Technical Guide

Digital & Analog Partyline Intercom Cabling Comparison

Overview

Digital partyline intercom products offer some significant feature and performance advantages over analog partyline intercom products and in most cases using the same cable types.

This document provides a comparison of the demands placed on a cable by both analog and digital partyline intercom products.

The goal of this technical guide is to provide readers with a clear understanding of the cable characteristics important to the performance of partyline intercom systems. It also explains the operation of the online Clear-Com digital partyline cable calculator:

[Digital Partyline Calculator](#)

Background

Each cable type has a number of physical and electrical characteristics that affect its suitability for an application. Among these are:

- *Number of cores*
- *Core twist properties*
- *Shielding*
- *Overall diameter*
- *Flexibility*
- *Voltage rating*
- *Flammability rating*

The electrical characteristics that are of particular interest for those transitioning from analog to digital partyline systems are:

- *DC resistance*
- *Signal attenuation*

Introduction

In both analog partyline systems, which have been in use since the 1960s, and more recently introduced digital partyline systems, standard 3-pin mic cable is used between a main station and beltpack to carry two things:

- *Power*
- *Data (Audio and Control)*

Power Limits

The one factor that affects a cable's ability to deliver DC power is its DC resistance which is related to its gauge. Figure 1 shows the relationship between cable gauge and DC resistance.
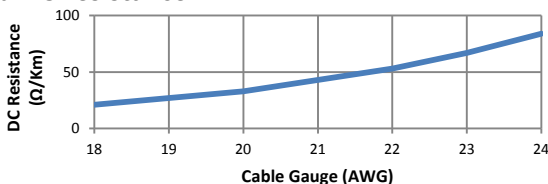

Figure 1 Cable DC Resistance vs Wire Gauge

The larger the cable (lower gauge number), the lower the DC resistance and the better its ability to deliver power over a longer distance. Here are some examples for both analog and digital partyline.

Analog Partyline

In an analog partyline system, the master station delivers around 30V DC to the line. The beltpack requires a minimum voltage of around 12 to 20V DC (varies dependent on type) at its input in order to operate. Most analog beltpacks draw the same **current** (around 25mA) from the line no matter what voltage they receive at their input.

Figure 2 shows how a cable can be considered as a simple resistance for calculation of power delivery length limits. The resistance of both cores used in the power delivery loop, the 30V core (R1) and the ground reference core (R2) must be considered in the calculation.
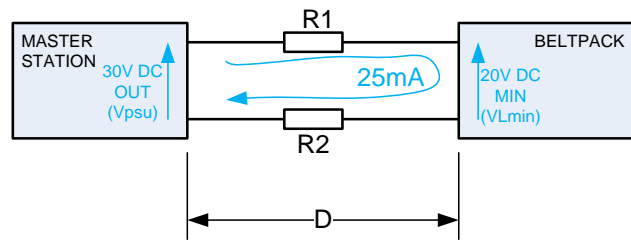
Figure 2 Analog Partyline Voltage Drops

In the example given in Figure 2, the maximum allowable value for the cable DC resistance can be calculated as follows:

$$(R1 + R2)\text{max} = \frac{V_{psu} - V_L min}{I_L} = \frac{30 - 20}{.025} = 400\Omega$$

Based on this calculation, assuming R1 and R2 are equal, a cable with a resistance of 33 ohms/km (such as 20awg **Belden 9463F**) could achieve a distance of:

$$Dmax = \frac{R_{MAX}}{R/Km} = \frac{400}{2*33} = 6Km$$

Note that this is with a single beltpack. Adding nine more to the end of the same cable, making a total of **ten beltpacks** gives a maximum power distance limit of:

$$Dmax = \frac{V_{psu} - V_L min}{I_L \text{ x } R/Km} = \frac{30 - 20}{0.25 \text{ x } 66} = \textbf{0.6Km}$$

The nature of an analog partyline system means that when it reaches its maximum cable length for power distribution, the user will experience a lowering of maximum audio level available at headsets before distortion levels increase.

Digital Partyline

In a Clear-com digital partyline system, the master station delivers around 59V DC to the line. The beltpack requires a minimum of around 24V DC in order to operate. Clear-Com digital partyline beltpacks take the same amount of **power** (around 3.5W) from the line no matter what voltage (within a specified range) they receive at their input.
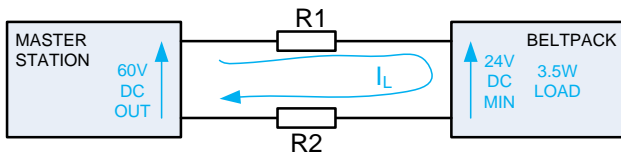
Figure 3 Digital Partyline Voltage Drop

This means that the calculation of maximum cable length is different to that for an analog beltpack. First it is necessary to calculate the current (I_L) that would flow in the circuit with the lowest acceptable voltage (V_L) available at the load:

$$I_L max = \frac{P_L}{V_L}$$

$$I_L max = \frac{3.5}{24} = 146 \, mA$$

then calculate the maximum resistance:

$$R1 + R2 = \frac{V_{psu} - V_L(min)}{I_L}$$

$$R1 + R2 = \frac{59 - 24}{.146} = 240\Omega$$

and maximum distance allowed as before:

$$Dmax = \frac{R_{MAX}}{R/Km}$$

$$Dmax = \frac{240}{2 \times 33} = 3.6Km$$

Again, if the number of units at the end of the line increases from one to **ten beltpacks**, the maximum cable length allowable (with **Belden 9463F**) drops to:

$$Dmax = \frac{V_{psu} - V_L min}{\left(\frac{P_L}{V_L}\right) \times R/Km}$$

$$Dmax = \frac{59 - 24}{\left(\frac{35}{24}\right) \times 66} = \textbf{0.36Km}$$

The nature of Clear-Com's digital partyline system means that when it reaches its maximum cable length for power distribution, units towards the end of the line will cease to operate until the cable connecting them to their main station is brought back within the required specification.

Data Limits

In addition to delivering power, in both analog and digital party line systems it is also necessary to ensure that the required data signal can be passed from source to destination.
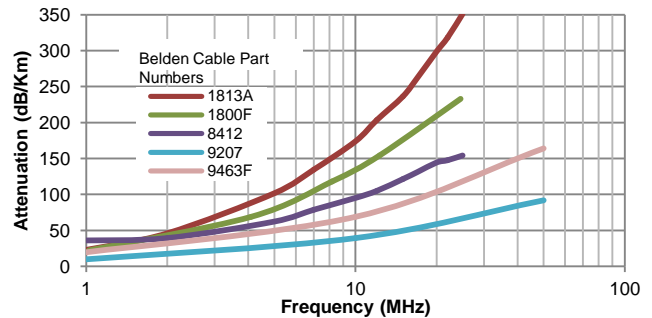
**Figure 4 Comparison of Cable Attenuation**

As shown in Figure 4, the attenuation of a cable over a given distance increases as transmission frequency increases. Figure 4 also shows us that some cable types are designed to be more suitable for transmitting higher frequency data whilst other cable types are designed to be suitable for lower frequency transmission.

Analog Partyline

In analog party line, the maximum data frequency of interest is the analog audio signal, a frequency of less than 20 KHz. Figure 4 shows us that at frequencies below 1 MHz, all of the cable choices shown have a very low attenuation (<30dB/Km).

The nature of the analog partyline system is also such that as cable attenuation between nodes increases, the effect observed by the user is a decrease in audio level heard at the headset with a low distortion audio signal still being received.

Take our previous analog partyline system as an example:
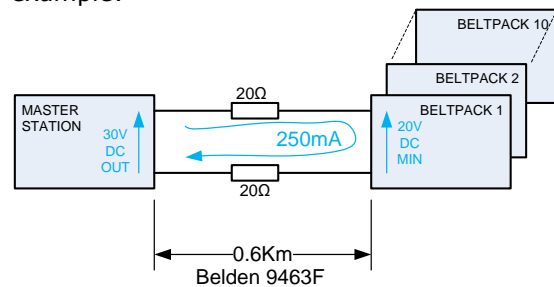
**Figure 5 Ten Beltpack Analog Partyline Example**

In this extreme case, assume the audio signal is 20 KHz and the cable attenuation at 20 KHz is the same as at 1MHz (In reality it will be much lower, but cable manufacturers do not specify cable attenuation at such low frequencies). There will be attenuation (see Figure 4) of around 30dB/Km so with our maximum allowable cable length the audio level will be reduced by:

$$Attenuation = 0.6Km \: x30 \frac{dB}{Km} = \: 18dB$$

Digital Partyline

In Clear-Com's digital partyline system, higher frequencies are used to transmit digitized audio and control data than are used in analog partyline systems. The maximum frequency used for transmission is around 25MHz.

At that frequency, cable attenuation increases but the nature of the transmission and reception technology used means that the system can operate with much greater levels of signal attenuation without loss of data.
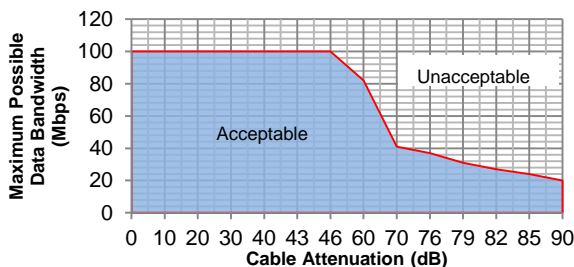
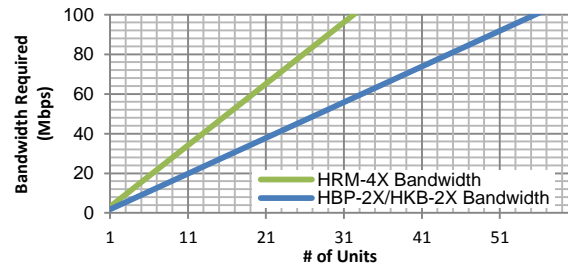**Figure 6 Clear-Com Digital Partyline Maximum Bandwidth vs Attenuation**

Figure 6 shows us that depending on the amount of data transmitted, Clear-Com's digital partyline system can operate with as much as 90dB of attenuation between nodes.

It should be noted that this ability to receive highly attenuated signals increases the possibility of crosstalk between cables. It is therefore important to maintain cable shield integrity through all connectors, splitter boxes and patch panels.

Each unit connected to a digital partyline requires a certain amount of bandwidth available on the line in order to operate. Clear-Com's digital partyline products each require the following bandwidth:

| Description	Model #	Bandwidth (Mbps)
HelixNet Beltpack	HBP-2X	1.8
HelixNet Beltpack	HBP-2XS	1.8
HelixNet Speaker Station	HKB-2X	1.8
HelixNet Remote Station	HRM-4X	3.1

Table 1 Clear-Com Digital Partyline Unit Bandwidth Requirements

Figure 7 Bandwidth required vs Number of Units

Figure 7 shows the bandwidth required on a Clear-Com digital partyline for differing numbers of digital partyline units.

Take our previous digital partyline example:
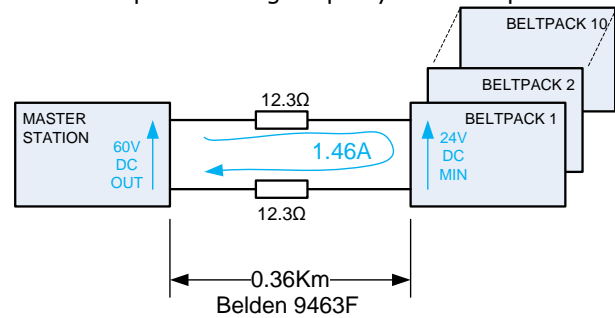
Figure 8 Ten Beltpack Digital Partyline Example

This system, with .36Km of cable with attenuation (from Figure 4) of around 130dB/Km will have an attenuation of:

$$Attenuation = 0.36Km \: x130 \frac{dB}{Km} = \: 48dB$$

From Table 1 we can calculate that these 10 beltpacks will require:

$$Bandwidth = 1.8Mbps \: x \: 10 = 18Mbps$$

From Figure 6 we can see that with 18Mbps of bandwidth required, the system will operate with attenuation up to 90dB. Our calculated attenuation for this example of 48dB above is well below that limit.

The nature of Clear-Com's digital partyline system means that when it reaches its maximum cable length for data attenuation, the user will begin to experience lost audio packets. When the maximum cable is exceeded by a significant amount, units will fail to connect to their main station. The units all provide a signal level meter on their display indicating the quality of connection back to their main station helping a system installer to see when they are approaching the system's limits.

Conclusions

Cable Types

Analog and digital partyline intercom systems place different demands on the cables used and whilst some cables are very good for both systems, some that are fine for one are not good for the other.

- *Analog systems require good shielding and little attention needs to be paid to attenuation at higher signal frequencies.*
- *Digital systems require particular attention be paid to attenuation at frequencies into the MHz range.*

Due to the combination of their low DC resistance and low attenuation at 25MHz data rates, Clear-Com recommends the use of:

- **Belden 9207** *cable for fixed digital partyline installations.*
- **Belden 9463F** *cable for portable or temporary digital partyline installations.*

See Belden's website at: **www.belden.com** for more details.

It is worthy of note that star quad cables have very high attenuation at 25MHz making them particularly poorly suited to digital partyline applications.

Limit Conditions

The nature of analog and digital systems dictates that their failure mechanisms are different when cable requirements aren't met.

Figure 9 and Figure 10 below give a comparison of what a user can expect from analog and digital partyline systems when approaching the limits of their cable's capabilities.

Calculator

The information included in this technical guide can be used to calculate the maximum acceptable cable length for any Clear-Com digital partyline system.

Alternatively, a user or prospective user can use the calculator spreadsheet available at the link below to determine whether a particular cabling installation meets the requirements of Clear-Com digital partyline.

Digital Partyline Calculator
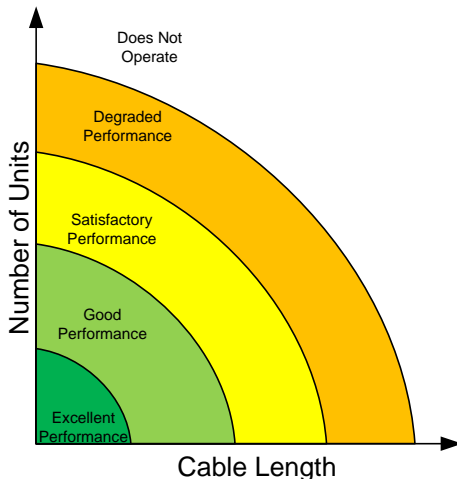
Figure 9 Analog Partyline Performance with increasing Cable Length and Number of Units
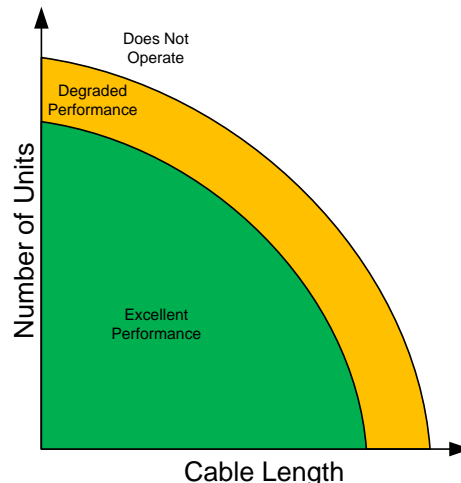
Figure 10 Digital Partyline Performance with Increasing Cable Length and Number of Units