

An Ongoing Refurb Log

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For years, I've been meaning to put together a collection of tips and techniques involving my insider refurb secrets for electronic test equipment and similar tech and not-so-tech items that we offer on **eBay**. A continuing **Thoughts on Refurb** and an expansion of **Degubbing Secrets**.

I'm not sure exactly where we are going with this just yet, but we'll sort of keep it in a "blog" format except that the **newest** stuff will normally be **last** to simplify and stabilize our layout.

Tektronix 2213 and 2215 Oscilloscopes

These were among the finest analog scopes of all time and are an ideal classic instrument for student, home, or light lab use. They are still fairly easy to find at community college auctions and still (when **properly presented**) can command around \$160 bare or \$240 with all the probes, docs, and accessories on **eBay**.

The usual problem is a stuck on-off switch. Except for one tiny detail, this is easily cured with a pffft of **Radio Shack** TV Tuner Cleaner and cycling the switch a few hundred times.

The infuriating detail is that the switch is **inside** the high voltage cage and that the cage lower left rear **4-40** Torx T-8 flathead screw is almost always frozen. Try drilling most of the screw out with a **#30** drill and then briefly **reversing**. Be careful to stay centered on the steel screw and not wander off into the softer aluminum case.

An alternative that does take some practice: Try "snorkeling" the TV tuner cleaner tubing through one of the lower left vent holes. Entering from behind the rear panel. A high intensity lamp shining through the top vents can help bunches. This may let you avoid removing the high voltage cage entirely.

The 2213 and 2215 are easily serviced. To open the case, remove two Torx T-10 screws on the back plastic endpiece and one from the case side. Torx screwdrivers are readily available just about anywhere these days...

NEVER attempt to service Tektronix (or any similar gear) without all the necessary Torx screwdrivers or bits!

There is a crucial difference between tuner cleaner and electronic spray solvents...

TV Tuner cleaner intentionally leaves a mineral oil residue. Electronic spray solvents do not. But may attack plastics.

A second chronic **early** 2213/2215 problem is that the switchmode power inductor may work a little loose with age and can create an up-the-wall annoying audio whine. These are very early production that used a triac preregulator. They often can be identified by a fixed rather than a removable line cord.

I've tried all sorts of silicon rubber glopping and neoprene washer isolation stunts, but none seem to work well for me. Others seem to feel there is no good solution. Other than avoiding any fixed line cord 2213 or 2215's. Please **email me** if you have a workaround here.

CRT's in the **-A** versions are slightly different than the originals in that they have an integral high voltage connector. They apparently can be substituted with minor and obvious rewiring.

A thorough cleaning is all that most of these scopes will need. If knobs are loose, check for Allen screws when present and tighten them if needed. An **.050** Allen Wrench might be required. These might be hard to find except in sets. Note that SAE and metric Allen wrenches are **not** interchangeable.

A quick and dirty checkout on any oscilloscope can be done by first getting any trace at all on the screen, then adjusting focus and brightness for a bright fine horizontal line. Next check the horizontal sweep time for smooth operation and no missing steps. Going everywhere from a full line to a spot moving slowly from right to left. Start with **line** or **auto** sync.

Switch to channel **1** and a fairly sensitive setting. Then touch the input connector with a screwdriver whose **blade** you are touching. Observe a sixty cycle hum display on the screen. Check the attenuator switch for changing display sizes. Then repeat for channel **2**. Finally, go to **normal** triggering and verify a trace only when you touch the input. Be sure you are on the **main** sweep when you do so.

If any of these tests fail, recheck all your switch settings and try again. On other instruments, be sure there are no hidden or rear switches that can cause grief.

An important rule...

Never attempt to go beyond simple refurb without having all of the needed service manuals on hand!

It is often possible to use [eBay](#) as a "lending library" to pick up service docs. If the repairable item is oddball enough, you can later resell the manuals. Sometimes for even more than you paid for them. Docs can also be found via [Google](#).

Online Tek help includes a very active [Yahoo TekScopes](#) user group. Plus the usual [sci.electronics.repair](#) and [sci.electronics.design](#) newsgroups. Other useful [Tektronix](#) resources include [Stan Griffiths](#) and [Dean Kidd](#). "Tektronix Blue" paint is available from Stan. But I've found that most retouch attempts on anything end up looking awful.

Note that [Tektronix](#) recently released all of their earlier tech docs to the public domain. **You can now legally copy and redistribute their early manual info.** "Early" apparently being anything they are not currently selling.

Dimpling Your Own Chad

It always pays to look around for ultra low cost quantity buys of strange stuff. So long as you avoid this trap...

Never overvalue something just because you know nothing about it! Or wrongly assume others will have any interest.

Our local county yard had a recent auction where bunches of old voting booths were offered. These turned out to be the "**dimpled chad**" Votomatics that were identical in make and model to the Florida ones that were the sole cause of the Iraqi war. And thus "should" see some strong demand as collectibles.

But they were not without their problems. Some were partial, others cracked or broken, others with nonworking lights. But the biggest problem was age had made the plastic side privacy panels brittle. Many were broken and the rest were quite fragile. Especially the crucial case top supporting clips.

I first sold a few of the very best of these following these [usual eBay rules](#)...

Never sell anything you feel bad about.
Always understate condition and value.
Always try for a 21 day cashout.
Defer refurb cost and time on unproven items.

Basic refurb was done by combining the best of the better units. A pop riveter, large retaining ring pliers, and five minute epoxy were of great help here. Speaking of which...

NEVER try to install or remove a retaining ring or snap ring without using the correct special pliers!

Thorough cleaning worked wonders. Fluorescent light problems were usually caused by missing, broken, or dead bulbs or starters. Most were easily swapped out. A few lights had cracked sockets. These did not seem worth fixing as enough functional units remained.

On all but the finest booths, I decided the best route was to **divide and conquer**. The actual voting machine part was typically in excellent shape. These also store and display better and ship more cheaply. And should be highly collectible.

Which brings about the obvious question: Who would gleefully buy a gutted voting booth with busted privacy panels? The not-so-obvious answer: **Amateur Astronomers!**

Uh, let's restate that: Who would buy a low cost rugged high quality aluminum case that includes its own snap-together legs for use as a combined field data gathering desk and equipment stash? With optional (but astronomically useless) internal fluorescent lighting that was easily removable for extra space or weight.

Long ago I found out that **pen plotter motors** were unsellable at any price but the identical **laser lightshow galvos** flew on outta here. The big message both then and now is...

Always seek out possible non-obvious uses and obscure markets for what may be otherwise hard-to-sell items.

Reading IC Date Codes

Most integrated circuit manufacturers use a four digit date code of **year-week** format. Thus **9845** would be in the fall of 1998, while **0312** would be winter of 2003. Often these will be the **lowest** or **last** number to avoid confusion with the actual part number.

Naturally, the assembled circuit board has to be **newer** than the newest of date codes present. Reading date codes can be a most handy tool to evaluate the obsolence and usefulness of many electronic items.

In particular, a 1996 date code is unlikely to work with Windows 98 and is probably not plug and play.

Salvaging Disasters

It always pays to carefully inspect what you are buying. Or at least view any available digital photos...

The true costs in a "bargain" buy lie in the shipping, storage, your time, and how many of the items can be refurbished.

Back in the days when DRMO still did \$50 deliveries, I took a chance on some unseen **fuel transfer pumps**. And got a great heaping pile of burned and rusted hulks for my effort. These were an incredibly stupid design that only the military could have dreamed up.

They were apparently designed to transfer fuel from drums to vehicles or aircraft or whatever. Instead of an intelligent mod to a stock pump, these beasts tried coupling a premium grade pancake instrument motor to a conventional but high end hydraulic gear pump. The motors and pumps, of course, promptly froze under typical military use. Brush sparking wasn't all that great either.

Once I got past the "oops" phase, I realized that...

Useless items can sometimes be salvaged by splitting them in half and selling each half to wildly different users.

Useless items can sometimes be salvaged by swapping the best parts from the worst items to the better ones.

Useless items can sometimes be salvaged by having the buyer do their own refurb. Who may be better at this than you are.

So, farmers or ranchers always want to avoid buying a new \$450 hydraulic PTO pump. And there'd be all sorts of robotic and automation uses for refurbished \$700 pancake servo motors. So long as you didn't do anything stupid with them such as coupling them to a hydraulic pump. In an explosive and corrosive atmosphere.

The first problem was physically separating the beasts. The screws, of course, were all frozen. Most were removed by using the impact wrench at a nearby garage. You can also buy a "hammer style" impact wrench at any auto supply for under \$10. The most obnoxious screws were dealt with by partially drilling them out and then using an **EZ-out** screw extractor. Penetrating oil works wonders.

The pancake motors were completely disassembled into piles of rotors, front bells, rear bells, and brush assemblies. Damaged rotors were discarded or traded to artists for craft projects. The other rotors refurbished nicely with steel wool followed by household copper cleaner. Being **extremely** careful not to leave any steel wool fragments remaining.

Most end bells cleaned up nicely with a little more steel wool work. Loose magnets were replaced with superglue, **being careful to keep the NSNSNS... pole orientations**. And the brush assemblies were fixed by mixing and matching. The final units did not look all that bad and worked just fine.

Nearly all of the hydraulic motors were also frozen. But also had exceptionally low hours on them. There were no signs of actual wear at all!

The pumps were first soaked in gasoline to try and free them up. The one side plate was then removed if needed to try and clean up the gears. But I avoided messing with the easily damaged main shaft seal. After cleanup, these were given the usual -- heh heh heh -- **Sherwin-Williams overhaul** with glossy black paint.

Being a standard major brand hydraulic part, rebuild kits were available for \$19 each. But rather than mess with these, we simply guaranteed the units to not be frozen and told the buyers they **might** have to do their own rebuild. A typical user would test their unit and go ahead and use it as is if there wasn't oil spraying all over everywhere.

Based on the premise of...

Iffen it ain't broke, don't fix it!

Buyers were overjoyed at paying \$25 to \$49 for a \$450 pump that, at worst, they would have to add \$19 and a little time to.

Finding Pinouts

On any strange older item with a mystery interface, the first thing to do is to try and contact the manufacturer. Sometimes simply **guessing the company url** will work. If not, start with **Google** or any of the other **search engines** on my **home page**. That good old **Thomas Registry** can also be of help.

Followed by the usual backup resources of the **sci.electronics.design** and also the **sci.electronics.repair** newsgroups, and the old **Deja News** newsgroup searching service, which is now part of **Google**.

Two lesser known methods to get pinout info are the **Data Bookshelf** and the **WayBack Machine**. Wayback is particularly useful to track name changes and who bought out who. Links to these and others are on my **Home Page**.

Note that interface pinouts will do you no good if you cannot also determine (or at least make a wild guess at) the **instruction set** or **command set** needed to go over that interface.

Let's look at two recent interface puzzles. The first involved an old **DecTalk** speech synthesizer. **Visual inspection** showed the input went to a mystery ic.

A chip that turned out to be a variant of a stock transient protector. One with "straight thru" pinouts. But **behind** the mystery chip was a plain old **Maxim** RS232 chip. Thus, we had a serial data interface we could make a reasonable guess was at 1200 baud. Based on its age and intended use.

While I could have played around with input combinations, I eventually found the pinouts on the web. And made sure the customer already knew how to interface the device.

Our second example was a "moving sign" LED display. This one was an older unsupported orphan and worth \$30 at best on **eBay**, so I just farmed it out to **another eBay seller**. But here is how I would have found the pinouts should the project have continued...

I first would have wrapped a 47K resistor around a scope probe so that I could simultaneously **touch and view** any given pin....

With TOUCH AND VIEW...

An UNCONNECTED pin appears as a large sinewave.

A CMOS INPUT pin appears as a clipped sinewave.

A GROUNDED pin appears as a solid, zero volt ground.

A LOW OUTPUT pin will be NEAR but not at ground.

A SUPPLY pin will be high and NOT drop if loaded.

A HIGH OUTPUT will be high and WILL drop if loaded.

A NEGATIVE pin is probably an RS232 signal line.

Make your first pass with the unit **unpowered**. This will separate unused pins from any ground or supply and active pins. Then apply power to find supply values, output states, and such. Special treatment may be needed for TTL inputs (try pulling them to zero with a 330 ohm resistor) or when higher power buffers or line drivers are in use.

On an older LED scrolling display with a 20 pin DIP header, it may be reasonable to assume a parallel port interface over ribbon cable. And that the wire sequence would be port compatible in sequential order. From here, ASCII characters and control sequences could be applied to work out the exact interface and coding.

Thoughts on Pricing

There is nothing more disconcerting than placing an oddball electronic or medical item on **eBay** and having the item grabbed by **Buy It Now** nanoseconds after you posted it. Clearly, you should have charged a lot more.

I've found that it pays to purposely list any big ticket item once or twice with a **much higher** pricing than you expect to receive for them. What you are doing is betting a week or two of delay and \$3 to \$6 dollars worth of your lost filing fees against a \$100 or higher additional return.

More often than not, the bet pays off.

Should you have items in large quantities, the opposite tactic may work: Open with a **lower** than desired price and then slide the price **upward** to continuously seek out the most you can get for the items consistent with selling all of them in a reasonable time period. I've found a **fifteen month sellout** is often optimum.

Much more on eBay selling strategy appears on our [Auction Help](#) page. Especially our [eBay Secrets](#), [Son of eBay Secrets](#), [eBay Selling Strategies](#), our [eBay Buying Strategies](#), and [eBay Photo Secrets](#) files. Along with bunches of others.

A Refurb Summary

Here's a repeat of the guidelines I just placed in [ENHEBAY2.pdf](#)...

Make a **determination as quickly as possible** whether an item can be sold as is, as is with minor cleanup, needs minor repair, needs major rework, sellable as is, sellable for parts, mixed and matched with others in the group, stripped for parts, held for parts, or flushed outright.

A dozen **projects needing minor rework** (tighten the screws, replace knobs, improve cosmetics) can be done in the time it takes to doing anything major to one item. And much more certainly. Always ask "**What am I getting into?**"

Have your **hired help do the routine stuff** such as any initial cleanup and final out-the-door appearance upgrading. Spend your own time where it will do the most good; but delegate otherwise.

eBay can often be **used as a lending library** to get the repair and service manual for any higher ticket item that has a high probability of repair. Always try to have full tech info before attempting anything major in the way of repairs. Often the manual can be resold at a profit or as item added value.

It is super important to **keep your refurb area clear!** Ideally, a project should be handled **only once**. If absolutely necessary while waiting for parts, the item can be placed in a tote and tagged with required further action.

Any item kept for ten weeks without completing refurb **will most likely never be finished**. Continually review all of these projects for downgrading and elimination.

The **earlier you flush** an unsellable product and the less time you spend with it, the lower your losses in dealing with it.

There is no point in **trying to compete** with instrument repair and calibration houses. Normally, the unit should be brought up to "**clean used - appears fully functional - guaranteed to be serviceable**" condition.

Warranty repairs or **trying to meet original specs** are another game entirely. One that takes all sorts of special gear, NIST traceability, factory authorization, and expertise. In exchange for lower prices, the buyer is expected to assume more risk.

While it pays to **keep an inventory of crucial items** for some popular gear (such as common hardware and Tektronix or HP knobs), stashing tons and tons of random replacement parts makes no sense whatsoever.

If you do not like the vibes at any time or point during refurb, flush or downgrade the project. **Never sell anything you feel bad about in any manner**. The final key test is "**Would you be proud to keep this as a personal tool or instrument?**"

Some of the **simplest tools will often end up the most useful**. Hex Allen wrenches, Vise Grips, and live power field tracers for sure. Potent cleaners and goop removers. Fresh adhesives that include silicon rubber (use most), epoxy, and superglue.

Sources of repair and replacement items include a hardware store or two, **Small Parts**, **W.W.Grainger**, and **McMaster-Carr**. Plus, of course, such electronic houses as **Digi-Key**, **Mouser**, or as last resorts, **Allied** or **Newark**.

Do not attempt any repair or refurb without having the bare **minimum test equipment needed** to properly deal with it. A modern oscilloscope (or its pc equivalent) is essential for just about any technical work.

Be sure to **research item demand** before you even think about beginning refurb. Useful tools include present and past **eBay** sales, **Google**, **Thomas Register**, the **Wayback Machine**, or **sci.electronics.design** and **sci.electronics.repair** newsgroups .

It is often possible to take a dozen broken identical items and end up with ten good ones by **mixing and matching parts**. This often will end up your most economical refurb and upgrading route.

It is infinitely better to **compete three of four refurb items** than to have dozens of them piling up unfinished. Do not start any new projects before you eliminate some of the older ones.

Second tier brands are probably not worth pissing over. HP (Agilent) and Tektronix test items **are a lot more sellable than everything else put together**. But HP Oscilloscopes are totally worthless, their last useful one being the 130C.

Tektronix Copyrights

Tektronix has recently and formally released the copyrights on **all** of their more obsolete test equipment. And **eBay** suppliers of varying quality have been rushing to make Tek service docs available on CD.

I was particularly impressed by the **aa4df** CD that has 38+ service manuals for nearly all of the **Tek 500 Series** plugins. Typically at a \$20 or so price.

The **500 series** consisted of mainframe power supplies of one through six slots that held individual single, double, and (rarely) triple plugins such as function generators, oscilloscopes, power supplies, counters, amplifiers, etc. While now somewhat long in the tooth, these remain highly useful for student or home use.

While there is a hard-to-find and pricey extender card available, it is simplest to remove the cover of a **TM503** and place the plugin being serviced in the **center** slot. This gives somewhat better access (especially at the front) than by using the obvious **TM501**.

One recent **TM501** repair found a separately dealt with plugin problem with a "broken" power switch. This was traced to a tiny piece of brittle plastic on the power control rod which was easily replaced by a pair of ordinary nylon cable ties.

Glass Beads and Shot Blasting

I've always wanted a **shot blast cabinet**, because these are absolutely superb for refurbing water meters or finishing small metal parts or stripping paint or for removing rust or whatever. But these are huge and dirty and require access to a big time air compressor.

One newer alternative is to add a **shot blaster attachment** to a pressure washer.

Northern Tool has some nice ones for as little as \$25. Getting the media can be a real hassle over shipping costs. **Checker Auto** specifically excludes this item from their "free shipping to your nearest store" policy. I found **McMaster Carr** to have the best mix of shipping and product costs. Search under "**blast media**".

Tek 465 Vertical Attenuators

The finest "aerospace era" oscilloscope of all time has to be the **Tektronix 465**. These remain an excellent choice in a high performance but somewhat dated solid state **100 Megahertz** oscilloscope. And units needing some repair or refurb can now be found at bargain prices.

One **465** I was working on seemed to have extremely erratic attenuators. Normally the double gold cam driven contacts do not even need cleaning, let alone any service. But between the contacts was a pair of **10X** and **100X** plug in compensators. Reseating their pins a time or two cleaned up most of the problems in a big hurry. These are under the shields that say "**Caution -- Delicate Materials**".

Look for the Obvious

Sometimes the simplest and most mundane problems can produce the most outrageous symptoms. Ferinstance, back in the days of **4000 series** CMOS, if you forgot to connect the power supply, chances are that the circuit would more or less work, but with rotten risetimes and frequency response. What happened was that any **logic inputs** that happened to be high routed enough supply power through the **protection diodes** to more or less make stuff sort of happen!

On an oscilloscope of "second tier" quality, the symptom was a ridiculous overshoot on cal waveforms, combined with way too little amplitude. This was a plain old **broken wire** on the input BNC connector! The picofarad or two between the wire and where it was supposed to be soldered to was enough to couple the highest frequency waveform components.

A touch of solder provided an instant cure.

Treat Antiques with Respect

Think twice and then some about refurbishing really valuable antiques. Its super easy to do irreparable damage and trivial to get in over your head.

Ferinstance, plugging in an old tube radio to "see if it works" is **guaranteed** to cause smoke and fire because the electrolytic caps are near certain to be shorted.

An associate asked me to rework a **Weston** panel meter that seemed to have a wide spread between "as is" and "museum quality restoration" pricing. **Brasso** and some Q-tips promptly revealed the totally unlegible nameplates were in fact near mint. A careful check with a current limited 9 volt battery showed me a perfect

pointer and accurate operation. The unit seemed to be a low serial but clearly later variation on a **Weston's Model 1** with an 1880's patent date. The lack of a model number was very encouraging.

Later **eBay** feedback determined a **1910** era date. Here's what the partially refurbished item looks like...



The pumice or whatever in **Brasso** seemed to be about the right coarseness of abrasive, so I mixed it with orange super cleaner and again used Q-tips to scour the awful grime off the lacquered copper case. There was a finish break or two, but the improvement was otherwise spectacular. Repainting would obviously be a no-no because of the unique original red lacquered finish.

The wooden bases cleaned up beautifully by cleaning, sanding, and oiling. Separating them was not advisable because of the complex wiring to the antique series resistor in the lower base. The item is now up on **eBay**.

Medical Gear and the FDA

Some medical gear can resell for outrageously high prices. Others are totally worthless, or may need one unobtainable part for refurb. Much of it may require a **FDA Certificate** or involve strict **eBay Restrictions** for resale.

In general, med equipment is a lot simpler than it may first appear. But may do strange things in funny or dangerous ways. Thus, it is super important that you understand exactly what the instrument is intended for and **all of** the safety considerations involved in its use.

In particular...

Any items specifically involved in any way with life safety are best avoided entirely!

I just picked up an **autoclave sterilizer** at an auction. Autoclaves are basically a pressure cooker that often runs at **121** degrees Centigrade and **15 PSI**. These values are high enough to destroy all known organisms for medical sterilization or to provide curing for industrial adhesives, plastics, and related processes. It seems the "**tattoo parlor**" market is driving **eBay** prices for autoclaves quite high.

This particular unit looked like all it needed was a "**Sherwin Williams Overhaul**". After a thorough cleaning I replaced the line cord and a broken fuseholder and a broken drain line and reglued and tightened or lubricated a few other items. The knobs and feet were replaced as they were mangy from outside storage. And the case was repainted. The seal looks just barely ok. After few more minor details, it promptly sold on **eBay** at a premium **BIN** price.

Playing the Slots

I was rudely surprised when the big pallet full of sealed **slot machine display** boxes had mostly upgrade pulls in it. At any rate, these rebuild fairly well with some effort, and we now have the really great results up on **eBay**. These are absolutely superb as a first student microcontroller or **Basic Stamp** project.

These also are legal to own anywhere **so long as the displays have no provision or mechanism for coins or tokens of any kind**. But actual use of your final total design should obey any and all of your local or state regs.

Here's what these dudes look like...



Besides cleaning and an occasional broken pilot light assembly, the big usual problem was burned out bulbs. These turned out to be a standard long life incandescent bulb called a **657** that **Jameco Electronics** has for 15 cents each.

Two reassembly tips following a total teardown: The cable retaining clip is best put in by **loosely** setting the wheel sideways on the frame up out of the road.

The clip then snaps right in but otherwise would be a real bear. There is also a loose "U" bracket between the stepper and the frame. To avoid trying to hold too many things at once, use a pair of long nose **vise grip pliers** to clamp the bracket in place. This ridiculously simplifies reassembly.

The 28 volt bulbs can be tested by dimly lighting them with any old 12 or 15 volt supply. The lower left socket pin is common, with the three horizontal pins on the same level being the low, medium, and high bulbs. The rest of the pinouts appear on our **eBay Store**.

Because of the time and extra bulb costs, it doesn't pay to get too much ahead of actual sales. Keeping two units on deck ready to go and four diagnosed for repair seems to be about the right mix of risk and reward.

Avoid "TV Repair" Shop Items

I was suprised how much the value of tv repair shop items has recently dropped. **Photofacts** sell only marginally on **eBay** at four cents each, and full tube caddies seem to be not doing very well at \$30 or less.

The fact that old tv's even needed repair was telling. As was their lack of cable and video inputs, their huge size and weight, the hot chassis safety issues, their pitiful pre-comb color separation, their lack of regulation that left you with a tiny midscreen image and everything else wrapped around, and a need to reconverge your color alignment in a very painful process if you so much as moved the tv a few feet. Plus sound best described as mesmerizingly awful.

All of which can get ugly when the old shop items get **outrageously overvalued** by whoever is trying to sell them. Especially if utterly obsolete stock is combined with **Eico** or **Dumont** or **trade school kits** or similar worthless marginalia. More on my earlier tv repair experiences in **WAYWERE.PDF**.

For More Help

See **REFURB.PDF** for an earlier tutorial on equipment reconditioning. Plus our **DEGUB.PDF** for additional debugging secrets. Extensive tutorials on **auction buying** and **eBay selling** appear in our **Auction Help** library.

Our current offerings can be found on our **Bargain Pages** and by way of our **eBay Auctions** and **eBay Store** links. As usual, custom assistance is available per our **InfoPack** services.

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