Case Study. Frequency Distribution System with > 1000 outputs

Update January 2017

This case study was written in 2012. Today, we would still offer the DA1-100-10 distribution amplifier as used in this system. But alternatively, we can now offer the DA1-150-10-E distribution amplifier.

The DA1-150-10-E has all the advantages of the DA1-100-10 plus RS232 and Ethernet interfaces for full control and monitoring.

Case Study

Precision Test Systems Ltd designed one of the largest frequency distribution systems it has ever done. This installation was for a major GSM cell phone manufacturer.

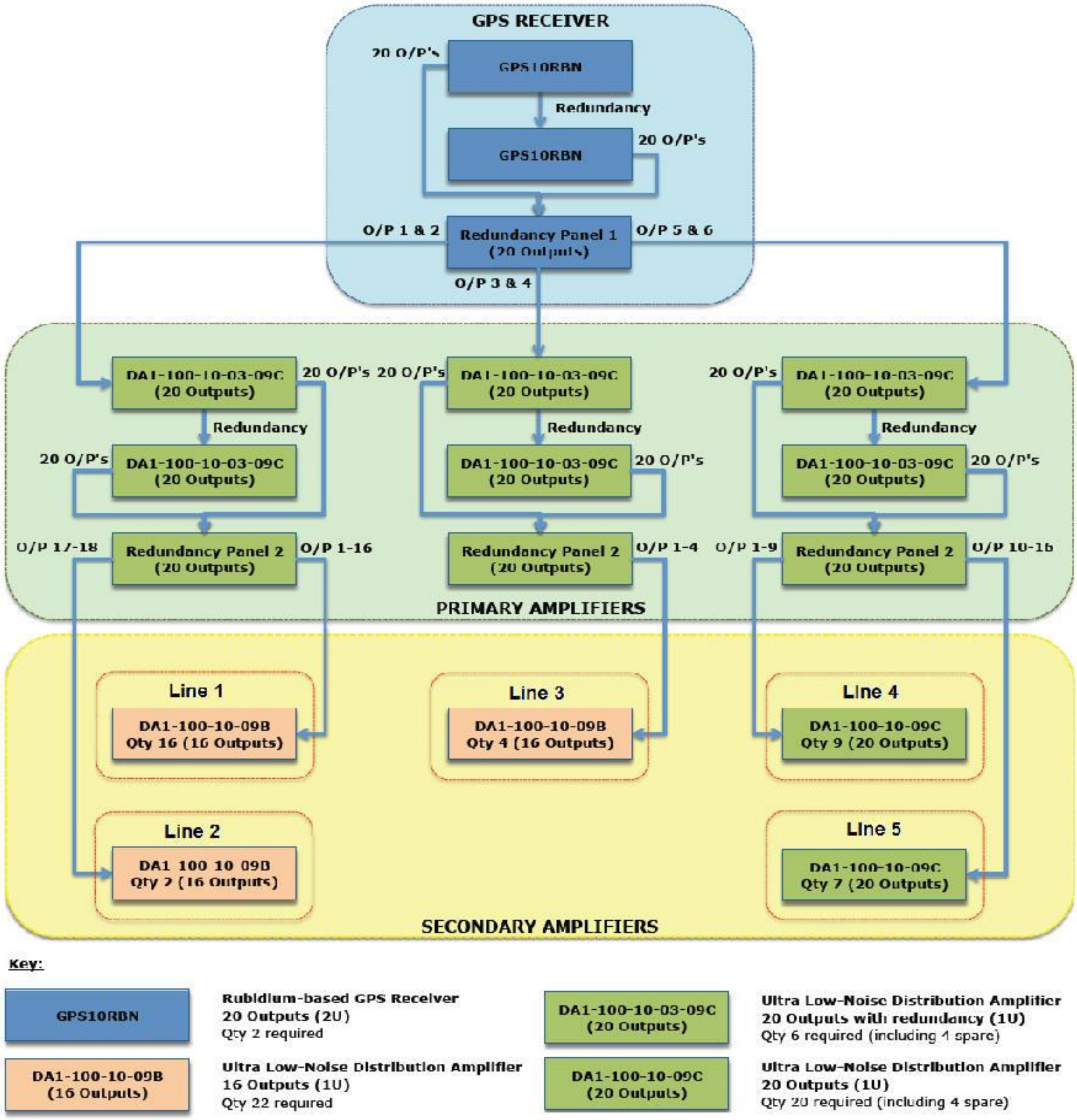
The design remit that we received from the customer included these salient points:

- A 10 MHz distribution system disciplined by the GPS satellite system.
- The main frequency standard was to be based on a rubidium oscillator and be redundant.
- The system was to provide up 700 x 10 MHz outputs with the option of expansion to over 2000 outputs.
- All outputs must meet stringent phase noise specifications.
- All outputs must have 90 dB of isolation between them.
- Individual output levels must be variable from < 0 dBm to > 10 dBm.

We decided to base the entire system on our GPS10RBN Frequency Standard and our DA1-100-10 range of distribution amplifiers.

Theory of Operation

Refer to the block diagram on the next page:



Frequency Reference

The primary frequency references were two GPS10RBN GPS Disciplined, Rubidium Frequency Standards.

The two GPS10RBN's were interconnected to form a redundant pair. Both units are identical, there is no master or slave unit. Simply whatever unit is turned on first becomes the master. When the second unit is turned on, it senses the first unit is working so disables itself and becomes the slave unit.

Having two identical units for the master and slave makes repair and back-up easier.

Each GPS10RBN unit has twenty 10 MHz sinewave outputs at a level of +14 dBm. These two sets of twenty outputs are fed to a redundancy panel. The redundancy panel simply consists of twenty passive splitters. Being passive devices, they have very high reliability, which is essential as this panel forms the twenty redundant outputs.

Primary Amplifiers

There are three pairs of redundant amplifiers. Each redundant pair operates in a similar manor to the redundant frequency standard. Whatever unit is turned on first becomes the master.

Each redundant pair consist of two DA1-100-10-03-09C distribution amplifiers and a redundancy panel. Thus, there are three sets of twenty redundant outputs making sixty redundant outputs in all.

Redundancy

Note there is multiple redundancy. The redundant frequency standard is separate to the amplifiers and the amplifiers are separate to each other. So, if one amplifier fails, just that part of the redundant system is affected with automatic switchover to the slave unit. Once switchover has occurred, the slave becomes the new master. The original faulty master is now disconnected from the system and sent for repair.

These sixty redundant outputs are now fed to the secondary amplifiers. Each secondary amplifier now gives sixteen or twenty outputs depending upon the models. 672 outputs were actually used in this installation.

Future Expansion

Only six of the twenty redundant outputs from the primary frequency standard have been used. Therefore, if the primary and secondary amplifier sections were repeated, over 2000 output can be realized.

Phase Noise

One of the targets was for low phase noise. The DA1-100-10 series of distribution amplifiers used in this design are all ultra-low phase noise, designed for serial inter-connection, thus one amplifier feeding another. But it must be understood every time this is done, the phase noise increases. So it is essential to keep serial interconnections to a minimum. With this system, there is a maximum of two amplifiers in series.

The target phase noise stipulated by the customer was as follows:

- -90 dBc/Hz at a 1 Hz offset
- -130 dBc/Hz at a 10 Hz offset
- -145 dBc/Hz at a 100 Hz offset
- -152 dBc/Hz at a 1 kHz offset
- -155 dBc/Hz at a 10 kHz offset

The actual system beat all the above targets by 1 to 3 db.

However, it must be noted we could have provided even lower phase noise if the ULN option was fitted to the primary frequency reference. But the customer didn't need this, and since it is an expensive option, it was not fitted.

Channel Isolation and Output Level

Every final output can be adjusted from < 0 dBm to at least +10 dBm, some outputs can actually give +13 dBm output level. Every output is isolated by at least 90 dB and reverse isolation is nearly impossible to measure, greater than 190 dB in theory.

Precision Test Systems invites comments or questions about this case study. Email sales@ptsyst.com