The Locking HDMI® Connector

The locking HDMI connector is an unnecessary solution to an extraneous problem. That is, it should never have evolved. I'm not saying that HDMI connectors don't fall out of their sockets; they often do. What I'm challenging is why. There is nothing in the HDMI specification to say that a connector should be made loose and floppy and fall out easily. Seriously, that would be pretty stupid, wouldn't it? Everyone knows that there's an HDMI specification, but how many installers have read it? None – don't need to. How many cable vendors have read it? ...really? The reality may shock you.

In this paper we'll explore the HDMI 1.4b specification section on the male type A connector. We'll show where the vast majority of brands are getting it wrong, and how locking or some other unique retention techniques may actually do more harm than good. The end goal is to ensure the connector fits well and stays seated long term without the need for a locking mechanism. I assert that this is achieved simply and effectively by making the connectors properly in the first place.

HDMI Specification

Section 4.1.9.2 of the HDMI 1.4b specification details the dimensional and tolerance requirements of the male type A (standard size) HDMI connector. It is poignant to note that this specification is unchanged from HDMI's inception in 2003 (v1.0). HDMI 1.4b fig 4-3 below shows explicit reference to the "spring property for locking " mechanism that's right there in the spec, being the spring tabs in the receptacle to mate with the two holes in the male connector's underside;

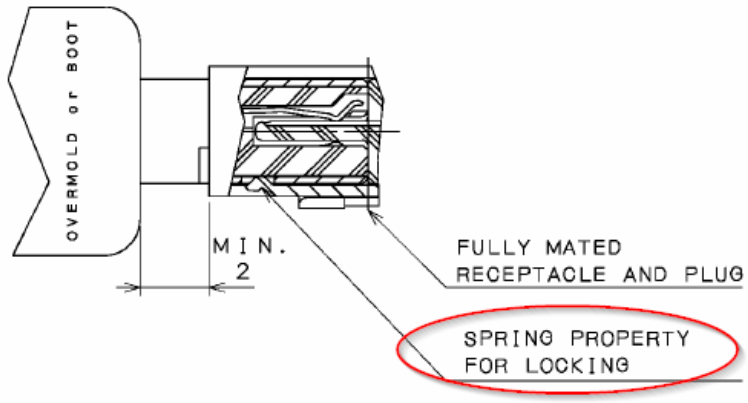


Figure 4-3 Type A Receptacle and Plug Mated Condition

Source: HDMI 1.4b specification, page 27

Now refer to Appendix A at the end of this paper, and you'll also see that every detail of the connector's dimensions have been carefully considered and engineered, some to within a mere 0.05mm tolerance. What is NOT specified is construction materials and methods – that's at the discretion of the manufacturers. This is where things can and do go wrong, and the custom installer is the unwitting victim.

What makes HDMI connectors fall out?

HDMI connectors do not conspire to leap out of receptacles when you (or the cleaner) are not looking; there are forces at play that work against the connector staying seated. These can be simply referred to as 'extraction forces', the most obvious being linear pulling - what you intentionally do to unplug the cable. It's the unintentional forces that we need to avoid.

The tight tolerance design per the specification should be snug fitting, augmented by the two parallel spring tabs which are intended to secure the connector by friction. How effectively it does this is the resulting 'retention force', measured in kgs or lbs. For a connector to come free it must have extraction forces exerted upon it of which exceed its native retention force. It's simple physics.

Unwanted dropouts occur when forces such as those caused by cable weight and rigidity (coil effect), and excessive mounting length, exceed the retention force of the connections. Again, it's all physics. These things are ever-present in the installation itself, and place strains on all connectors whether locking or not. All of these things must factor into the determination of a cable's design achievement, not just how well it stays in.

A vast majority of HDMI cables in the market are made using connectors with chronically insufficient native retention force, so it doesn't take much to pull them free. We conducted a simple pull test of several leading HDMI cable brands using a Mark-10 force gauge. The results produced a startlingly consistent typical measurement of 800g/1.8lbs of required peak retention force. A good connector should target at least double this for dependability.

Connector Construction Methodology

The ubiquitous method for building a connector (oddly regardless of cable price point) is to punch out the connector from a thin gauge steel plate, then fold it into its final form to create a shell. This type of construction is easily identifiable by the seam on the underside, between the mandatory friction holes, as pictured below;

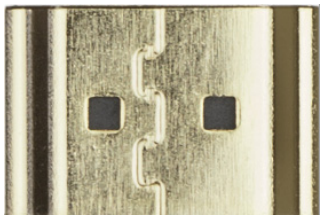


Fig 1: Example of folded steel HDMI connector

This is the cheapest, easiest way to make HDMI connectors in mass quantities, at literally many hundreds of units per minute in most factories. However the seam limits the resulting rigidity of the shell, particularly as it's always on the underside, right between the mandatory friction 'locking' holes. It takes little effort to vertically crush such a connector between you're your thumb and forefinger. It is this flex that reduces the friction required for connector retention in the receptacle.

As HDMI cables have become more and more commoditized, the gauge and quality of the metal used in the folded shells has unfortunately further eroded to meet price pressures. In these circumstances the possibility of effective friction based retention fades fast, further exacerbating the problem. For the mandated spring tabs in the receptacles to work effectively, the male connector shell must be very rigid to promote the requisite friction. A different, superior process is required.

However the solution by some manufacturers was not to do this, but rather add a locking mechanism to the existing inferior design to help it stay in place.

The Locking HDMI Connector

The locking HDMI connector was seen as an innovative solution by some savvy manufacturers, becoming a great marketing tool for coveted product differentiation. This category grew in popularity, seen as a saviour by many custom installers in the absence of viable alternatives.

What I find ironic is that of the multitude of locking solutions in the market, all are bespoke engineered to adapt to an otherwise very badly made connector. There's a glimmer of true engineering prowess in every design concept, but it's a patch rather than a true fix. That is, the root cause of the poor retention capacity is still present, just with a lock added to ensure it stays in place.

Also, if an HDMI cable has a locking mechanism, does that make it a good HDMI cable overall? A lack of fundamental engineering in the connector should be a red flag to question the multitude of other engineering elements that goes into good cable design and production – twisted pair geometry, stranded or solid core, skew characteristics, insulation permittivity, solder points and jitter minimisation, etc. Or the big question – is it compliant, true High Speed and capable of reliably conveying 4K, for example?

The other more worrying aspect about locking connectors is the propensity for damage to the mating receptacle. HDMI was never designed to lock absolutely, and must exhibit optimised extraction ability for safety purposes. After all, the cause of HDMI cable dropouts is the passive forces that are present in an installation, as mentioned before. Add a lock and those forces are still there, maintaining unresolved strain on the receptacle. This can lead to damage.

Some systems do not lock, only add friction to aid retention. A recent example of such strategy by one vendor is the addition of convex dimples on the top surface of the male connector. This works to increase friction and thereby retention force, but unfortunately can only do so by exceeding the dimensional limits of the HDMI specification. This is set with +0.04/-0.05mm tolerance for good reason. The challenges compliance and risks expanding sockets irreparably. That is, it makes other cables even more loose in the same socket after such a cable is used. Beware.

The Kordz Solution – The Die-cast HDMI Connector

In 2008 Kordz introduced the die-cast HDMI connector. This single piece engineered zinc-alloy connector, easily identified with its seam-free design (pictured Fig 3, next page), is several times stronger than its folded steel counterpart. It results in retention force approximately 2 ½ times the industry average, at around 2kg/4.4lbs. It is 100% compliant to the specification's dimensional limits, and has no form of protrusion or lock anywhere. It's

remarkably clean, is engineered to fit remarkably well, and is anti-fatigue proven to perform to >1,000 insertion/extraction cycles.

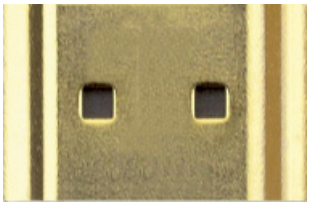


Fig 2: Kordz die-cast HDMI connector

For five years this connector dominated the custom installation market in Australia, with Kordz voted #1 favourite custom installation HDMI cable in 2012 & 2013 by the readers of Connected Home trade magazine[#]. However it was previously only available with our Gen-4 flat cable series. New for 2014 Kordz will be bringing the die-cast connector to a range of round profile cables for the first time. Look out for it with EVO-R & EVS-R residential series, and the commercial R-series; R.3 for bespoke rack install and R.6 Reference Lab grade.

Conclusion

When a majority of manufacturers make products in essentially the same way as each other, such methodology becomes 'normal'; majority rules. However it is fact that when it comes to HDMI connectors, this majority method is clearly not a good way, which is why it evolved as 'normal' for HDMI connectors to not fit properly. As a perceived solution to this, adding some form of locking mechanism seemed logical enough, but only because the industry had not figured out the root cause of the problem. However, we at Kordz did – as a long term HDMI Adopter company we studied the specification, applied specialist engineering, and used the best materials to simply make the connector properly in the first place. No lock necessary, with unrivalled installation reliability and longevity.

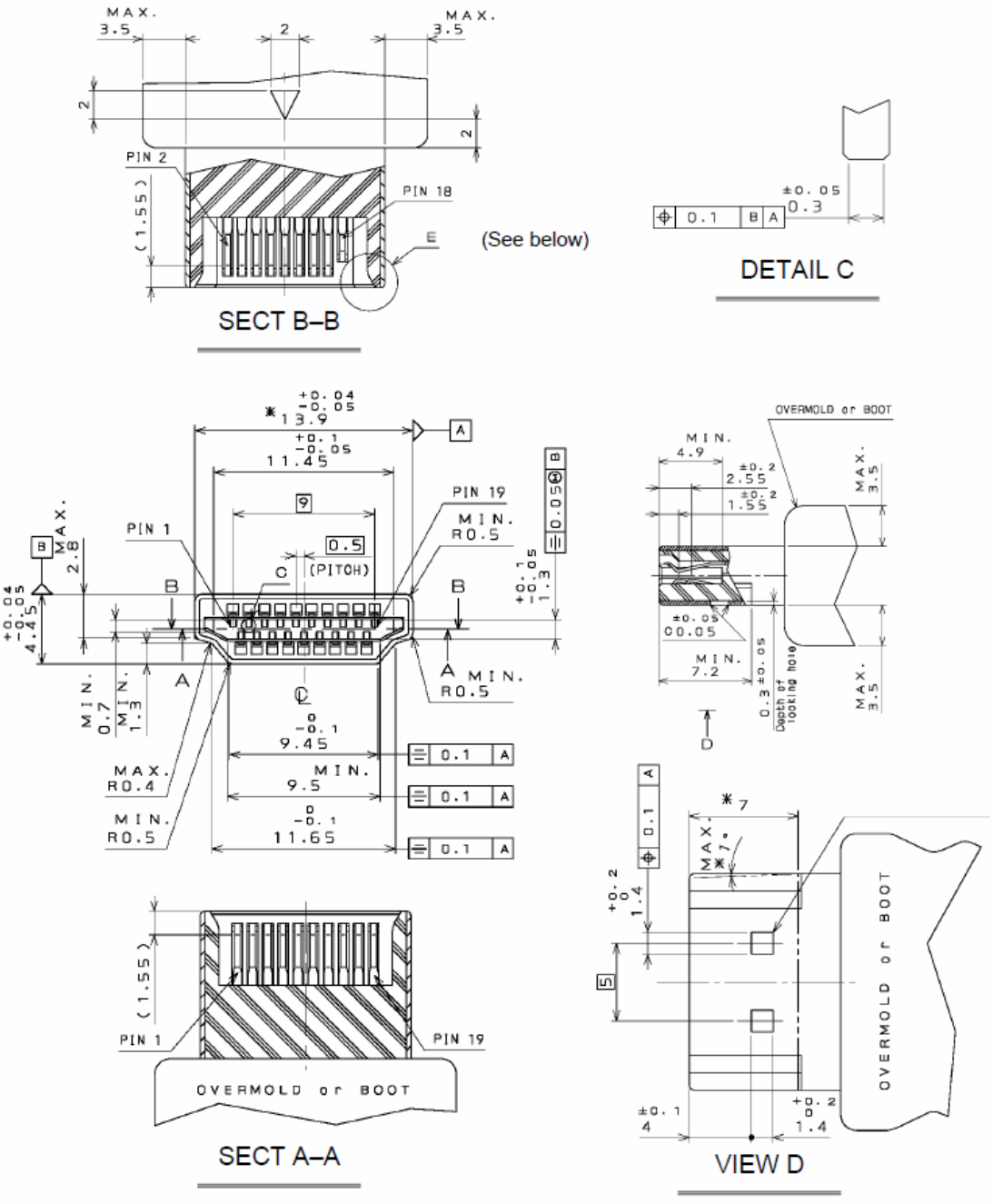
So for those currently using or seeking locking HDMI connectors, consider this - **do you specifically want locking, or do you just want it to not fall out?** A truly good cable addresses both issues of retention *and* reducing install based extraction forces, resulting in reliable longevity, reduced installation and troubleshooting times, and alleviating call backs for something as silly as the HDMI falling out.

The die-cast connector achieves this impeccably, with this standard of engineering reaching every part of the cable for best overall performance for 4K and beyond. Kordz is an HDMI 2.0 Adopter company.

A publication of Connection Magazines Pty Ltd

Appendix A

4.1.9.2 Type A Plug



- The dimension of *13.9mm (+0.04 / -0.05) (on main section) should be measured at the point *7mm (on view D). The taper (on view D) shall be one degree max.
- The shell should not have a dimple other than the ones for locking.
- The triangle mark ▽ (on SECT B-B) is optional.

Figure 4-2 Type A Plug Mating Interface Dimensions

Source: HDMI 1.4b specification, page 26 (all dimensions in mm)