TO LVD OR NOT TO LVD.... THAT IS THE QUESTION!

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INTRODUCTION

If Shakespeare were alive today and wrote a play about the life of a modern day cell technician or outside plant engineer named Hamlet, his lead character might have asked his most famous question this way - "To LVD or Not to LVD?. That is the question!"

In today's world, the ability to count on a dedicated power technician, whose specialty is to understand everything about the power plant and its functionality, rarely exists. Rather, the power room and the battery plant fall under the jurisdiction of a "universal technician" who must quickly learn the salient features and conditions of a variety of configurations, of which the power board and the batteries are in many cases a minor element in his overall view of the universe.

In order to properly answer the question, then, for today's universal technician, we must:

- define exactly what an LVD is and understand its intended function.
- examine its effect when placed in series with either the load or the battery.
- confirm the design engineering philosophy of the user and/or review the intended application of the LVD.
- compare its functionality with a battery disconnect device.

WHAT IS AN LVD ANYWAY?

Is a Low Voltage Disconnect assembly [LVD] the "mother of all necessity" or simply another "bell and whistle" in a modern dc power plant?

First, let's define the LVD and its intended function: *An LVD is an electro-mechanical device containing a contactor and a solenoid that acts as a switch in certain low voltage situations. The LVD is usually installed as an integrated component in the distribution cabinet of a dc power board.*

The dc power board and the batteries comprise the most fundamental parts of a dc power plant or system. When a Low Voltage Disconnect is installed in the power board and the LVD is energized, it provides a complete circuit path to the loads – i.e. the telephone equipment being powered by the dc power plant from the rectifiers and/or the battery string. When a pre-set low voltage threshold is reached, logic from the controller circuit in the power board opens the contactor to disconnect the dc circuit, thus shutting down the load, protecting the load and preserving the battery. The LVD is said to operate in a normally open state.

The primary function then, of an LVD device is two-fold: [1] protect the load from receiving voltage below a specified input level which could cause damage to the affected equipment; and [2] protect the batteries from excessive use in an extended ac outage where no alternate back-up power source is available.

An LVD device actually differs from a battery disconnect assembly, in that the LVD is there to disconnect the batteries [or conversely, the load] in extreme low voltage situations. The battery disconnect device, on the other hand, provides protection against extreme high-voltage shorts in the battery, and permits a way to safely disengage batteries for servicing.

Prior to divestiture in 1984, it was common to centralize all power and switching in the central office [CO]. Since the telephone company [ILEC, CLEC or LDC] generally operated its CO as a fully-manned site, the FCC mandated certain procedures, and most carriers decided for reliability purposes that a back-up generator was an essential requirement; the dc power plants were installed with no LVD's.

The advantage to a power system with no LVD is obvious: we eliminate a potential source of failure, and since a generator ensures the batteries will never reach their end-cell voltage under almost all conditions, the use of an LVD is not relevant.

After divestiture, the explosion of the cellular network occurred. Coupled with the acceleration of geographically dispersed network architectures, the number of power plants installed at remote sites proliferated. Commonly referred to as outside plant applications [OSP], these sites are for the most part unmanned. And, they generally provide for only two to four hours of battery backup, although in some cases eight hour back-up may be specified. When these sites multiply into the thousands, the cost for replacing batteries or telephone equipment due to damage caused by lack of a disconnect capability can become expensive.

HOW DOES AN LVD WORK?

The LVD is placed in series with either the battery [i.e. directly between the bus voltage and the battery termination] or in series with the load [i.e. in the path of the bus connecting to the load]. These are sometimes referred to as battery-side or load-side LVD's.

Battery-side LVD

Figure 1 shows a block diagram of an LVD connected in series with the battery. Note that in this application the rectifiers are connected directly to the +24 vdc bus. –48 volt dc/dc converters provide –48 volt output to –48 volt loads, and are fed from the +24 volt bus. The LVD is installed to connect between the battery string and the +24 volt output bus. In a –48 volt application, the LVD would be connected in the same manner to the –48 volt bus.

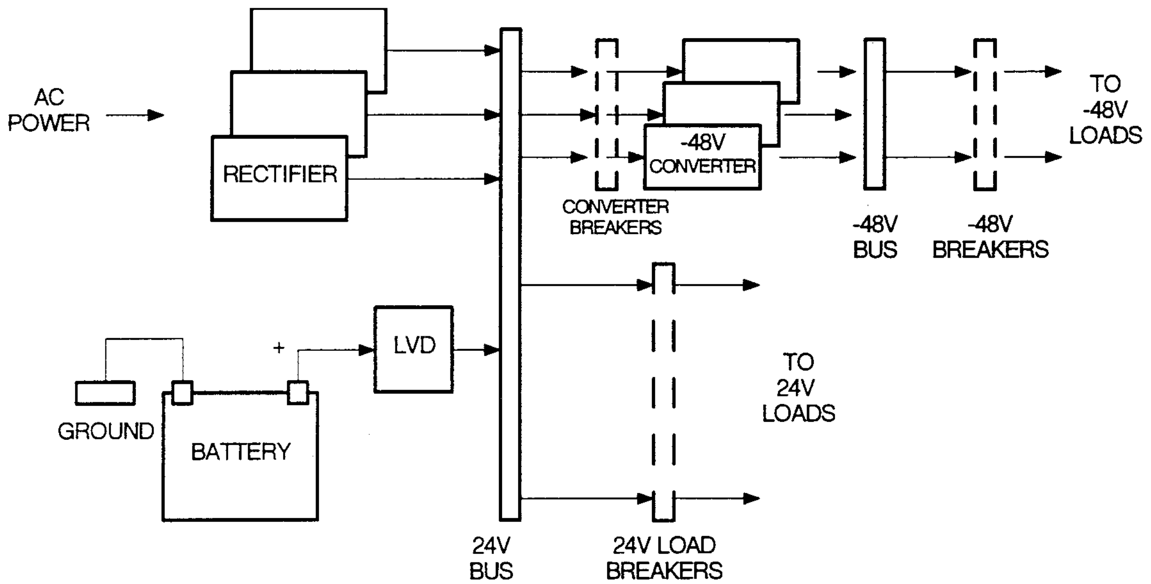

Figure 1 – Low Voltage Disconnect in Series with the Battery

The advantage of a battery-side configuration is that since the rectifiers are connected directly to the output bus, there will always be power to the load whenever ac is available. In the event of an LVD contactor malfunction, the rectifiers still provide power to the bus.

The disadvantage of the battery-side LVD is that the load can experience a slow increase in voltage as the rectifiers ramp up [current walk-in] from a very low voltage at first turn-on to the recommended operating voltage. That is because the rectifiers are connected directly to the output bus and pass voltage through to the loads as soon as the ac is restored. This could have a negative effect on certain types of telephony equipment.

However, in today's "state of the art" systems, which employ high-frequency switch-mode rectifiers, the voltage ramp-up occurs within 3 seconds or less. Further, much modern equipment contains its own disconnect device with its own internal restore voltage set point. So if the restore point is set properly in the telephony equipment, voltage to the equipment will be within the specified range at turn-on.

However, one point of caution is worthy of note when using a battery-side LVD. There is a hysteresis that occurs between the open-point voltage and the restore-point voltage. If the difference between the open-point voltage and the restore point voltage is less than the battery "bounce-back," then a "chattering" effect could occur in some instances depending upon the control logic employed. In most modern day "state of the art" systems, however, this possibility has been designed out.

Load-Side LVD

Figure 2 shows an LVD installed in series with the load. Again, in this application as shown, there are two voltages provided from the power plant – i.e. both +24 and -48 volt loads. However, in this instance the LVD is placed on the other side of the output bus away from the battery string, but in a position to disconnect the current from both voltage busses.

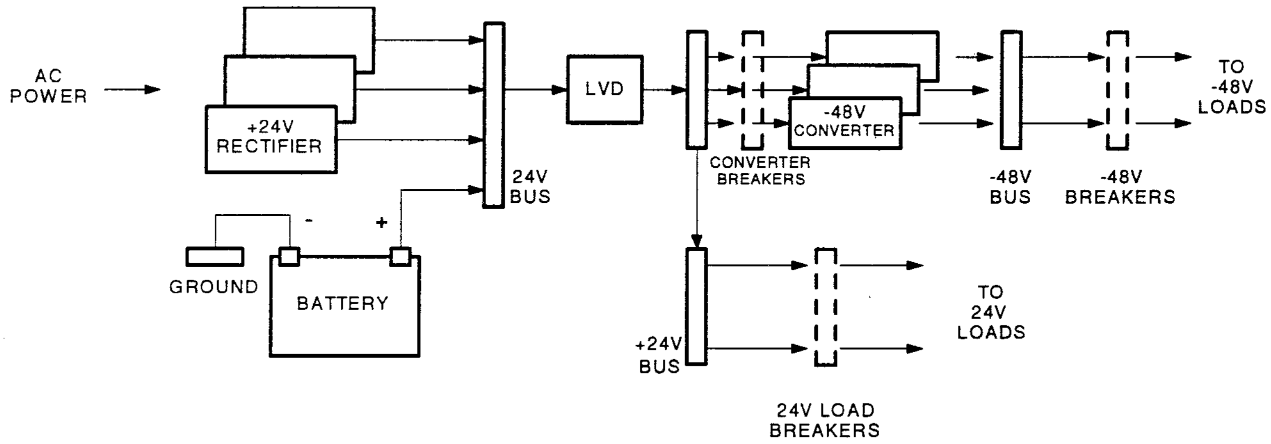

Figure 2 – Low Voltage Disconnect in Series with the Load

The advantage of this is straightforward. When the LVD re-engages to bring the load on-line [after the battery has discharged to its recommended open-cell voltage], the LVD does not permit a reconnection to the load until the rectifier voltage has reached its correct pre-set restore-point. For example, this could be 48 volts in a 48 volt system, or 24 volts in a 24 volt system.

Again, in the event of an LVD failure, the rectifiers and the batteries are prohibited from supplying power to the load, even when ac is available or the batteries are fully charged. However, one footnote is in order: modern electronics and technology have increased the MTBF [Mean Time Between Failure] of many LVD devices today to equal that of other components in the system.

WHICH CONFIGURATION IS BEST?

In my experiences over the past fifteen years or so, I have listened to the engineering arguments of both dyed-in-the-wool battery-side power engineers and dyed-in-the-wool load-side power engineers. In reality, with the advances in today's technology, it probably boils down to an age-old axiom: *"beauty is in the eye of the beholder,"* despite all engineering arguments to the contrary. At least that is my conclusion.

The more sensible approach in today's environment is to look at the application and pick the solution that best serves the application.

There are certain applications when a battery side LVD may work better than a load-side LVD. For instance, let's suppose you are installing a power system in an office building, and there are unique fire or safety considerations. In some power boards it is possible to tie-in an EPO (Emergency Power Off) connection to the battery-side LVD, ensuring a complete disconnect from the batteries in an emergency power-off situation.

On the other hand, if you're installing equipment in a microwave co-locate, and it is critical to keep the microwave equipment functioning as long as possible before dropping the site, you may want to provide a "load shed" capability. In this instance, you wish to drop the less critical equipment first to [1] reduce the load on the battery and [2] keep the more critical equipment running to the last possible moment.

Figure 3 shows a load-side, load-shed configuration, utilizing two LVD's.

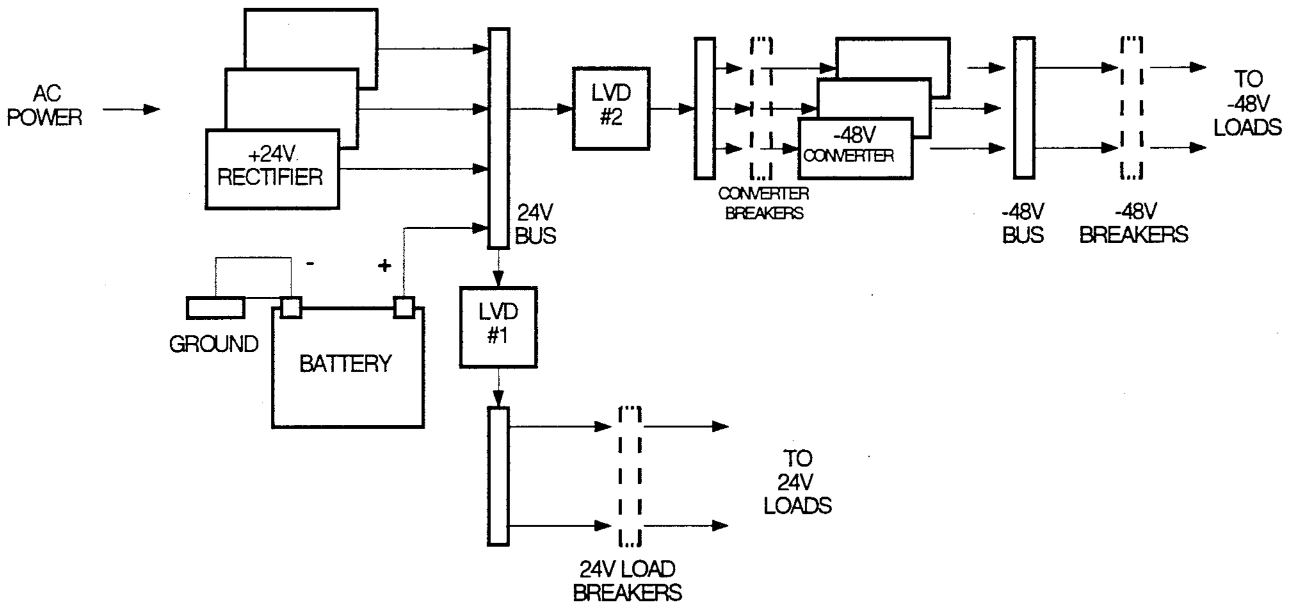

Figure 3 – Low Voltage Disconnect in a Load-Shed Configuration

Note that in this instance LVD #1 could be set with a trip voltage set point at say 22 volts. This would permit disconnecting the less critical load before the LVD #2 disconnects the remaining load where the voltage threshold has been set to trip the most critical load at 21 volts, for example.

LVD's vs. Battery Disconnect Devices

We cannot leave the subject of Low Voltage Disconnects without commenting on the differentiation of the LVD and the true Battery Disconnect Assembly.

It is not uncommon to see the LVD used as a means to disconnect the loads from the batteries in order to service the battery strings. In fact, some power equipment manufacturers offer a manual disconnect switch as part of the LVD assembly for this purpose. While this paper will likely not dissuade those who for one reason or another "swear" by the practice, a cautionary note should be provided.

As we have discussed in this paper, the fundamental purpose of an LVD is to provide a safety mechanism for both the communications equipment and the battery. Once the battery reaches an open-cell voltage [typically 1.75 volts per cell [vpc] for a valve-regulated lead acid [VRLA] battery], the load and batteries disconnect to prevent permanent damage to either the communications equipment or the battery.

Further, it is always considered better not to apply stress on the LVD contactor or any part of the assembly any more than is absolutely required. Thus, repetitive engagement of the LVD by-pass mechanism to service the batteries could be considered a disadvantage.

On the other hand, the fundamental purpose of a battery disconnect assembly is two-fold: [1] to protect the power board from any unusual high current shorts from the battery to the bus; and [2] to provide a means to disconnect the battery string from the circuit flow for servicing.

The battery disconnect assembly can either be rack mounted as an addition to the power board frame, space permitting, or it can be wall mounted near the battery string. Most experienced telephone engineers recommend that it be placed as close to the battery string as possible for both convenience and voltage drop considerations.

If multiple battery strings are deployed, then a battery disconnect device is connected to each string [whereas LVD's are not usually installed in multiples]. This permits a technician to service one string of batteries while all other strings remain on-line. Many of our sales engineers believe strongly in providing redundant multiple-string configurations with dual battery disconnects as a minimum for VRLA applications where redundancy is considered critical to the overall application. But that is the subject for a different discussion.

Some engineers also believe that Battery Disconnect Assemblies are served best by use of a fuse to ensure the interrupt capacity in case of a Short Circuit Fault across multiple battery strings tied to a common bus is exercised correctly. But that too is subject for a different discussion.

SUMMARY

Remote sites for both wireless and wireline applications lend themselves to the proper use of LVD's. This is especially true when back-up generators are not present and network redundant paths are not clearly established. On the other hand, they may not be considered necessary for CO's and other manned or properly backed-up sites. EPO requirements are now a valid consideration and may affect the use of an LVD. Battery disconnect devices certainly help today's "universal" service technician deal with batteries on a less threatening basis.

To determine what is the best use [or non-use] of LVD's and battery disconnect devices for your particular requirement, we strongly recommend consultation with your preferred power equipment or installation services sales engineer. He or she should be able to work through all the critical issues and recommend the best solution that is right for your particular application.