

## Normal SATA SMART Attribute Behavior

This document reviews the current behavior of SATA SMART attributes for Seagate drives and will identify normal changes that occur in the SMART Normalized value with drive usage.

Table 1 shows the SMART attributes that are supported along with associated data that is associated. Ranges of attribute values are given along with the threshold and any warranty application. The last column identifies the method used to determine the Normalized calculation. The power on behavior of the SMART attributes revert back to the last saved values, therefore they are not reset on power cycles.

**Table 1: Seagate Attributes**

Attribute Name	No.	Normalized Attribute Range	Normalized Attribute Threshold	Status Byte Value	Pre-Fail Warranty	Normalized Value Calculated
Raw Error Rate*	1	1-120	44	0Fh	Yes	Logarithmic
Spin Up Time*	3	1-100	0	03h	No	Scaled
Start/Stop Count	4	1-100	20	32h	Yes	
Retired Sectors Count*	5	1-100	36	33h	Yes	Scaled
Seek Error Rate*	7	1-100	30	0Fh	Yes	Logarithmic
Power-on-hours	9	1-100	0	32h	No	Scaled
Drive Power Cycle Count*	10	1-100	97	13h	Yes	Scaled
Raw Error Rate	12	1-100	20	32h	Yes	Scaled
IOECC Count	184	1-100	99	32h	No	Subtraction
Reported Un-correctable	187	1-100	0	32h	No	Subtraction
SMART Command Timeout	188	1-100	0	32h	No	Subtraction
High Fly Writes	189	1-100	0	3Ah	No	Subtraction
Airflow Temperature	190	-127 to 127	45	22h	No	Subtraction
Temperature	194	-127 to 127	0	22h	No	Subtraction
ECC On the Fly Count	195	1-166	0	1Ah	No	Logarithmic
Pending-Sparing Count	197	1-100	0	12h	No	Scaled
Uncorrectable Sector Count (Offline Scan)	198	1-100	0	10h	No	Subtraction
SATA Receive Error Count	199	1-200	0	3Eh	No	Scaled

\* = Warrantable attributes (bit 0 of status field is set).

When describing the normalized calculation method, there are three categories, Scaled, Subtraction and Logarithmic.

**Definitions of Normalized Calculation Methods:**

**Scaled:** A basic math calculation that use a division method to determine a percent value that is then subtracted from the highest normalized value. And example is shown below:

Example, Attribute 5

$$\text{Norm} = 100 - (100 * \text{NumberOfRetiredSectors} / (\text{NumberOfSparesAvailable}))$$

**Subtraction:** Similar to the scaled except the tracking counter is used directly in the normalized calculation.

Example, Attribute 184

$$\text{IOEDC Error} = 100 - \text{Life Time IOEDC Errors.}$$

**Logarithmic:** Uses an approximated logarithmic calculation that requires a minimum number of operations before the calculation is performed. Prior to this calculation a default value is used.

Example, Attribute 1

$$\text{Read Error Rate} = 10 * \log_{10}(\text{NumberOfSectorsTransferredToOrFromHost} / (\text{Number of sectors requiring retries}))$$

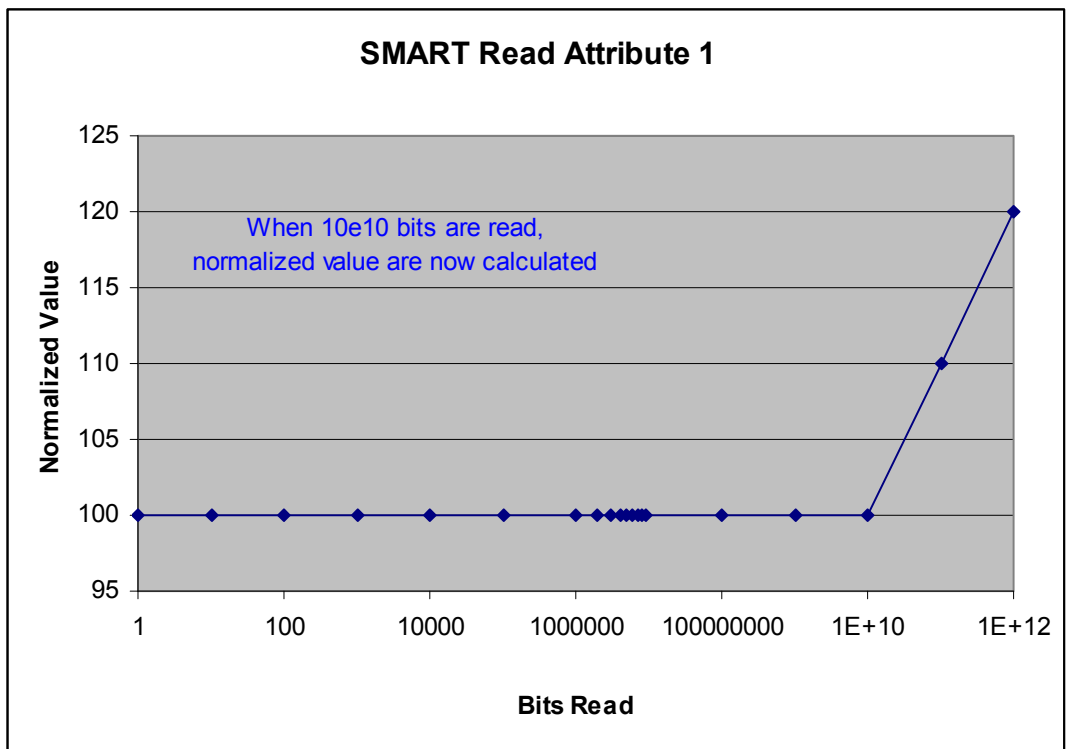
Default value = 100.

Attributes that use the “Scaled” or “Subtraction” method for normalized calculation are very linear in its behavior. The logarithmic calculation does display some unusual behavior since the attribute requires a minimum number of operations before the normalized value is valid, this results in a step function behavior that could be misinterpreted that the drive is experiencing issue and poorer error rate performance. This is not the case. The two attributes that will be discussed are attribute 1 (Raw Error Rate) and 7 (Seek Error rate).

**Raw Error Rate Attribute:**

The attribute value is only computed when the number of bits in the "transferred bits" count is in the range  $10^{10}$  to  $10^{12}$ . The counts are cleared when the Number Of Bits Transferred To the Host =  $10^{12}$ . This attribute will normally have values of a 100 prior to having the corrected amount of sectors transferred. The normalized value would increase when the transfer count increases. See Chart 1.

Chart 1: Increase in Read Sectors by Host

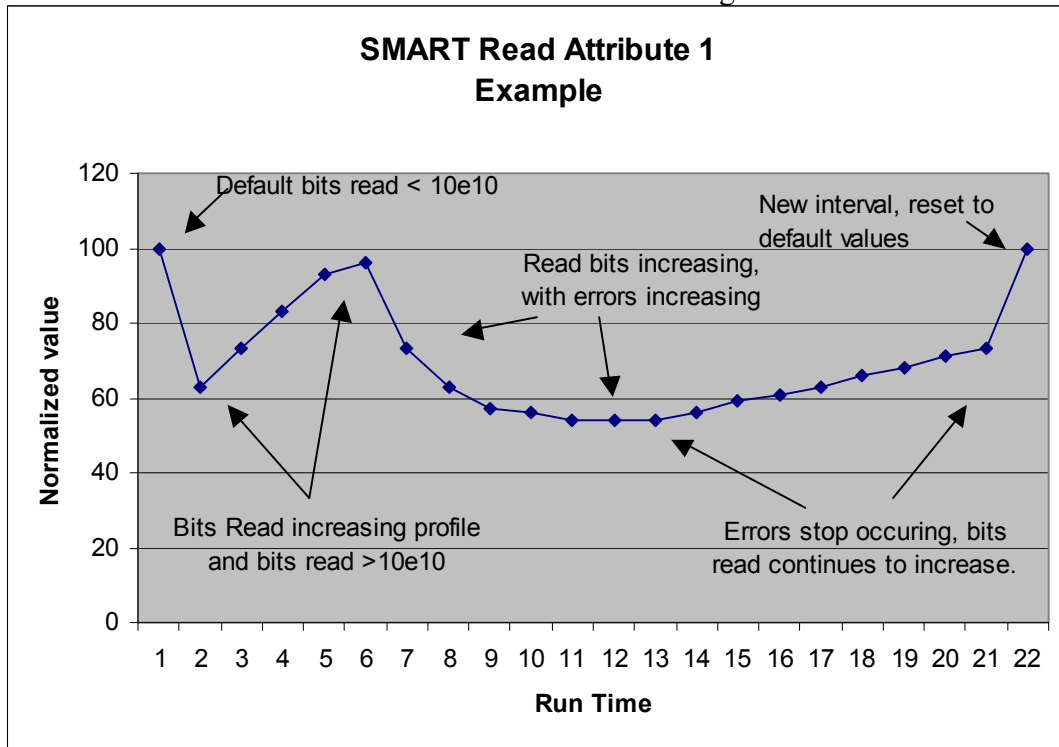


Should Raw read errors start to occur, then there will be an initial step function downward providing the minimum numbers of bits read is reached. On chart 2, the initial point is the default value before 10e10 bits have been reached. At that point the normalized calculation is done that shows the value dropping quite a bit, even there has not been any errors between the two points. As the bits read increases, so does the normalized value, this is representing by the run time hours of 2 through 6.

On hours 7 through 11, the interval has reset and has accumulated back up to the 10e10 values again with some errors that have occurred. From that point on until the 11<sup>th</sup> hour point, the bits read increase and so does the number of read errors. The normalized value shows a slow reduction in value.

On hours 12 through 21, the read errors stop occurring, but the bits read continue to increase, thus showing a slow increase in the normalized value. The last point at hour 22, so the interval resetting after 10e12 has been exceeded, thus the default value is present again.

Chart 2: Read Errors Occurring

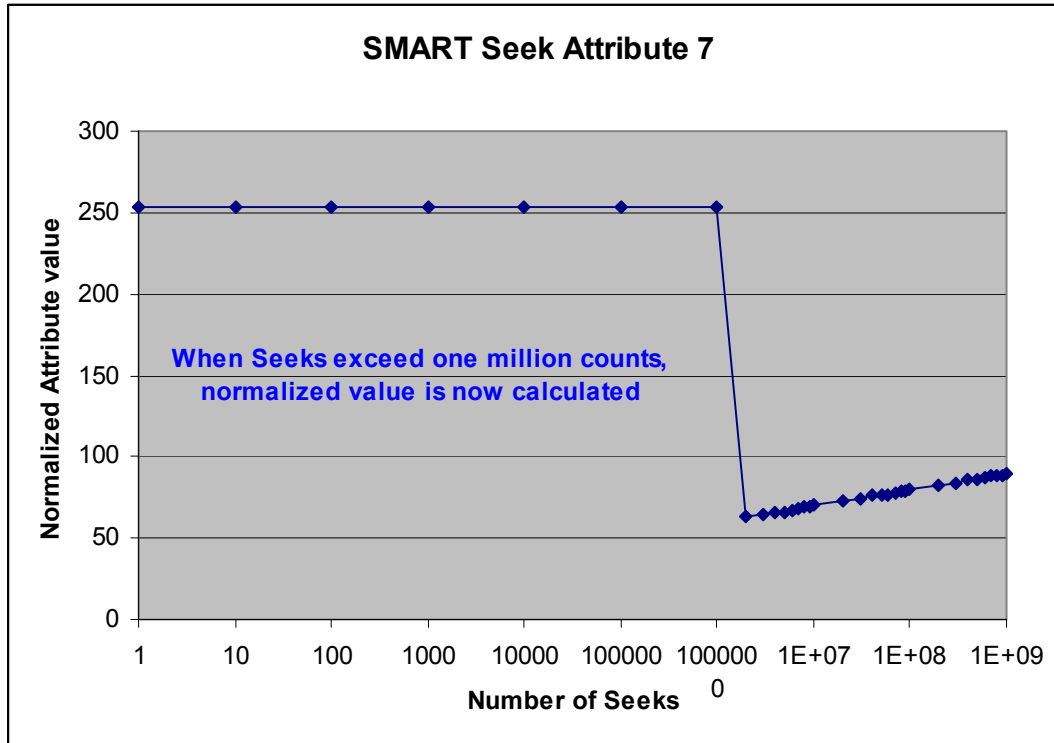


For Seagate drives for attribute 1, the normalized values between 44 (the threshold) and 55 that show a decreasing trend would be the range of values to monitor more closely.

**Seek Error Rate Attribute:**

The seek attribute, when performing normally will have a value starting at 254. As commands are received that requires the drive to perform a seek operation and the number of seek has exceeded a count of more than 1e6, then the normalization calculation is done that results in a step drop from 254 down to 60. See Chart 3 below:

Chart 3: Increase in Commands from Host requiring a Seek operation



Should seek errors start to occur, then there will be an initial step function downward providing the minimum numbers of seeks are reached.

On chart 4, the initial point is the default value before 1e6 seeks have attained. At that point the normalized calculation is completed that shows the normalized value dropping in value, even there has not been any errors between the two points. As the number of seeks increases, so does the normalized value, this is representing by the run time hours of 4 through 13.

On hours 14 through 19, seek and seek errors continue to accumulated causing the normalized value to decrease.

On hours 20 through 33, the seek errors stop occurring, but the number of seeks continue to increase, thus showing a slow increase in the normalized value. The last point at hour 34, so the interval resetting after 1e9 seeks has been exceeded, thus the default value is present again.

For Seagate drives for attribute 7, the normalized values between 30 (the threshold) and 45 that show a decreasing trend would be the range of values to monitor more closely.

Chart 4: Seeks Errors Occurring

