 scratch
				NS	=	47

Since a maximum size scratch exists  $N \leq 40$  but  $NS = 47$  so the part is not good.

EXAMPLE #2: S.Q. = 60-40

Size - 3" diameter

Qty						
1	1"	#40 scratch	$40 \times \frac{1}{3} =$	13.3	=	N40
2	3/4"	#20 scratch	$20 \times \frac{1.5}{3} =$	10	=	N20
				NS	=	23.3

Since a maximum size scratch does not exist  $N \leq 60$  and  $NS = 23.3$  the part is good

### DIGS

The dig number defines the maximum diameter of digs in units of 0.01 mm. In the case of irregularly shaped digs the diameter shall be the average of the maximum length and the maximum width.

Dig Number	Maximum Diameter	mm	inches
	50	0.50	0.020
	40	0.40	0.016
	30	0.30	0.012
	20	0.20	0.008
	10	0.10	0.004
	5	0.05	0.002

Digs smaller than 0.025mm (0.001") are not counted. The maximum size digs shall not exceed one per 20mm (0.787) of computing diameter.