IRIG Standard and IEEE Extensions

This document recommends preferred definitions for specifying IRIG-B signals and explains IEEE (1344) Extensions. A recommended design approach is provided for applications where IRIG-B and NTP (and other) time protocols are required, together with recommended signal isolation practices. While the document references Tekron International GPS clocks & products, the general information is not manufacturer specific.

IRIG defines a serial string protocol where time information is communicated in a continuous stream of binary data. The IRIG standard defines protocols including IRIG-A, B, D, E, G & H. It does not define the electrical values (voltages), nor does it define the physical medium or connectors etc.

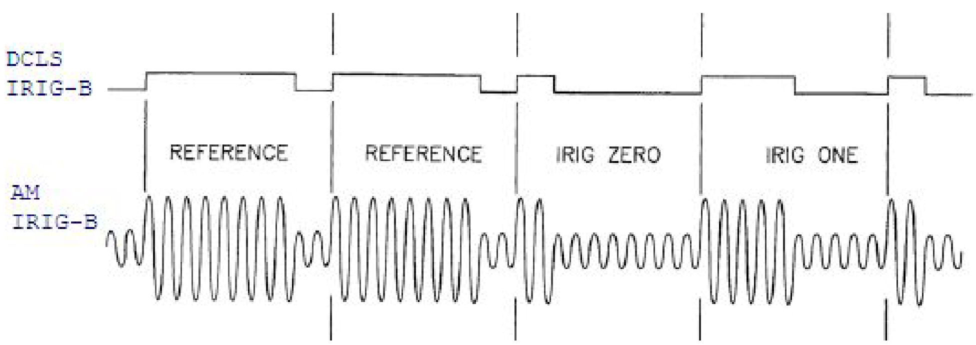
The IRIG Time Protocol was first published in the 1960's by the American Military. IRIG refers to the **I**nter-*r*ange **i**nstrumentation **g**roup, which is the Standards body of the Range Commander Council (Telecommunications and Timing Group). The standard defined timing protocols for the various American weapon testing grounds in order that standardised time-stamps could be applied to weapon test data. Since then, selected protocols have found wider industry application. IRIG-B is widely used in the electrical industry, thus is the focus of this document.

The IRIG-B serial protocol uses a bit string of approx 100 bits, repeated each second. These bits provide time and control information. Not all bits are used, and some are available for user defined control functions. Time information contained in the early edition of IRIG-B standard protocol included:

- Seconds
- Minutes
- Hours
- Day of year

What are "DCLS IRIG-B" and "AM IRIG-B"?

Design documentation and drawings often refer to IRIG-B, being the specific IRIG protocol. However, as described above "IRIG-B" alone in design documents should be not be used as it is a generic term; it specifies neither the specific protocol, nor electrical parameters or connectors. Typically IED's use one of two common IRIG-B protocol types, generally referred to as DCLS IRIG-B and AM IRIG-B.



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Specifically "IRIG-B" is defined by the code format IRIG-B*xyz*, where *x* is the modulation type, *y* is the frequency and *z* is the coding. The two common types are:

- IRIG-B0*yz* – Unmodulated, also called DC Level Shift (e.g. DCLS)
- IRIG-B1*yz* – Amplitude Modulated (AM)

AM IRIG-B (Amplitude Modulated)
This is used by older IED's. It less accurate than DCLS IRIG-B, but has the advantage that it can be run further than electrical DCLS signals.

AM IRIG-B signals generally use coaxial cables, and most commonly BNC connectors. However, use of BNC connectors does not guarantee that it is an AM IRIG-B signal being used!

DCLS IRIG-B (DC Level Shifted)
This is the more common IRIG-B type for newer IED's. It offers better accuracy than AM IRIG-B, but cannot be used in runs of more than 100m (unless you use Tekron "MOFR" signal repeaters or fibre).

Remember that the standard defines the protocol, but not the electrical parameters. DCLS IRIG-B is commonly output at 5V. This is referred to as a TTL output when using Tekron clocks and MOFR's. Tekron clocks and MOFR's can also be ordered with "HV" MOSFET outputs, allowing switching of an external supply voltage (up to 300Vdc) to provide higher voltage signals where required by certain IED's.

While Tekron clocks can provide both DCLS IRIG-B and AM IRIG-B output (amongst others!), in your substation design you need to know which signal type to route to which IED.

IEEE Extensions
You may have noted that in the list of information contained in the IRIG-B protocol, the actual year information is not included. This is the reason that year information needed to be programmed in manually to some IED's.

To overcome this, the IEEE 1344 standard (1995) defined "extensions" to the IRIG-B time codes, adding year, time quality and other information to the IRIG-B string. This standard was later superseded by IEEE C37.118.

In 2005 the IRIG standard was updated (200-04 edition), with year information being added to the standard protocol. However, while Tekron clocks are up-to-date with outputting this latest IRIG format (with year information), your IED firmware may be expecting an older version protocol, and thus ignore the year information, or expect it to be part of the more complete IEEE extension.

Thankfully in the electrical industry we don't really need to worry too much about the history and inner detail when setting up a Tekron GPS clock. The extensions add additional information to the code string, and their presence is unlikely to affect IED's that were designed prior to these extensions being available. Therefore, when setting up a clock, we recommend enabling IEEE 1344 Extensions (Even parity) and enabling Binary Seconds, to the clock output as standard.

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Parity and other Extensions;

IEEE 1344 Parity: Early editions of the IRIG-B did not include parity information, and different clock and IED vendors approached this differently. Tekron TCG 01, outputs an even parity, but the TCG 01-E has a setting to allow the user to set even or odd parity. Not all IED vendors test the IRIG-B string for parity, so unless it is specifically stated we recommend the **even** parity setting.

Straight Binary Seconds: An optional part of the IRIG-B code has been the inclusion of Binary Seconds data, being the number of seconds since 00:00 of the current day. This is available as an output option with the latest TCG 01-E (check box “straight binary seconds”). Implementing this output will cause no harm to connected IEDs, and we recommend you enable this as standard, just in case a future connected device requires it.

AFNOR NFS 87-500: You will also find this Extension option in the Tekron setup as an alternative to IEEE. AFNOR NFS 87-500 is a French standard time code extension to IRIG-B adding day, day-of-month and year information. Tekron are a truly “international” company and support this extension if required, but we don’t anticipate the need for this in the NZ market.

What if I need IRIG-B and NTP?

It’s now common in substation design to require Network Time Protocol for Ethernet connected devices such as substation management systems and IEC 61850 IED’s, but also to provide DCLS IRIG-B and AM IRIG-B to legacy and other devices. While you can have multiple clocks (and antennas) to meet these requirements, Tekron manufacture GPS clocks with all these outputs in one clock. The selection of product(s) required is best based upon the number of separate NTP outputs needed.

Where a large number of output ports are required, it is possible to synchronise additional Tekron NTP (and other) clocks to an IRIG-B source, thus with one antenna provide a wide range of distributed time sources. In the design of such systems, it is the IRIG-B source that should be first considered, as it is possible to generate NTP from an IRIG-B signal, but not the other way around (NTP to IRIG-B conversion does not occur due to NTP’s lower time accuracy).

Signal Isolation

A “Time Sync Time Bus” providing time signals over copper cabling between distributed IED’s needs careful consideration of bus loading (how many IEDs can be connected), noise and galvanic isolation. One simple and effective solution is to isolate the time bus between panels. For this purpose Tekron provide the MOFR (Multiple Output Functional Repeater) which facilitates not only isolation, but also signal regeneration and conversion. For example a twisted copper (or fibre) time bus can be run though the substation, with MOFR’s being installed at each panel to provide an isolated time signal to equipment in that panel. There are MOFR’s that from a single DCLS IRIG-B input can generate both an AM IRIG-B signal and DCLS IRIG-B output. This allows for example just a DCLS IRIG-B signal to be routed throughout the substation to all the modern IED’s, with the AM IRIG-B being generated only where required for legacy devices.

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Design for the future

Tekron International aim for their clocks to be the only clock you need at your substation; thus they offer a wide variety of outputs to support all your existing and future IED timing requirements such as:

- Fibre outputs (where IRIG-B DCLS is converted to an optical equivalent)
- RS-422 outputs which provide an alternative serial string giving time information that is required by some devices such as some RTU's. (MOFR's can convert this to electrical RS-485 and RS-232 formats if required)
- One pulse per second outputs as used by some IED's and PLCs
- DCF-77 time protocol
- NTP Network Time Protocol (for IEC 61850 systems, and often PC based SCADA master stations)
- Optional PTP Precision Time Protocol (IEEE 1588)
- Comprehensive range of solutions for signal isolation
- Note that some of above may require an order option, or dedicated output

Summary:

- "IRIG-B" alone does not adequately define protocol or electrical requirements. Specify AM IRIG-B or DCLS IRIG-B (or the full IRIG-B code) to be more specific. To be helpful, also specify the electrical requirements (desired voltage level) for the IED and to be really helpful, specify the connector type at the IED (BNC, screw terminal, DB9 etc).
- Enable IEEE Extensions (Even parity) and Binary Seconds outputs as standard for your GPS clock
- Design isolation into your system when distributing time signals between panels
- Consider the future needs for NTP and PTP protocols at your substation
- If you have problems with your time synchronisation system, check the IED's documentation for its latest firmware. What type of IRIG-B signal is it expecting, and where is it expecting year information? Does the year information need to programmed direct into the IED, is it expected as part of 200-04 protocol, or within IEEE extension?

For more information on IRIG-B, refer to Tekron Internationals "A Guide to Time", Appendix B. Also available from the Tekron International web site is a copy of the IRIG standard.

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