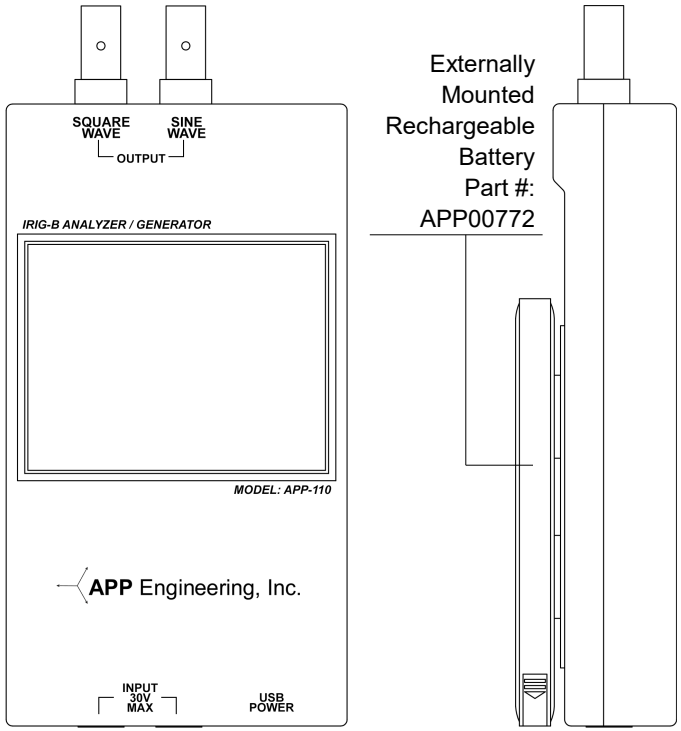
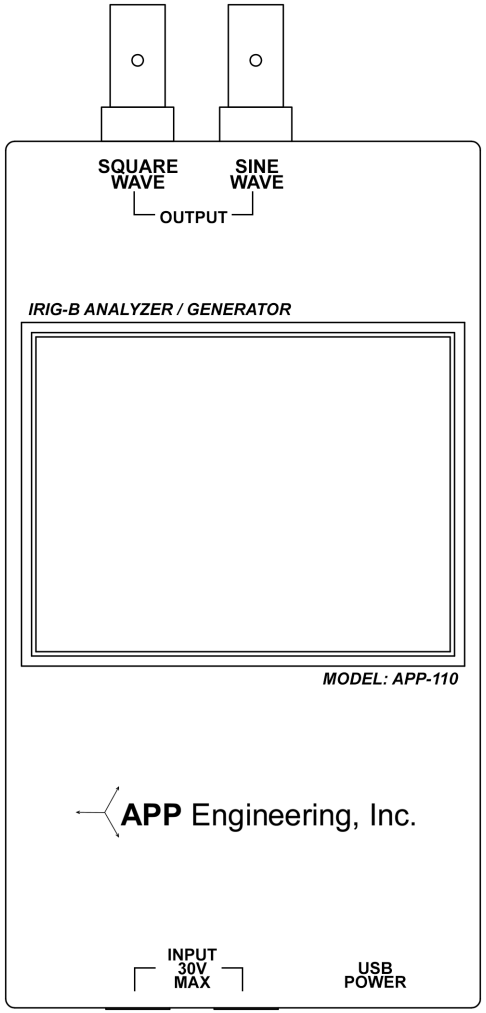
APP-110 KIT (PART #: APP00780) PARTS LIST	
Part number	**Item**
APP00771	IRIG-B Analyzer/Generator Device
APP00772	Rechargeable Battery
APP00773	120 VAC micro-USB Charing Adapter
APP00774	Dual Banana to BNC Female Adapter
APP00775	3 ft BNC Cable Male-Male
APP00776	Test Probes
APP00777	BNC T-Connector Male-Female(2)
APP00778	Carrying Case with Foam
APP00779	Manual Hardcopy



APP Engineering, Inc.

APP Engineering, Inc.



APP-110 IRIG-B ANALYZER/GENERATOR™ MANUAL

Manual Part Number **Edition**

APP00779 Edition 2, April, 2022
Printed in the USA
APP Engineering, Inc.
5234 Elmwood Avenue
Indianapolis, IN 46203

Assistance
Product maintenance agreements and other customer assistance agreements are available for APP Engineering, Inc. products. For assistance, contact APP Engineering, Inc. at 317-536-5300. Further information is available on the APP Engineering, Inc. website at www.appengineering.com.

Trade Information
All brand and product names are trademarks or registered trademarks of their respective companies.

Warranty
The material contained in this document is provided "as is," and is subject to being changed, without notice, in future editions. Further, to maximum extent permitted by applicable law, APP Engineering, Inc. disclaims all warranties, either expressed or implied with regard to this manual and any information contained herein, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. APP Engineering, Inc. shall not be liable for errors or for incidental or consequential damages in connection with the furnishing, use, or performance of this document or any information contained herein. Should APP Engineering, Inc. and the user have a separate agreement with the warranty terms covering the material in this document that conflict with these terms, the warranty terms in the separate agreement will control.

The above warranty is exclusive and in lieu of all other warranties, whether expressed or implied, including the implied warranties of merchantability, fitness for a particular purpose and non-infringement. This warranty gives you specific legal rights. You may have other rights, which vary from state to state.

Disclaimer of Damages
Regardless of whether any remedy set forth herein fails of its essential purpose, in no event will APP Engineering, Inc. be liable to the purchaser for any special, consequential, indirect or similar damages, including any lost profits or lost data arising out of the use or inability to use the software even if APP Engineering, Inc. has been advised of the possibility of such damages. Some states do not allow the limitation of exclusion of liability for incidental or consequential damages so the above limitation or exclusion may not apply to you.

PHYSICAL SPECIFICATIONS

Dimensions:	6.73 in (L) × 3.39 in (W) × 1.24 in (H)	(Standard)
	171 mm (L) × 86 mm (W) × 31 mm (H)	(Metric)
Weight:	7.1 ounces	(Standard, device only, no battery)
	200 grams	(Metric, device only, no battery)

ENVIRONMENTAL SPECIFICATIONS

Operating temp:	Min: -20 °C / -4 °F | Max: +70 °C / +158 °F	(Dry, no battery)
	Min: 0 °C / 32 °F | Max: +45 °C / +113 °F	(Dry, incl. battery)
Storage temp:	Min: -30 °C / -22 °F | Max: +80 °C / +176 °F	(Dry, no battery)
	Min: -10 °C / -14 °F | Max: +45 °C / +113 °F	(Dry, incl. battery)
Rel. humidity:	Max: 80 % when temp. ≤ 40 °C / 104 °F	(Non-condensing)
	Max: 50 % when temp. > 40 °C / 104 °F	(Non-condensing)

TECHNICAL SPECIFICATIONS

Screen size / resolution:	3.5 in diagonal / 320 pixels × 240 pixels
Screen technology:	Backlit TFT LCD / Resistive touchscreen
Screen color depth:	262 thousand colors
USB socket:	5.0 VDC female micro-USB power connector

INPUT SPECIFICATIONS

Input socket:	3/4 in spaced female banana plug connectors	
Maximum input voltage:	30 V	
Oscilloscope auto-ranging*:	±5.75 V / ±11.50 V	(Vertical axis range)
Input voltage accuracy:	±0.1 V	(Vertical axis accuracy)
Maximum input bandwidth:	12 kHz	

*Ranging is fixed at ±5.75 V for 1PPS, unmodulated IRIG-B, and modulated IRIG-B

SQUARE WAVE BNC OUTPUT SPECIFICATIONS

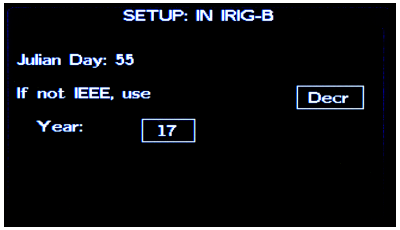
Output sockets:	Female BNC connector for square wave output	(Left)
Output voltage range:	0.0 V — +5.0 V output voltage	
1PPS edge rise time:	12 µs (0.0 V to +5.0 V)	

SINE WAVE BNC OUTPUT SPECIFICATIONS

Output sockets:	Female BNC connector for sine wave output	(Right)
Output voltage range:	-3.3 V — +3.3 V output voltage	
1PPS edge rise time:	4 µs (0.0 V to +3.2 V)	

DISCLAIMER OF THIRD PARTY HARDWARE

Unless stated, these specifications do not include or consider the operation or use of third-party hardware, which include the Rechargeable Battery (Part #: APP00772) and the 120VAC micro-USB Adapter (Part #: APP00773). APP Engineering, Inc. is not liable for any injuries or damages resulting from the use of these hardware. For more information, please refer to the included third-party documentation.



This screen is also used to set the Year being displayed on the Oscilloscope Screen if the IEEE 1344 Extension is not present in the IRIG-B time signal being input.

To set the year, tap to toggle the Incr/Decr button to increase or decrease accordingly, then tap the field labeled "Year" to increment or decrement the year.

IRIG-B TECHNICAL INFORMATION

IRIG time signals are repeating series of bits represented by pulses. The IRIG-B time signal repeats every 1000 ms and will be referred to as a "frame". Each frame is divided into 100 bits, each 10 ms long. Depending on the pulse width in each 10 ms bit, the pulse will represent a binary 0, a binary 1, or a marker. The marker pulse serves two purposes, as a reference marker at the start of the frame, and as position markers for every 10th 10 ms in the frame. A frame has a total of 1 reference marker and 10 position markers. The pulse widths of the three signals are as follows:

Table 4: Pulse widths for different signal representations

Pulse width	Signal representation
2 ms	Binary 0 bit
5 ms	Binary 1 bit
8 ms	Reference/position marker

Each frame begins with a reference marker, and each 100 ms segment is terminated with a position marker on the last 10 ms. This leaves each 90 ms or 9 bits of data for each segment. The data structure in the first 500 ms of the frame are common to all IRIG-B time signals. The following 300 ms (500 ms - 800 ms) are for optional user defined control functions. The last 200 ms (800 ms - 1000 ms) are for optional Straight Binary Seconds (SBS) of the day.

The APP-110 IRIG-B Analyzer/Generator reads and outputs IRIG-B time signals with the IEEE 1344 Extension. The IEEE 1344 Extension includes data such as the two digit year, whether daylight saving time is active, the UTC offset, and the quality of the time signal. It is placed in the 300 ms for user defined control functions.

Apart from SBS, all numbers are Binary Coded Decimals (BCD), which are binary representations of base 10 digits. Each field starts with the least significant digit and each digit starts with the least significant bit. The digits are separated by index markers, which always have a bit value of 0. Unused empty bits also always have a bit value of 0. Table 1, Table 2, Table 3, and Diagram 1 on the center pull-out sheet of this manual outline the structure of the IRIG-B time signal and the IEEE 1344 Extension.

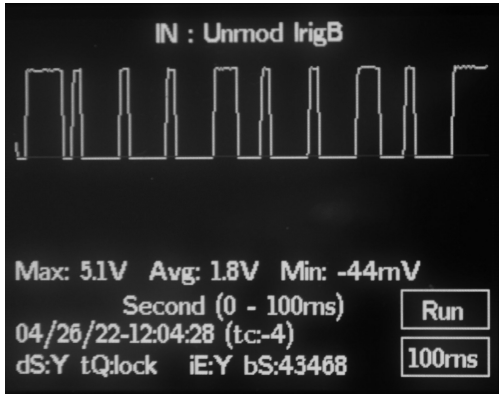
Safety Notices
Do not install substitute parts or perform any unauthorized modification to the product. Return the product to APP Engineering, Inc. for service and repair to ensure that safety features are maintained.

WARNING	**A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like, that if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until you fully understand and are prepared to address the indicated conditions.**
CAUTION	**A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until you fully understand and are prepared to address the indicated conditions.**
WARNING (Servicing)	**Do not attempt to service or repair the APP-110 IRIG-B Analyzer/Generator™. In the event of service and/or repair issues, return the APP-110 to APP Engineering, Inc. Opening the case will void the warranty and may lead to serious bodily injury or death.**
WARNING (Operating Environment)	**This instrument should not be used in an explosive environment. It should not be used in the presence of flammable gases or liquids. This instrument should not be used in a damp or wet environment or an environment that is subject to condensation.**
WARNING (Input Voltage)	**This instruments inputs should not be subjected to more than 30 VDC or 30 VAC. Do not apply more than 5 VDC/2.5 A to the USB charging port. Voltage or current should not be applied to any other part of the instrument.**

Additional Document Notes
Throughout this manual, the APP-110 IRIG-B Analyzer/Generator™ may be referred to as the "APP-110", the "device". It may also be referred to as the "Analyzer" or "Generator" depending on the function in the context.

INITIAL OPERATION

To operate the device provide USB power to the USB port using a battery or by using a wall plug. The device will power on.



OSCILLOSCOPE SCREEN

The first screen that will appear upon powering on the device will be the Oscilloscope Screen. It displays the oscillography from the banana jack inputs on the bottom of the device.

The title of the screen indicates what type of signal the device is reading. It will show "Unmod IrigB", "Mod IrigB", or "1PPS" depending on what the device is reading, or any one of the three if the device is reading a general signal.

The first line under the oscillography will always show the maximum, average, and minimum of the window that is being displayed.

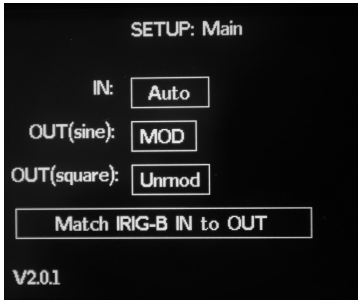
The second line indicates which 50 ms or 100 ms window is displaying. The names of these intervals (Second, Minute, Hour, Julday, Year, Control, and BinSec) are based on the IRIG-B time signal format. When reading IRIG-B time signals, this line indicates what data the window is showing.

When the device reads a valid IRIG-B time signal, the last two lines will show the decoded IRIG-B time signal and its related information, including the UTC Time Code, Daylight Saving Time Figure of Merit, IEEE 1344 Extension is present (Y or N), and the Binary Second of the day. When the device reads a 1PPS signal, the last two lines will show the pulse width and the period of the cycle.

Tap the Run/Hold button to toggle between Run and Hold states. The Hold state will freeze the oscillography and the related decoded information on-screen the moment it is tapped.

Tap the 50ms/100ms button to toggle between showing a 50 millisecond window and a 100 millisecond window. All decoded information shown in the last two lines is of a 1000 ms interval. In the case of an IRIG-B time signal, the beginning of the frame is determined by the rising edge of the reference marker. In the case of a 1PPS signal, the beginning of the frame is determined by the rising edge of the pulse.

Tap the left and right ends of the oscillography to move backward and forward by the window width inside the 1000 ms interval.



Tap the title at the top of the screen to go to the next screen.

MAIN SETUP SCEEN

The Main Setup Screen has 4 buttons.

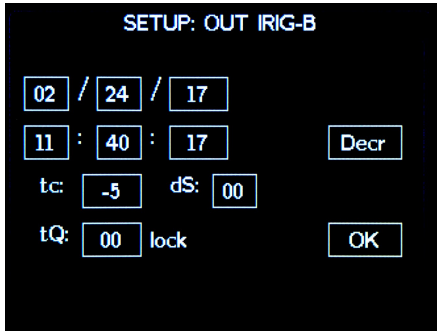
The first button, labeled "IN", is used to choose the expected input of the banana ports at the bottom of the device. Tap the button to cycle through the options (Auto, Unmod, Mod, and 1PPS). Choosing "Auto" will set the mode based on what the input is reading.

The second button, labeled "OUT(sine)", is used to choose the signal of the SINE WAVE BNC output on the top of the device. Tap it to cycle through the options (MOD, 1PPS, 60Hz, and 50Hz). "60Hz" and "50Hz" output 2.3 VAC.

The third button, labeled "OUT(square)", is used to choose the signal of the SQUARE WAVE BNC output on the top of the device. Tap it to cycle through the options (Unmod, and 1PPS).

The 1PPS output always has a pulse width of 8 milliseconds with a period of 1000 milliseconds.

If an IRIG-B signal is being input, tapping the "Match IRIG-B IN to OUT" button will synchronize both outputs to the IRIG-B signal being input at the moment the button is pressed. When successful, the button will change to say "Done Matching".



IRIG-B OUTPUT SETUP SCREEN

This screen has 9 fields that can be set, an increment/decrement toggle button, and an OK button.

The information that is set here will be output to both BNC outputs when an IRIG-B mode is chosen in the Main Setup Screen.

To increase or decrease the values, tap to toggle the Incr/Decr button accordingly and tap a field to increment or decrement it.

Tap the "OK" button to save the IRIG-B time signal that has been set. The outputs will not output the set time signal otherwise.

IRIG-B INPUT SETUP SCREEN

When there is a valid IRIG-B signal, this screen indicates the Julian Day of the input.

Table 2: Structure of the IEEE 1344 Extension and SBS (500 ms to 1000 ms)

10 ms pos	Bit addr	Bit val	Bit desc	
500	31	1s bit	Year - Ones	Year
510	32	2s bit		
520	33	4s bit		
530	34	8s bit		
540		0	Index	
550	35	1s bit	Year - Tens	
560	36	2s bit		
570	37	4s bit		
580	38	8s bit		
590		Marker	Position 6	
600	39	Bool	Leap second pending	
610	40	Bool	Leap second +/-	
620	41	Bool	DST pending	
630	42	Bool	DST active	0: no 1: yes
640	43	Bool	Time zone sign	0: +ve 1: –ve
650	44	1s bit	Time zone	
660	45	2s bit		
670	46	4s bit		
680	47	8s bit		
690		Marker	Position 7	
700	48	Bool	TZ half hour offset	0:none 1:+0.5h
710	49	1s bit	Time figure of merit	Refer to Table 4
720	50	2s bit		
730	51	4s bit		
740	52	8s bit		
750	53	Bool	Parity bit	
760		0	Empty	
770		0	Empty	
780		0	Empty	
790		Marker	Position 8	
800	54	2^0s bit	SBS - bits 0 to 3	SBS: 0 to 86399
810	55	2^1s bit		
820	56	2^2s bit		
830	57	2^3s bit		
840	58	2^4s bit		
850	59	2^5s bit		
860	60	2^6s bit		
870	61	2^7s bit		
880	62	2^8s bit		
890		Marker	Position 9	
900	63	2^9s bit	SBS - bits 9 to 16	SBS: 0 to 86399
910	64	2^{10}s bit		
920	65	2^{11}s bit		
930	66	2^{12}s bit		
940	67	2^{13}s bit		
950	68	2^{14}s bit		
960	69	2^{15}s bit		
970	70	2^{16}s bit		
980		0	Empty	
990		Marker	Position 10	

Table 3: Time Figure of Merit code

Binary	Decimal	Value
0000	0	Normal operation, locked (best quality)
0001	1	Within 1 ns
0010	2	Within 10 ns
0011	3	Within 100 ns
0100	4	Within 1 µs
0101	5	Within 10 µs
0110	6	Within 100 µs
0111	7	Within 1 ms
1000	8	Within 10 ms
1001	9	Within 100 ms
1010	10	Within 1 s
1011	11	Within 10 s
1111	15	Clock failure, fault (time not reliable)

Table 1: Structure of the IRIG-B time signal, BCD time of year (0 ms to 500 ms)

10 ms pos	Bit addr	Bit val	Bit desc	
0		Marker	Reference	
10	0	1s bit	Second - Ones	Second
20	1	2s bit		
30	2	4s bit		
40	3	8s bit		
50		0	Index	
60	5	1s bit	Second - Tens	
70	6	2s bit		
80	7	4s bit		
90		Marker	Position 1	
100	8	1s bit	Minute - Ones	Minute
110	9	2s bit		
120	10	4s bit		
130	11	8s bit		
140		0	Index	
150	12	1s bit	Minute - Tens	
160	13	2s bit		
170	14	4s bit		
180		0	Empty	
190		Marker	Position 2	
200	15	1s bit	Hour - Ones	Hour
210	16	2s bit		
220	17	4s bit		
230	18	8s bit		
240		0	Index	
250	19	1s bit	Hour - Tens	Hour
260	20	2s bit		
270		0	Empty	
280		0	Empty	
290		Marker	Position 3	
300	21	1s bit	Day of Year - Ones	Day of Year
310	22	2s bit		
320	23	4s bit		
330	24	8s bit		
340		0	Index	
350	25	1s bit	Day of Year - Tens	
360	26	2s bit		
370	27	4s bit		
380	28	8s bit		
390		Marker	Position 4	
400	29	1s bit	Day of Year - 100s	Day of Year
410	30	2s bit		
420		0	Empty	
430		0	Empty	
440		0	Empty	
450		0	Empty	
460		0	Empty	
470		0	Empty	
480		0	Empty	
490		Marker	Position 5	

Diagram 1:

Structure of IRIG-B Time Signal and IEEE 1344 Extension

IRIG-B Time Signal Structure (0 ms - 100 ms) — CORE

0	10	20	30	40	50	60	70	80	90
REF	SECONDS:ONES				INDX	SECONDS:TENS			POS 1

IRIG-B Time Signal Structure (100 ms - 200 ms) — CORE

100	110	120	130	140	150	160	170	180	190
MINUTES:ONES				INDX	MINUTES:TENS			0	POS 2

IRIG-B Time Signal Structure (200 ms - 300 ms) — CORE

200	210	220	230	240	250	260	270	280	290
HOURS:ONES				INDX	HOURS:TENS		0	0	POS 3

IRIG-B Time Signal Structure (300 ms - 400 ms) — CORE

300	310	320	330	340	350	360	370	380	390
DAY OF YEAR:ONES				INDX	DAY OF YEAR:TENS				POS 4

IRIG-B Time Signal Structure (400 ms - 500 ms) — CORE

400	410	420	430	440	450	460	470	480	490
DAY OF YEAR: HUNDREDS		0	0	0	0	0	0	0	POS 5

IRIG-B Time Signal Structure (500 ms - 600 ms) — IEEE 1344 EXTENSION

500	510	520	530	540	550	560	570	580	590
YEAR:ONES				INDX	YEAR:TENS				POS 6

IRIG-B Time Signal Structure (600 ms - 700 ms) — IEEE 1344 EXTENSION

600	610	620	630	640	650	660	670	680	690
LEAP SEC PEND	LEAP SEC +/-	DST PEND	DST ACTV	TIME ZONE SIGN	TIME ZONE				POS 7

IRIG-B Time Signal Structure (700 ms - 800 ms) — IEEE 1344 EXTENSION

700	710	720	730	740	750	760	770	780	790
TZ HALF HOUR	TIME FIGURE OF MERIT				PAR	0	0	0	POS 8

IRIG-B Time Signal Structure (800 ms - 900 ms) — STRAIGHT BINARY SECONDS

800	810	820	830	840	850	860	870	880	890
STRAIGHT BINARY SECONDS:BIT 0 - BIT 8									POS 9

IRIG-B Time Signal Structure (900 ms - 1000 ms) — STRAIGHT BINARY SECONDS

900	910	920	930	940	950	960	970	980	990
STRAIGHT BINARY SECONDS:BIT 9 - BIT 16									POS 10