PHILIPS

via e-mail: lighting@energystar.gov

February 23, 2017

Ms. Taylor Jantz-Sell
ENERGY STAR Program Manager
US Environmental Protection Agency
1200 Pennsylvania Avenue NW
Washington, DC 20460

RE: ENERGY STAR™ Lamps v2.1 Draft 1 Comments

Dear Ms. Jantz-Sell:

Philips Lighting appreciates the opportunity to provide the attached comments on Draft 1 of the ENERGY STAR™ Lamps v2.1 Requirements.

Please contact me if you have any questions.

Sincerely,

Anthony W. Serres

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Philips Lighting

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PHILIPS

Comments on Draft 1 - ENERGY STAR™ Lamps v2.1

February 22, 2017

Philips Lighting appreciates the opportunity to offer the following comments on Draft 1 of the ENERGY STAR Lamps v2.1 Requirements. Our comments follow the order in which the respective topic appears in the document. Also, as a NEMA member, we support and echo their comments.

Section 1.1 – Included Products

We repeat our previous request that ENERGY STAR include the AR111 shape in the specification. An internet search reveals many brands of halogen AR111 lamps on the market, including GE, Halco, Philips, and Sylvania. There are LED versions from Soraa, Optima and Philips. Sales information on these products, as reported to NEMA, are aggregated with MR16 types and other low voltage lamps, thus no clear picture of the market exists, but there is a potential to save energy as we have pointed out in prior comments.

Section 7.1 – Table 2 – LED Package

We generally agree with the proposed LED Package variation. If this proposal goes forward, it would allow a product to be qualified immediately after the lamp is tested to the listed performance metrics in Table 2. We support this, but since the LED is a key component, we further suggest that the variation also require life/lumen maintenance tests at 3000 and 6000 hours for the final certification.

Section 9.3 – Elevated Temperature Light Output Ratio

LED technology is now at a level that enables high-output directional LED lamps with input power that exceeds 20W. This is significant for two reasons: 1) Lamps with an input power over 20W must be tested at 55C instead of 45C,[1] and 2) Single optic designs that use chip-on-board (CoB) LEDs are more temperature sensitive than a multiple LED design. These effects combine to impose severe limits on lamps with chip-on-board LEDs.

[1] Unless the product is marked not for use in recessed fixtures.

The figure below shows the thermal behavior of a typical CoB LED. (Lumileds CoB Core Gen 2) http://www.lumileds.com/products/cob-leds/luxeon-cob. (The figure is taken from the datasheet: http://www.lumileds.com/uploads/561/DS155-pdf.)

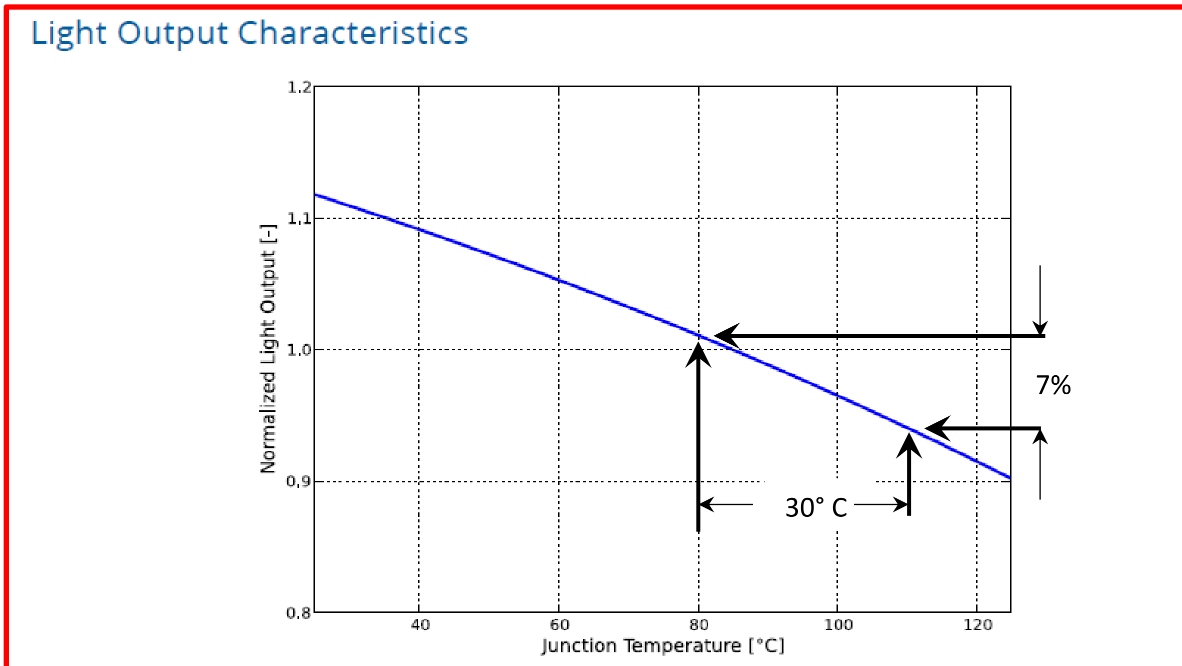


Figure 2: Typical normalized light output vs. junction temperature for L2C2-xxxxxxxxExx00 at specified test current.

The figure shows that CoB LEDs have a steep temperature dependence. Temperature dependence for discrete LEDs is typically not as steep. If the LED junction temperature is typically 80°C in the lamp, at 25°C ambient, then it will increase by about 30°C to 110°C at 55°C ambient. From the figure above, this unavoidable 30°C junction temperature increase will result in a 7% light output drop, if there are no other effects. (The increase will likely be more than 30°C, because LEDs are less efficacious at higher temperatures, resulting in more heat and a higher junction temperature. It may also be more for CoB LEDs from other manufacturers.) This leaves the lamp designer with less than 3% to work with, to include all other effects on light output, and design margins. These other effects (current variations with temperature, electronic component variations with temperature, etc.) are not insignificant. A 3% margin is too small and we strongly suggest that Energy Star allow a ratio of 0.85 for lamps greater than 20W. As this is a slight relaxation of the existing requirements, it would not affect currently certified products.

Section 10.1/10.2 – Lumen Maintenance and Lifetime

We are somewhat flummoxed that ENERGY STAR has chosen to drop the life requirements for directional lamps with this revision after appearing to take the decision not to reduce the life during the v2.0 revision process. Many manufacturers chose not to introduce ‘value’ directional lamps after it appeared that the 25,000 hour life requirement would not change.

That said, the proposal to reduce the lifetime requirement to 15,000 hours is acceptable for R, BR, and ER directional lamp shapes. We strongly encourage ENERGY STAR to implement this change 12 months after the effective date of the v2.1 specification to provide industry with the time needed to test and qualify dedicated 15,000 hour products to the new requirement. While longer-life lamps can continue to be certified (note box 13), these lamps are generally PAR, MR, and MRX types. These types are typically used in applications with long operating cycles, i.e., 10 to 12 hours a day where a long life product can reduce maintenance costs. Thus we ask that the PAR, MR, and MRX types retain the 25,000 hour requirement.

For those products with a 15,000 hour life, the calculated lumen maintenance test duration, according to the DOE test procedure, is 4,400 hours. ENERGY STAR currently requires a minimum of 6,000 hours, regardless of rated life. To speed entry of new products in to this highly competitive market and reduce test burden, we propose that ENERGY STAR allow testing times in accordance with the DOE test procedure.

The DOE LED Lamps Test Procedure for Life Testing requires at least 10 samples, with the reported lifetime being the average of the middle two units. In practice, this allows as many as four failures if 10 lamps are tested. We propose that a 9/10 failure rate be reinstituted in Energy Star, as in prior lamp specifications. We are not aware of any LED lamp failure rate evidence that would indicate this change would undermine consumer confidence or the ENERGY STAR brand.

A requirement of zero failures puts a very high requirement on the manufacturer. Since the failure of any component could cause the test as a whole to fail, the manufacturer has a great deal of risk. If a failure does occur during testing, a large amount of time (potentially nearly 6000 hours, if the failure occurs near the end of the test) will be lost. This is in contrast to any other Energy Star-regulated parameter, where failure will be known immediately.

Recall that ENERGY STAR originally increased the requirement from 9 of 10 passing to 10 of 10 to align with an interim DOE rulemaking. In a subsequent rulemaking, DOE changed their requirement to be less restrictive and allows up to 4 failures. Given this change in the DOE requirements, we encourage ENERGY STAR to return to its original 9 of 10 requirement. This change would not require retesting and could be incorporated as part of the v2.1 revision.

In theory, a manufacturer could test multiple batches of lamps during initial qualification, to reduce the risk of a failure during lumen maintenance testing. However, when the time comes for verification testing, we would expect that only a single batch will be tested. Thus, the use of different batches at the time of qualification does not reduce risk to the manufacturer.

Probability analysis:

p = probability that a lamp passes the test

n = the number of lamps tested (10 in this case)

We address this problem with the binomial theorem.

Probability that 10 of 10 will pass = p^{10}

Probability that 9 of 10 will pass = $p^{10} + 10(1-p)p^9$

If the manufacturer decides that he will accept a 0.1% chance of failure of the long-term lumen maintenance test, then the probability that an individual lamp passes, p, must be 0.9952, if the criterion is that 9 of 10 lamps must pass, and p must be 0.9999 if the criterion is that 10 of 10 lamps must pass. This is a change from an allowed failure rate of 48 of 10000 to 1 of 10000 lamps. It requires a lot of work in the design and in the manufacturing to maintain this level (especially for consumer products).

Section 12.4 – Flicker/Temporal Light Artifacts (TLA)

We greatly appreciate that ENERGY STAR has included measurements of flicker/temporal light artifacts in this specification, and that ENERGY STAR has proposed only reporting the values at this time. We wish to echo the NEMA comments on this issue that this appears to conflict with ENERGY STAR's support of NEMA's efforts to develop: a standard for Temporal Light Artifacts, a standard for dimmer-lamp compatibility, and a qualification/marking program to label these products. We think it is preferable to use the forthcoming NEMA TLA standard, LSD-75, over the ASSIST metric for several reasons:

LSD-75 will contain measurement procedures for two metrics, Pst, which measures performance at visible frequencies (less than about 70 Hz) and SVM, which measures performance at higher frequencies where stroboscopic effects appear. The document also gives guidelines for values of the metrics that should not be exceeded in general indoor and outdoor applications. Energy Star could decide to require reporting of either or both of the metrics.

The ASSIST method is only useful for visible flicker (less than about 70 Hz). It provides no measure for stroboscopic visibility.

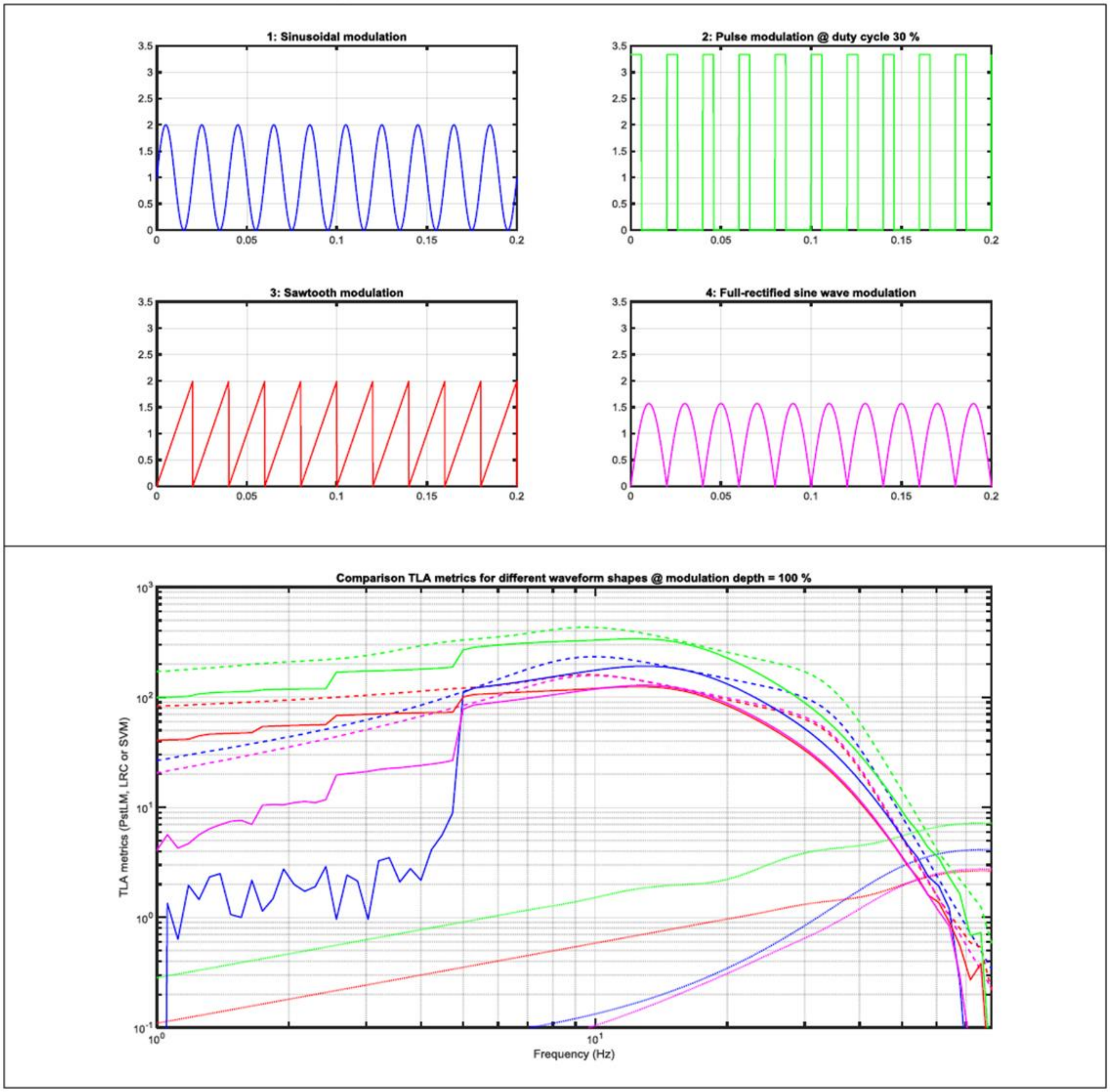
The three figures that follow compare the ASSIST, Pst and SVM methods over a range of 1 to 80 Hz on logarithmic scale. The solid lines are the ASSIST calculation. The dashed lines are the Pst calculation and the dotted lines are the SVM calculation (SVM is less relevant at the frequency ranges shown in the figures because it deals with stroboscopic effects). The sample rate was 20,000 samples/second. The waveform duration was 60 seconds. Frequencies between 1 and 80 Hz were used (80 points, logarithmically distributed). Results were calculated for four different simple waveforms (sine, 30% duty cycle pulses, triangle, and full-wave rectified sine).

The figures show that for all four waveforms, the ASSIST metric values are close to, but lower than the corresponding values of the Pst metric. Therefore, the Pst metric is more stringent than the ASSIST metric.

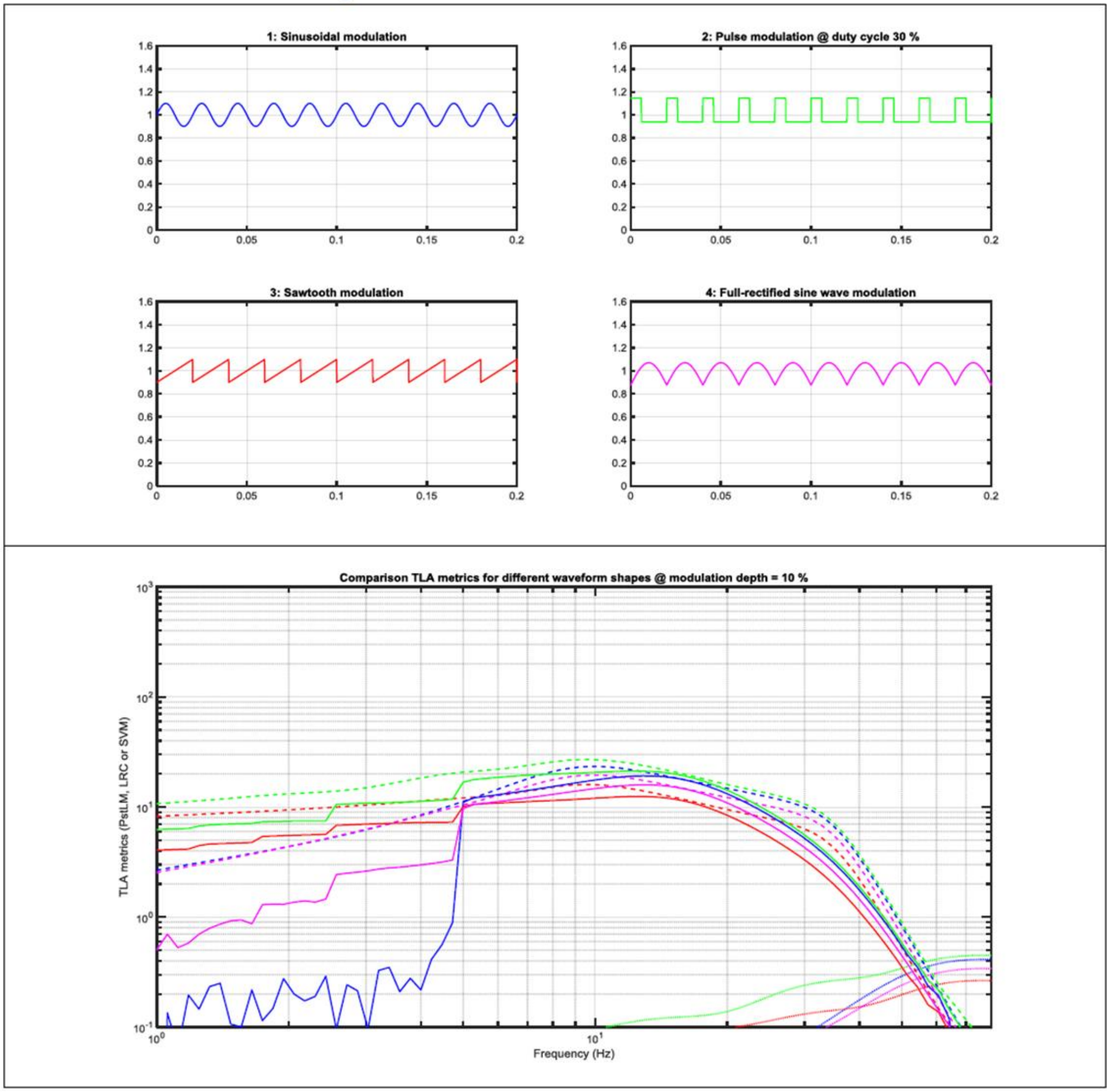
A couple other points:

- The NEMA TLA measurement method has been verified through round-robin testing by several NEMA companies.
- The ASSIST metric shows numerical artifacts below 5 Hz, and is not suitable for those frequencies.
- The Pst metric has existed for many years in the IEC and has stood the test of time.

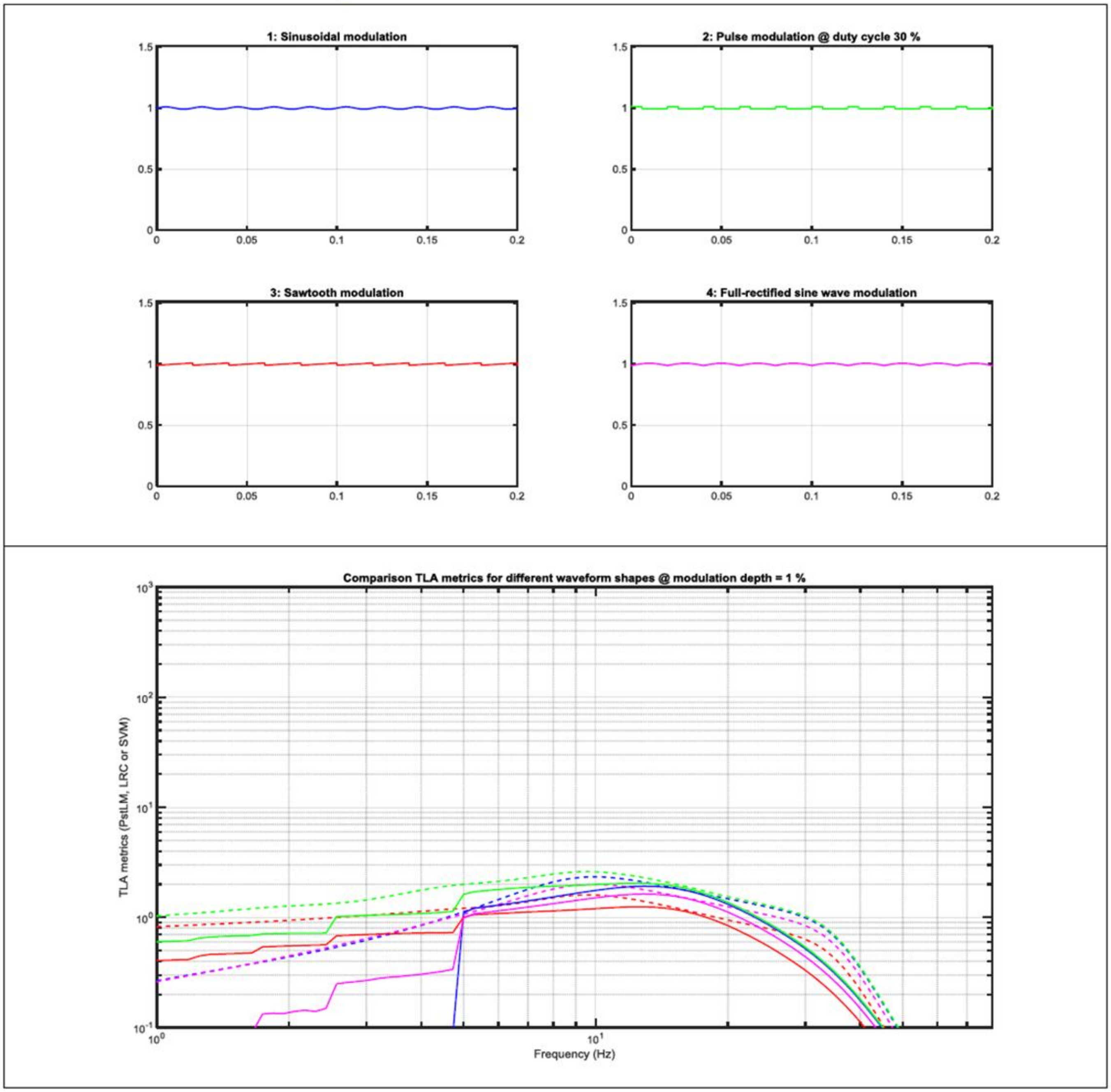
Case 1: Modulation depth 100 %



Case 2: Modulation depth 10 %



Case 3: Modulation depth 1 %



END COMMENTS