GPS10RBN: 10 MHz, GPS Disciplined, Rubidium Frequency Standard

Key Features

- Completely self-contained unit. No extra P.C needed. Full information available via LCD.
- Rubidium Oscillator locked to GPS satellite signal. Accuracy to parts in 10^{-13} (Stratum 1 performance)
- Free run mode. Rubidium still gives an accurate output without a GPS satellite signal (Stratum 1)
- Two 1 pps time outputs. Typical error < 20 ns compared to UTC. Jitter < 300 ps
- Low Phase Noise, e.g. -135 dBc/Hz at 10Hz
- Multiple 10 MHz Outputs plus other outputs
- Windows software with full control and monitoring of the GPS10RBN via RS232, USB, Ethernet or the web.
- 19" 2U high rack mountable case.
- Very Low Microphonics
- Many options. See list of options in this brochure.
- Custom built options available upon request
- High quality design

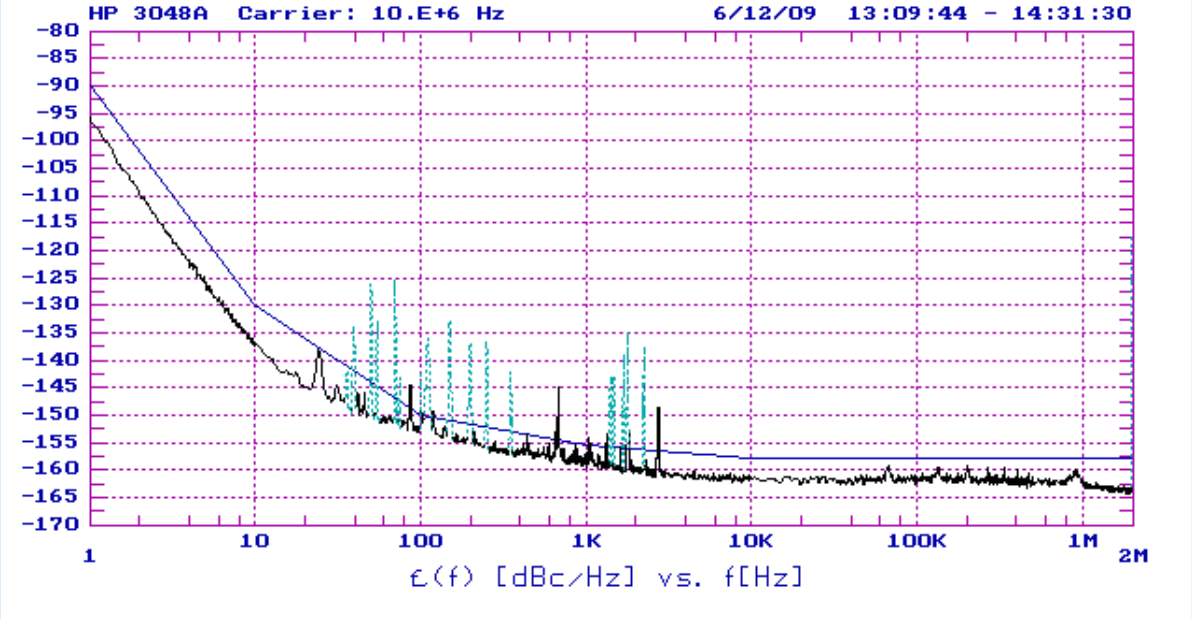
General Description

The GPS10RBN is a 10 MHz, GPS disciplined, ultra low phase noise, rubidium frequency standard. It combines the short-term stability of an atomic rubidium oscillator with the long-term stability and traceability of the Global Positioning Service (GPS) set of satellites. The GPS10RBN achieves short and long-term frequency accuracy of parts in 10^{-13}. Thus the GPS10RBN exceeds the requirements of a Stratum 1 level frequency standard.

Options for the GPS10RBN include 5 to 20 isolated sinewave outputs, an antenna amplifier or fiber optic GPS link, enabling the antenna to be placed up to 1 km from the GPS10RBN, various fixed high frequency outputs, alarm relay outputs, redundancy, battery backup supply, time code outputs and a variable frequency output.

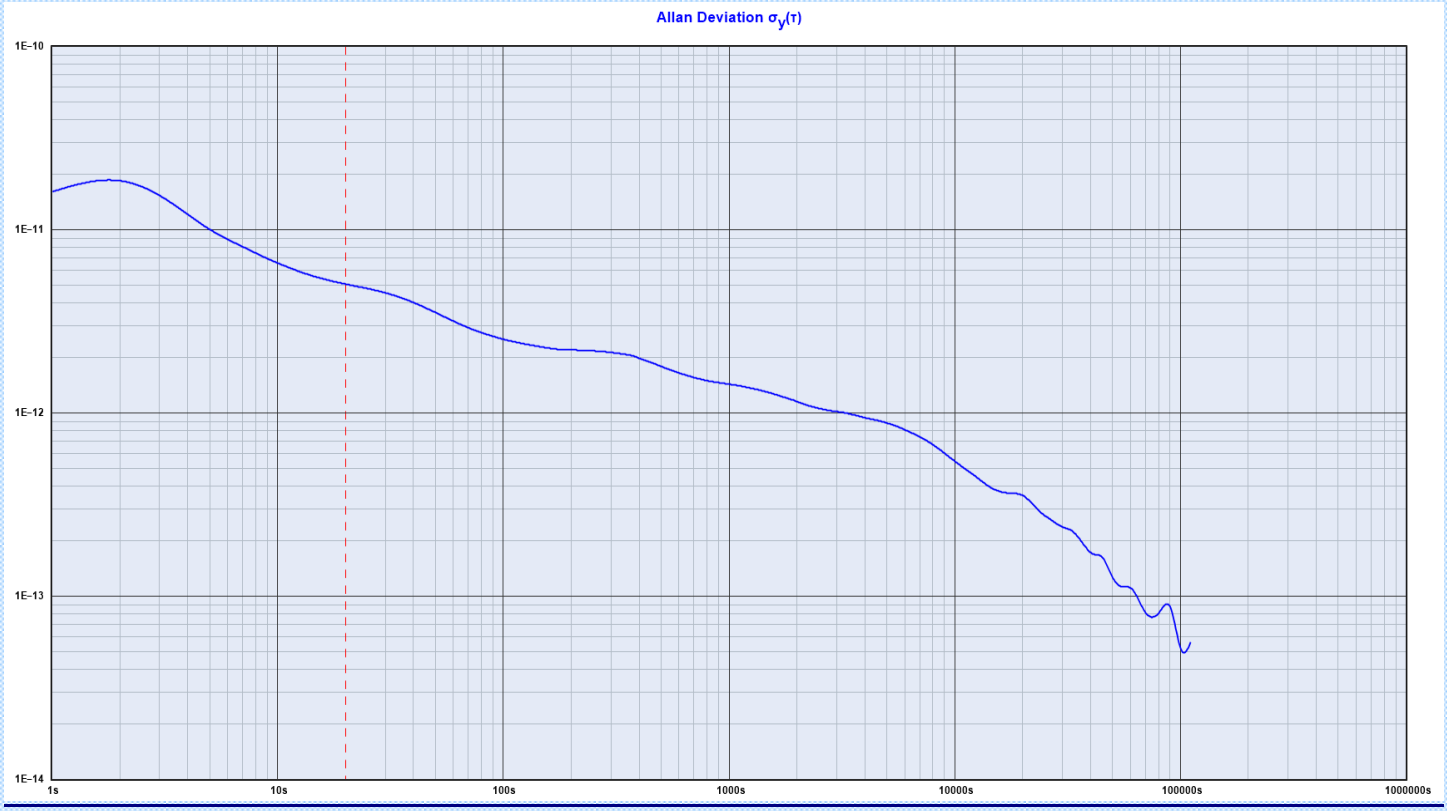
Ultra Low Phase Noise

The GPS10RBN has very low phase noise. Phase noise is typically -95 dBc/Hz at a 1 Hz offset with a -162 dBc/Hz noise floor. Low phase noise is a very important parameter. A typical plot of the phase noise is shown below. This phase noise can even be improved further with the ultra low phase noise option (option 26).



Allen Deviation

Below is a plot of the Allen deviation. Typical Allen deviation is < 2 x 10^{-11} at 1 second dropping to less than 1 x 10^{-13} at 1 day. Even lower Allen Deviations are available. Contact Precision Test for details.



Accurate Timing Outputs

There are two 1 pps (pulse per second) outputs that are derived from the GPS receiver or the rubidium oscillator. The leading edge of the GPS 1 pps signal is aligned to UTC time ± 20 ns. The Rb 1 pps output signal has very low jitter of < 300 ps. These outputs can drive TTL levels into 50 Ω.

Keyboard Control and LCD Display

A 16-way keyboard is used to interface to three microprocessors that control the GPS10RBN. The LCD display's over 50 different menus. These menus show all the relevant information including time, position (longitude, latitude, height), number of satellite tracked, health of each satellite and the status of the rubidium oscillator.

Multiple Frequency Outputs

The GPS10RBN has many different output options. These outputs are:

Buffered 10 MHz sinewave outputs. Each output is fully isolated from each other. The amplitude of each output can be individually adjusted from 0 dBm to +13 dBm. Reverse isolation of each output is 130 dB and channel to channel isolation is typically 90 dB. Five outputs as standard. Up to 20 outputs can be optionally installed. Optional output level to +20 dBm is available. By connecting more distribution amplifiers, up to 1000 outputs can be realized, all delivering a low phase noise output.

- Optional square wave output that can drive TTL levels into a 50 Ω load impedance. The frequency of the square wave can be set to 10, 5, 2, 1, 0.1 MHz and 1 pps via the front panel keyboard.
- Dual one pulse per second outputs aligned to UTC, as mentioned above.
- Optional high frequency outputs can be specified at the time of ordering. These fixed high frequency outputs can be as high at 10 GHz (higher frequencies available upon special request) and are phase locked to the main frequency reference. Note: this option only generates one fixed frequency.
- Optional DDS Output enables the GPS10RBN to produce a sinewave and squarewave output that is locked to the GPS10RBN. The frequency range of this output is 1 µHz to 80 MHz (1 µHz steps).
- 10µHz to 1640 MHz (10 µHz steps). This option can be used to generate the popular 2048 kHz and 13 MHz frequencies as well as any frequency in the range 1 µHz to 80 MHz or 10 µHz to 1640 MHz.
- Optional Time Code Output. This option generates the industry standard IRIG-B, IRIG-E, SMPTE, NTP etc. Also a 48 bit BCD time code can be generated with option 16.

Free Run Mode. Ideal for portable applications

The GPS10RBN is normally operated with the Rubidium oscillator's 10 MHz output, locked to the GPS satellite system. In the event of a failure of the GPS signal for any reason, the GPS10RBN will automatically switch over to free run mode. In this mode, the GPS10RBN's Rubidium Oscillator still achieves Stratum 1 performance over a 72 hour period.

Also the GPS10RBN can be used for portable applications where a satellite signal is not available, or the time required to lock the GPS10RBN is not available. When the GPS10RBN is powered up it can be set to the free run mode. The Rubidium Oscillator "remembers" the last known good frequency setting and adjusts itself to this frequency. Thus an accurate 10 MHz is available within a few minutes of switch on. This mode is ideal for setting up GSM base stations that require an accurate time base for frequency measurement.

RS232 and Optional Interfaces

The RS232 interface allows complete control and interrogation of the GPS10RBN. Optional USB or Ethernet adapters allows the GPS10RBN to be controlled via the USB port of the PC or from a network.

GPS10RBN Rear panel

Options

The GPS10RBN has many options enabling it to work in varied applications. Not all options can be installed at the same time. Some options require a separate case. Some of the options are listed below:

Option 01 and 02: Second Frequency Output, 0 to 500 MHz spot frequency and 500 to 1 GHz spot frequency

This option gives a second frequency output. The frequency is fixed and cannot be changed. The spot frequency must be advised by the customer prior to manufacture. The frequency can be in the range 0 to 1 GHz. Some examples are shown below:

01A	500 MHz Square x 1	01E	10.24 MHz Sine x 5	01J	5 MHz Sine x 5	01N	5 MHz Sine ULN
01B	100 MHz Sine x 1	01F	8.0 MHz Sine x 5	01K	1 MHz Sine x 5	01P	75 MHz Sine ULN
01C	10.23 MHz Sine x5	01G	100 MHz Sine ULN	01L	100 kHz Sine x 5	01R	13 MHz Sine ULN
01D	10.24 MHz Sine x 1	01H	16 MHz Sine ULN	01M	5 MHz x 5 LN	01U	50 MHz Sine x 5

Option 02Aand option 02B. : Second Variable Frequency Output, 780 to 820 MHz or 800 to 1200 MHz.

This option gives a second frequency output. The frequency is variable and can be changed from 780 MHz to 820 MHz or 800 - 1200 MHz in 100 kHz steps. The frequency output has good phase noise and low spurious.

Option 03: Second Frequency Output, 1 GHz to 3.2 GHz spot frequency

This option gives a second frequency output. The frequency is fixed and cannot be changed. The spot frequency must be advised by the customer prior to manufacture. The frequency can be in the range 1 GHz to 3.2 GHz.

Option 03A: Second Variable Frequency Output, 2.25 GHz to 2.65 GHz

This option gives a second frequency output. The frequency is variable and can be changed from 2.25 GHz to 2.65 GHz in 100 kHz steps. The frequency output has good phase noise and low spurious.

Option 04 and Option 35: Antenna Amplifier /Fiber Optic Link

These options can be used to extend the range between the GPS antenna and the GPS10RBN. Up to 300 m (1000 feet) can be realized with a cable and amplifier, up to 1 km (3200 feet) with a fiber optic GPS link.

Option 05, 05A and 05B: DDS Signal Generator

Option 05 adds a DDS (direct digital synthesis) signal output to the GPS10RBN. The DDS output has a squarewave and sinewave output. The frequency of this output is adjustable from 1 µHz to 80 MHz in steps of 1 µHz.

Option 06: RS232 Cable

The RS232 cable connects the GPS10RBN to a PC enabling control and interrogation of the GPS10RBN.

Option 07, 07A and 07B: Alarm Relay/TTL Output
This option adds an alarm output. Option 07 and 07A add a dual changeover relay that is activated in the event of an alarm. Each relay contact is rated at 30 VDC and 1 Amp (5A for Option 07A). Option 07B is a TTL output signal only.

Option 08: Redundancy
Option 08 adds redundancy. With this option, two GPS10RBN's can be configured into a redundancy set-up with five main 10 MHz outputs (up to 20 outputs optionally available). Normally one unit will supply the 10 MHz outputs (locked to the GPS satellite). In the event of failure of this unit, the 10 MHz outputs will be automatically switched to the second GPS10RBN unit. The second GPS10RBN unit will then supply the 10 MHz outputs, locked to the GPS system.

Option 09: IRIG-B Output
This option gives the industry standard IRIG-B or IRIG-E time code output. The output can be internally set to give an AM modulated signal or TTL output.

Option 11: Clock / Date Display Unit
Option 11 provides a remote Clock / Date display. The display consists of a 6 digit 25 mm high digital LED display that can be read from a distance of 10 meters.

Option 12: Additional sinewave outputs
The GPS10RBN has five isolated 10 MHz sinewave outputs. Option 12 adds a further outputs up to 20 in total.

Option 12A: 10.23 MHz Outputs
This option changes the five sinewave outputs to 10.23 MHz. A rear panel input connector allows the DDS option (option 05) to generate 10.230 MHz and be available on these five isolated outputs.

Option 13: Mute Sinewave Outputs in the event of an alarm
This option disables all the sinewave outputs in the event of an alarm or error.

Option 14: Service manual. The service manual has service information and realignment procedures.

Option 15: Windows Software

This windows software operates on Windows 2000/XP/Vista. It allows all the main parameters of the GPS10RBN to be monitored and recorded by the PC.

Option 16: BCD Time Code Output
This option gives a 48 bit BCD time code output. The time output is in the format HH:MM:SS.sssssss. The fractional seconds have a resolution of 100 ns. The output is updated every 100 ns and is accurate to UTC to within 200 ns.

Option 18: Ethernet Port
This option adds an Ethernet port. This allows the GPS10RBN to be controlled and monitored via an Ethernet network or internet.

Option 19: +24VDC Input or Option 19B: +12 VDC input
This option allows the GPS10RBN to be externally powered by a +12 or +24 VDC supply. In the event of AC power being lost, the GPS10RBN will instantly switch over to the external DC supply.

Option 20: 2.048 MHz G703:10 output
This option gives the popular 2.048 MHz output. The output is a squarewave with amplitude of ± 1.2 V in 75 Ω

Option 21: Lightening Protection
This option adds lightening protection to the antenna input. The protection is placed close to the GPS antenna.

Option 22: 0 to 1640 MHz DDS Output
This option adds a DDS output. The output can be set anywhere from 0 to 1640 MHz in 10 µHz steps.

Option 23: GSM Interface
This option enables the GPS10RBN to send a SMS (short message service) or text to ten GSM mobile phones in the event of an error.

Option 24: Frequency Change to 5 MHz (also requires option 12 additional 5 outputs to be installed)
This option changes all sinewave outputs to 5 MHz instead of 10 MHz. A 10 MHz output is still available.

Option 25: USB Adapter. Allows GPS10RBN to be controlled from a USB port of a PC.

Option 26: Ultra Low Phase Noise: Phase noise is -113 dBc/Hz at 1 Hz with a -170 dBc/Hz noise floor.

Option 28: Control of GPS10RBN over the internet: Ideal for remote monitoring of the GPS10RBN.

Option 30, 30A, 30B: Squarewave and Pulse Outputs
Opt 30: Squarewave Output. Gives a TTL output switchable in frequency to 10, 5, 2, 1, 0.1 MHz and 1 pps.
Opt 30A: 5 x squarewave outputs at 1 MHz (other frequencies available)
Opt 30B: Pulse Output. 5 x pulse outputs, each can be individually set to 1 PPS, 10 PPS, 100 PPS, 1k PPS or 10k PPS

Option 32: Slave Output.
Adds a slave 10 MHz output. This can be used to connect further distribution amplifiers to the GPS10RBN.

Option 33: Carrying Case. A plastic carrying case with foam insert is used to carry and protect the GPS10RBN

Option 34: High Power Outputs. The 10 MHz output levels are increased to a maximum of +20 dBm.

Option 35: Fiber Optic Link for Antenna: Allows GPS Antenna to be located up to 1 km away from GPS10RBN.

Option 36: Fiber Optic 10 MHz Output
This option adds a fiber optic output together with a fiber optic receiver. This allows the 10 MHz output to be routed over very long distances using fiber optic cable.

Option 37: Guaranteed Phase Noise Specifications: Phase noise plots of every output included.

Option 38: NTP Server: NTP Server Output via the Ethernet.

Option 39: 2nd RS232 Port: A second RS232 port to be used with various options, freeing up original interface.

Option 40A and 40 B External Locking Inputs: Allows GPS10RBN to be locked to external 10 MHz or 1 pps signals

Option 42: Different Connectors: The standard BNC connectors can be replaced with TNC, SMA or other types

Applications

Applications of the GPS10RBN include, but are not limited to, the following examples:

- Reference frequency source in a calibration or standards laboratory
- Portable frequency standard
- Calibration of GSM Base Station Clocks
- Reference Frequency and Time source for the electricity generating industry
- Synchronizing of telecommunication and computer networks
- Space Measurements.

High Quality of Construction

The GPS10RBN is made to the highest standards. A purpose built aluminum 19” rack mount case houses all the circuits inside the GPS10RBN. The GPS10RBN is CE marked for sale within the EEC.

Active Antenna Supplied as Standard

The GPS10RBN is supplied with an active antenna. This small unit can be easily fitted to buildings, roofs etc.

GPS10RBN Specifications

Description	Specification	Remarks
10 MHz Outputs		
Connector	Rear panel BNC socket	
Frequency	10 MHz	
Accuracy	Refer to Allan Deviation section	
Signal Type / Amplitude	Sine wave @ 0 dBm to + 13 dBm	Internally adjustable
Harmonic Distortion / Spurious	-30 dBc / - 120 dBc (> 0.5 MHz)	
Return Loss	> 23 dB @ 10 MHz	
Reverse / Channel to Channel Isolation	> 130 dB / 90 dB	
Squarewave Output (Option 30 required)		
Frequency	10, 5, 2, 1, 0.1 MHz and 1 pps	
Accuracy	Refer to Allan Deviation section	Selectable by keyboard
Amplitude (open circuit / 50 ohm)	0 to 5 V / 2.7 V , TTL Compatible	
1 PPS Outputs		
Connector	Rear panel BNC socket	
Frequency	1 pulse per second	
Amplitude (open circuit)	0 to 5 V, TTL Compatible	
Amplitude (50 ohm)	0 to > 2.5 V, TTL Compatible	
Accuracy to UTC time (GPS 1 pps output)	< 20 ns (6 sigma)	
Jitter of Rubidium Osc. 1 pps output	< 300 ps	After cable delays taken into account
Slave Output (Option 32 required)		
Connector	Rear panel BNC socket	
Frequency	10 MHz	
Accuracy	Refer to Allan Deviation section	
Signal Type	Sine wave	
Amplitude	> 3 dBm	Fixed level output
Harmonic Distortion	- 20 dBc	Typically -40 dBc
Phase Noise Response (Typical). 10 MHz Outputs		
At 1 Hz Offset	-90 dBc/Hz	Lower phase noise optionally available with < -110 dBc @ 1 Hz with a -166 dBc/Hz noise floor.
At 10 Hz Offset	-135 dBc/Hz	
At 100 Hz Offset	-152 dBc/Hz	
At 1 kHz Offset	-157 dBc/Hz	
At 10 kHz Offset	-162 dBc/Hz-	
At 100 kHz Offset	-162 dBc/Hz	
Allan Deviation when locked to GPS Satellites (Typical)		
Observation Time 1 / 10 seconds	$<2.5 \times 10^{-11}$ / $< 1 \times 10^{-11}$	GPS10RBN in full lock for > 1 week. > 3 satellites in view. Ambient temperature change less than 3 °C
Observation Time 100 / 1000 seconds	$< 3 \times 10^{-12}$ / $< 1.5 \times 10^{-12}$	
Observation Time 10k / 100k seconds	$< 6 \times 10^{-13}$ / $< 1 \times 10^{-13}$	
Observation Time 1 week	$< 1 \times 10^{-13}$ /	
Rubidium Drift when GPS10RBN NOT Locked to GPS Satellites		
Drift due to aging	$< 5 \times 10^{-11}$ per month	After 30 days operation
Drift due to temperature	$< 5 \times 10^{-11}$	0 °C to +50 °C
GPS Receiver		
Number of Channels / Frequency	12 parallel / 1575.42 MHz	Simultaneous operation / L1 Frequency
Acquisition Time / Positioning Accuracy	< 50 s typical / < 25 m	With current position / time data. No SA
Jamming Immunity	-79 dBm @ 1575.42 MHz	Measured at active antenna input
Antenna	Active micro strip patch	Powered by GPS10RBN

Miscellaneous		
Operating Temperature	0 °C to +50 °C	
Storage Temperature	-20 °C to +60°C	
Magnetic Field	< 2 x $10E^{-10}$ for 1 Gauss field reverse	
AC Power Inlet with switch	IEC320 power cord	Rear Panel
AC Voltage Range	100 - 240 VAC (usable 90-260 VAC)	Automatic switchover
Power consumption	50 watts typical operating, 100W warm-up	Warm up period is < 10 minutes at +20 °C
Fuse rating	3.15A, 250 VAC slow blow type	
Dimensions Width x Depth	482.6 mm x 323 mm	
Height and weight	88 mm and 7 kg	
Supplied Accessories		
Antenna	Active type, 5V @ 20 mA	
Power cord	IEC320 type	
Instruction manual		
Option 05: DDS Generator Output		
Overall Frequency Range / Step Size	1 µHz to 80 MHz in 1 µHz steps	Usable to 90 MHz
Frequency Accuracy	± 300 µHz plus main 10 MHz error	Subject to jitter specification
Sinewave Frequency Range	10 kHz to 80 MHz	
Sinewave Output level	> 0 dBm into 50 Ω	
Spurious and Harmonic Output	-40 dBc and -20 dBc respectively	Option > +10 dBm available (opt 05A)
Squarewave Frequency Range	1 µHz to 80 MHz	
Squarewave Output Level	0V to 3V nominal into open circuit	Use 50 ohm termination above 1 MHz
Allan deviation (100 second)	2.5 x 10^{-12}	> 0 dBm into 50 Ω (10 kHz – 80 MHz)
Output 09: IRIG Time Code Output		
Output types	IRIG-B or IRIG-E or ESE TC-90	Internally selectable
Mark – Space Ratio (IRIG-B)	3.3 to 1	
Output type (IRIG-B) / Impedance	TTL or AM. 2.7 V p-p / 600 Ω	Internally selectable
All other options		
Consult Precision Test Systems for further details of other options. Not all options can be fitted at the same time.		

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Specifications and features subject to change without notice (101221)