

LeakAlertor™ Technical Reference Guide (Rev. D)

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NOTE: This guide has been written to give the water utility and plumbing professionals an overview of the actual operation and methodology the LeakAlertor employs in order to correctly identify leaking flappers. *If you do not wish to read this overview, please skip to the “Key Points” section at the end of this booklet, which covers the main technical points of the product.*

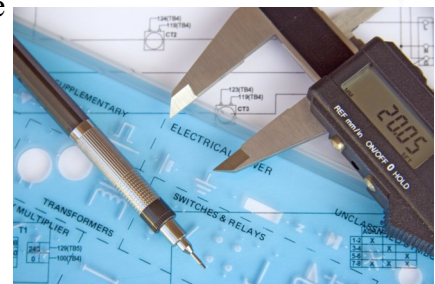
Introduction

One of the most critical design objectives for the LeakAlertor was simplicity of installation and use. Achieving that objective without any user setup or calibration required developing a unique sensor technology and a correspondingly complex mathematical process that would allow the product to be placed on virtually any tank and flapper based toilet (there are hundreds of different models), accounting for dozens of different types of fill valves, flappers, and variations in water pressure (even on the same toilet), while simultaneously ignoring external noise, incidental bathroom “disturbances” (use your imagination!), and all kinds of interference.

How Does It Really Work?

A leaking flapper will produce a drop in the water level inside the toilet tank, causing the fill valve float (or pressure sensor) to activate and refill the tank, which usually lasts several seconds. This phenomenon is often referred to as a “phantom flush”. As the flapper continues to leak, this process repeats itself. When a fill valve action occurs (“phantom flush” or an actual flush initiated by the user), water is forced into the tank at a rate that is a function of the water pressure, toilet feed-valve, and the ports of the fill valve itself. The pressurized water produces turbulence inside the tank, which in turn produces vibration. The LeakAlertor has been designed to specifically identify and isolate the vibration signature of a fill valve action and qualify it as either a normal flush cycle or a refill action in response to a leaking flapper. Easier said than done!

Because the vibration signature is different from toilet to toilet, the LeakAlertor must first “learn” its environment. After attaching the product to the toilet and pulling the battery activation tab, the user is instructed to flush the toilet. The LeakAlertor then mathematically models the toilet as a function of the vibration due to water turbulence, committing the “flush signature”¹ to memory. The “flush signature” is used to help determine other toilet characteristics, such as whether or not the flapper is leaking (see the “Technology Options” section for other modeled and data logged characteristics). Depending upon what has been determined by the LeakAlertor, the various visual and audible alerts are as follows:



¹The “flush signature” comprises the physical and timing characteristics observed and modeled by the LeakAlertor during the entire flush cycle. This includes but is not limited to the initial actuation of the flush handle, the evacuation of the tank water into the bowl, the closing “thump” of the flapper, and the complete refilling of the tank until the float attached to the fill valve rises to a level that turns off that same fill valve, thereby interrupting the water flow into the tank.



Operation: The LeakAlertor will periodically flash:

GREEN: Means the unit is functioning properly.

RED: Means the toilet is leaking and requires attention.
The unit will also beep to indicate a leak.

YELLOW: Means the battery is low. The unit will also chirp.
See the instructions inside the packaging for battery replacement.

The LeakAlertor contains other capabilities that are important to know and understand during the testing and evaluation process.

Although the user is instructed to flush the toilet after pulling the tab and waiting for the **GREEN** and **RED** lamps to flash, accompanied by beeping, there may be times when, for whatever reason, the user does not flush the toilet. Or, it could be an extremely quiet toilet (meaning that the turbulence is minimal due to a very quiet fill valve, low water pressure, or both). When the LeakAlertor is unable to properly qualify a flush, it will preset itself with specific default variables and attempt to “learn” the toilet characteristics over time. *So regardless of whether or not the user understands all of the directions, if the product is minimally placed somewhere on the toilet tank and the battery pull-tab is removed, the LeakAlertor will figure out what it needs to know in order to monitor the toilet for leaks.* It should be noted that depending upon what data is or isn’t modeled when the unit is first installed, and given the actual normal use of the toilet and any associated background noise, it can take up to 48 hours to “learn” the toilet and respond accordingly to leaks. However, extensive testing and actual field data has shown that in most instances, the LeakAlertor will mathematically model the toilet and detect leaks in just a few hours, or overnight at most.

Why does it sometimes take so long to identify a leak? First, it’s important to understand that a single “phantom flush” does not qualify as a leak.² The LeakAlertor is looking for both continuous and intermittent leaks: rather than produce a “cry wolf” product that overreacts to various external noise, the device first looks to discount background noise such as fans, vibration due to HVAC systems, hair dryers, stereos, etc. Second, the mathematical modeling algorithms are very complex due to the extraordinarily high number of variables that must be taken into consideration. Third, in order for the battery to last up to a maximum of 18 months before requiring replacement, the LeakAlertor periodically goes into a “sleep mode” to conserve power. The LeakAlertor is active in searching for leaks several times each day for several hours, during randomly occurring intervals. Statistically, most bathrooms will have “quiet” periods when they are not in use (for instance, at night) Those “quiet” times are optimum for LeakAlertor to evaluate the toilet for leaks. When a leak is identified, an internal software flag is set and the user is alerted. Once the leak has been fixed, the LeakAlertor will automatically reset itself. This can take up to 48 hours to accomplish, as several monitoring cycles in which no leaks are detected must first occur before the LeakAlertor will flash **GREEN**.

²Although it can be argued that a single phantom flush is certainly the result of a leak (water loss from the toilet tank), the LeakAlertor is designed to identify fill valve actions over intervals of time. An extremely slow leak may not cause enough fill valve actions within a given time frame in order for the LeakAlertor to qualify a leak. Leaks that constitute less than several gallons per day will probably not be detected by the LeakAlertor because of the unusually long time span between fill valve actions.

Technical Q&A

Will the LeakAlertor always detect a leak? There are a couple of anomalies that may prevent the LeakAlertor from detecting a leak:

- A properly working fill valve has a “snap action” on and off operation, meaning the valve is either on or off. However, some faulty fill valves may turn on just enough to bleed water into the tank at the same rate the flapper is leaking, producing little to no detectable turbulence. The LeakAlertor may fail to indicate the occurrence of a leak should the fill valve be faulty.
- If a leak is so slow that it only causes a fill valve action every 45 minutes or more, the LeakAlertor may fail to see enough occurrences to qualify a leak worth alerting the user. Two things should be noted here: (1) the water loss/waste is minimal in these instances, and (2), a slow leak invariably becomes a faster leak as the flapper continues to deteriorate or deform, which the LeakAlertor will detect.

Why does the LeakAlertor sometimes give an indication after a flush? Periodically the LeakAlertor will use the flush cycle to alert the user of its status, or to signal a detected leak:

- It is important to note that the “flush cycle” is defined as the total amount of time that the fill valve remains open to fill the tank, not just the noticeable “whoosh” of water that is used to initially evacuate the bowl when the flapper is held wide open.

Why does the LeakAlertor sometimes give an indication when no actual flush has been initiated by the user? Pretty cool, eh? The same technology that is used to detect turbulence can also detect the “presence” of someone nearby due to the noise that individual is producing.

- Operating a hair dryer, a nearby noisy shower, singing, loud conversations, can be detected by the LeakAlertor. The device assumes that someone is in the bathroom, and it will give an indication of the toilet’s status after the noise has ceased. Try this: take a hair dryer, turn it on for about 45 seconds within 5 to 10 feet of the LeakAlertor, and then turn it off and watch the unit respond.

Is it possible to test the LeakAlertor to make certain it will detect a leak? Yes. Construct a “leak simulator” by taking a length of fishing line or string and attaching a small weight to one end of the line (a fishing weight, like split-shot, works just fine). With the tank lid removed, press and hold the flush handle. While the water is draining from the tank, drop the weight through the opening below the flapper. Release the flush handle and allow the flapper to seat. Tape the other end of the line to the outside of the tank, allowing enough slack so that the line does not force the flapper to unseat. The fishing line or string will permit a small amount of water to flow. Leave your homemade “leak simulator” in place overnight (24 hours, at most). The LeakAlertor will indicate that a leak has been detected. After removing the “leak simulator”, the LeakAlertor will take up to 48 hours before resetting itself, ensuring that the leak has absolutely been corrected. **Note:** some flappers will leak intermittently, thus the delay to make sure that the user, if possible, has been alerted prior to the unit resetting automatically.

Why isn’t the beep any louder? Unlike smoke alarms that have been designed to emit ear-splitting sound, the LeakAlertor isn’t a lifesaving device. It is assumed that some people, once alerted to the fact their toilet is leaking, will procrastinate in fixing the leak. The idea is to alert them when they are nearby that their toilet is leaking, not annoy the crap out of them unnecessarily (no pun intended!).

What affects the battery life? In normal operation, the LeakAlertor will operate for more than a year on its internal battery. However, a leaking toilet that is not fixed will cause the unit to constantly beep and flash multiple times at the end of each flush cycle, decreasing the life of the battery.

Key Points

- ⇒ Regardless of user competency or the following of instructions, as long as the LeakAlertor is attached somewhere on the toilet tank and the battery activation tab is removed, it will “learn” what it needs to about the toilet and respond accordingly to leaks.
- ⇒ Depending upon normal toilet use and nearby environmental disturbances, the LeakAlertor can take up to several days to identify a leak, although most leaks will be identified within several hours.
- ⇒ The LeakAlertor will automatically adjust itself and cycle continuously as it seeks to correctly identify leaks and alert the user accordingly.
- ⇒ Once a leak has been detected and the user fixes the problem, the LeakAlertor will automatically reset itself within 48 hours.

Technology Options

- When leaks are detected, the annunciation can be scaled to respond according to the amount of water being wasted over time (ex: slow leak = a few slow beeps; fast leak = many fast beeps).
- Data logging of total water flow through the toilet, including total number of flushes and estimated water leakage, can be harvested during battery replacement.
- Internal tank monitor with telemetry. Capable of communicating with utility meters or notifying property facilities management for multiple tenant dwellings and commercial business operations. Call for product details.

Bulk pricing is available for pilot programs. Contact Annette Minnich or Lauren Egolf for information on how ***nth Solutions LLC*** can facilitate the administration and logistics for pilot programs, customer service sales and/or giveaways, conservation programs, etc.

For technical questions, email: engineering@leakalertor.com.

For marketing inquires, contact: Annette Minnich: annette.minnich@nth-solutions.com or Lauren Egolf: lauren.egolf@nth-solutions.com. Ph: 610-594-2191

nth Solutions LLC 15 E Uwchlan Ave Ste 412 Exton, PA 19341 • 1-877-LEAKALERTOR
www.leakalertor.com • 1-877-532-5253

There are approximately 286,000,000 toilets in the United States alone. ***nth Solutions LLC*** is committed to a Continuous Improvements Plan and ongoing R&D to ensure the highest quality products with the most up-to-date detection software available.