Why Settle for a Six-Pulse SCR Drive when Superior 12-Pulse Technology is Available at a Competitive Price?

By Don Alley, Vice President of R&D, Motion Control Engineering, Inc.

Motion Control Engineering introduced a 12-Pulse SCR drive, designed exclusively for elevators, in 1995.

Since that time, many questions have been raised about the merits of 12-Pulse vs six-pulse DC SCR drive technology. Statements and claims have been made, the most recent of which appeared in the August 1998 issue of Elevator World magazine (page 150) entitled, "Why Build in Extra Costs for a 12-Pulse Drive When a Six-Pulse Drive Meets Harmonics Standard?"

Unfortunately, claims made in this recent article regarding both costs and harmonics are erroneous, as I will explain below.

As the project development manager and "inventor" of the MCE 12-Pulse drive, I believe this is the appropriate time to share my "developer's insights" about this beneficial technology and how we have applied it in our elevator control systems.

The Benefits of 12-Pulse Technology

MCE manufactures elevator control systems using both six- and 12- Pulse SCR drives. We are in the unique position to speak as a user of both technologies, having manufactured and supported elevator controls using SCR drives since 1983. Our customers enjoy a number of significant advantages using our ***System 12*** drive with 12-Pulse technology.

- **Superior Technology: Competitive Cost**

  Comparison of costs of 12-Pulse technology versus six-pulse technology is best viewed from the standpoint of the customer. Motion Control Engineering designed and now manufactures its own 12-Pulse SCR drive exclusively for use in **MCE** elevator control systems.

  By developing and building our own 12-Pulse drives, we have eliminated the drive supplier and the extra layer of cost which ultimately had to be paid for by the customer. As a result, we are able to offer elevator control systems with superior 12-Pulse technology at prices that are directly competitive with controls using six-pulse technology.

- **Advantages of One Source**

  Since our drive and elevator control are both designed, manufactured, and supplied by one company, there is no need to travel across inter-company boundaries in order to resolve a problem.

- **Optimized for Elevators**

  By designing and manufacturing a 12-Pulse drive ourselves, we are able to more fully integrate the drive with the rest of our control system. This higher level of integration results in a drive that is truly optimized for elevators.

- **Drive Expertise in Action**

  As the product's designer, I began the 12-Pulse drive development project with a long list of desirable characteristics – which I had been accumulating for over a decade.

  Upon my completion of the drive design, we assembled a team of hardware and software experts to fully integrate the design with our IMC elevator control system.

  The resulting achievement, the ***System 12*** elevator drive, incorporates all of our "wish list" attributes. The various feedback loops and control algorithms embody our wealth of accumulated knowledge about the behavior and performance of elevator drives.

  Equally important is what we left out – features that were unnecessary for elevator operation, and those that might actually interfere with proper operation of an elevator.

Ultimately, careful decisions and the process of integration helped trim unnecessary costs and create a meaningful difference between the ***System 12*** drive and "generic" 6-pulse SCR drives.

Technical Advantages of 12-PulseTechnology

- **Smaller Filter Components**
  The size of the armature filter components in a 12-Pulse system is significantly reduced. In many cases, filters can fit in the cabinet with the controller and drive, saving wiring time and machine room space.

- **Reduced Phase Shift**
  Smaller armature filter components, made possible by the use of 12-Pulse technology, provide reduced phase shift (less delay in the response of the drive to current commands). This allows higher feedback gains without oscillation, translating into better performance.

- **Fewer Emergency Power Headaches**
  It is rare for harmonic distortion, generated by the elevator motor drive running on public utility power, to affect a building. However, when elevators switch to an emergency power source, which is much more easily affected by harmonic distortion, it can become a significant issue.
  The lower harmonic distortion of 12-Pulse drives makes it less likely that the emergency power generating systems and any equipment connected to them will be affected.

- **Reduced Response Lag.**
  The 12-Pulse drive provides an absolute improvement in response delay of 0.694 milliseconds when compared to a six-pulse drive.

  While this may not sound like much, any designer of AC or DC drives will tell you that an improvement in latency of this magnitude is significant.
  Research at **MCE**'s test towers has verified that this improvement translates directly into an improvement in drive response (for those readers who are interested in more technical depth, see box, *"How Much Faster?"*)

Isolation Transformer

How Much Faster?

The output structure of an SCR drive is a "sampled" system. This means that changes in output current occur only once every 2.777 milliseconds for a standard six-pulse drive and once every 1.388 milliseconds for a 12-Pulse drive.

It is possible that a command for a change in current may come just before the SCR could fire, resulting in little if any delay. However, it might also come just after the SCR could have fired.

In the latter case, the next opportunity for a six-pulse drive to fire would be 2.777 milliseconds later, while a 12-Pulse drive could fire after only 1.388 milliseconds.

Therefore, we could say that the average response delay (latency) for a six-pulse drive is half of 2.777 milliseconds or 1.388 milliseconds, while the average latency for a 12-Pulse drive is half of 1.388 milliseconds, or 0.694 milliseconds, which is a 0.694 millisecond improvement.

Expertise

The drive isolation transformer is a critical part of our 12-Pulse system. We have worked very closely with our suppliers on the technical characteristics of these transformers. The result of these efforts is the availability of optimized transformer designs to deliver the full benefits of 12-Pulse technology.

Vendor partnering ensures that every "system" component meets **MCE**'s exacting standards.

Harmonic Standard Explained

There is a document often referred to as IEEE 519 which is recognized as an American National Standard (ANSI). This standard recommends certain practices and requirements for the control of harmonics in electrical power systems.

IEEE 519 is a highly complex document, requiring great care and expertise for full understanding and correct interpretation for specific applications.

It is important to emphasize that there are no guarantees that a control system using an SCR drive will, or will not, comply with this standard prior to installation of the drive in the electrical environment where it will be used, unless a great deal is known about the electrical characteristics of the source of AC power. From a practical standpoint, this data can be very difficult to obtain.

Further, it is important to recognize that compliance with this standard is not an "all-or-nothing" proposition and there are no "magic bullet" solutions. Each installation must be treated uniquely.

I should emphasize that the title of the August 1998 *Elevator World* article referred to above, claiming that 6-pulse SCR drives comply with the IEEE 519 standard, is completely incorrect when referring to Current Harmonic Distortion – which is best thought of as a measure of the drive's contribution to harmonics on the AC power line. Voltage Harmonic Distortion is a measure of the total effects of all loads on the AC power.

A system that fails to meet the Current harmonic distortion requirements of IEEE 519 may still meet the Voltage harmonic distortion requirements. Meeting only one portion of the standard is not full compliance.

By their nature, 12-Pulse drive systems come much closer to compliance than do six-pulse drives, in elevator applications. However, for the typical elevator installation, neither system presently complies with the current harmonic portion of this standard (six-pulse drives fall short by a very large margin).

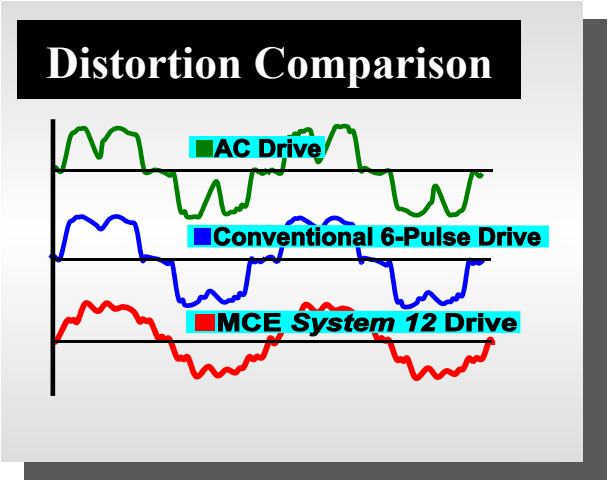
A discussion of the relative merits of six-pulse versus 12-Pulse SCR drive technology, and compliance with IEEE 519, can be found in the April 1992 issue of *Elevator World* magazine.

This article describes, in detail, why 12-Pulse SCR drive technology offers significant advantages in elevator systems and is inherently superior to six-pulse technology with regard to harmonic distortion.

Test Tower Research

MCE has done extensive research on harmonic distortion, performing direct comparison between a typical VFAC flux vector drive, a standard six-pulse DC SCR drive, and our 12-Pulse DC SCR drive.

Each drive was tested, one after the other, on one test tower elevator. The same AC power source was used during all three tests.



An AC hoist motor with horsepower identical to the DC hoist motor was substituted for the VFAC drive test.

The results of these tests clearly demonstrate the measurable superiority of **MCE**'s 12-Pulse SCR drive, over both the six-pulse SCR and VFAC flux vector drives, in terms of current harmonic distortion.

We know of no other instance where such a direct comparison of drive technologies has been performed -- while so many of the components were kept standardized throughout all tests.

Our full report of these tests, entitled, ***"Harmonic Analysis and Comparison,"*** is available from **MCE** upon request.

Interphase Reactor Unnecessary

In the August 1998 *Elevator World* article, the claim is also made that an interphase reactor is required in order to achieve a "true" 12-Pulse load, as referenced to the AC line.

That statement is most emphatically and absolutely incorrect.

As an aspect of the design of our ***System 12*** SCR drive, we determined that it is not necessary to use an interphase reactor (with the additional cost) in order to achieve a "true" 12-Pulse load with the reduced harmonics.

Our claims of reduction in harmonic distortion, as detailed in the, ***"Harmonic Analysis and Comparison"*** publication, are not theoretical but represent actual data taken from instrumentation measuring power quality at our elevator test tower. Our test data reflects the typical current harmonic distortion to be expected from 12-Pulse drive technology.

The benefits to be had from reduced harmonic distortion are real and very significant. The fact that the ***System 12*** drive provides these benefits is clearly demonstrated in our publication.

Conclusion

The simple truth is that our 12-Pulse SCR drive is the product of desire and experience – the desire to provide our customers with the very best technology available, and the experience to invent, develop, and manufacture it.

As we approach shipment of ***System 12*** drive number 2,000, field experience has clearly proven the superiority of this technology.

We couldn't be more pleased with the results. ■