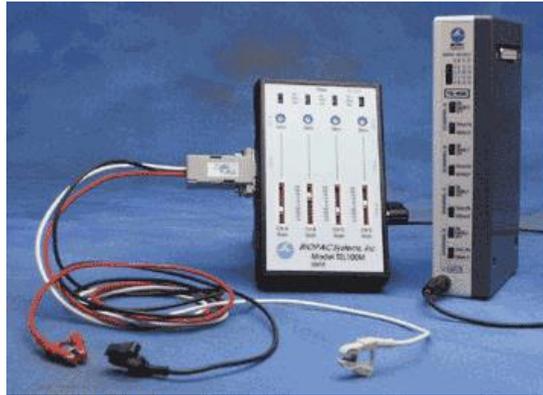


TEL100C REMOTE MONITORING SYSTEM



The TEL100C is a remote monitoring system designed for use with an existing MP System. In addition, the TEL100C System can be used with existing BIOPAC amplifiers (e.g., ECG100C, RSP100C) and/or other TEL100C Systems. Up to four TEL100C Systems can be connected to a single MP System, and a single TEL100C System can be used with as many as 15 existing amplifiers or direct analog inputs.

Each TEL100C System consists of four major components (as shown above):

- transmitter with 4 channel inputs (TEL100M-C)
- receiver (TEL100D-C)
- cable to connect transmitter to receiver (CBL117)
- up to four *Simple Sensor* electrode/transducer assemblies (which must be purchased separately).

The TEL100C is intended for biophysical ambulatory measurements (ECG, EMG, joint angle, acceleration, respiration, finger twitch, heel/toe strike, PPG, EDA/GSR, temperature, etc.). The system is **not** designed for high-accuracy, precision measurements (force, pressure, strain, etc.). Any slowly moving signal that must be measured to high accuracy and precision should be recorded with the respective amplifier module (typically DA100C or SKT100C).

TEL100D-C

The TEL100D-C is a four-channel receiver module that is compatible with all other MP160/150 modules. The TEL100D-C includes filtering and channel select controls.

- Select the **bank** (A, B, C and D) to assign channels to. Make sure no other 100C series amplifiers are assigned to those same channels.
- If certain channels in a particular bank are already being used (and can't be moved), then turn the telemetry channel off, via the **Enable ON/OFF** switch on the front panel of the TEL100D-C.

Up to four TEL100D-C units can be connected to a single MP160/150, allowing for up to 16 channels of transmitted data originating from up to four separate TEL100M-C units. For every TEL100M-C, a TEL100D-C must be available to receive its data signals.

TEL100M-C

Each TEL100M-C is a miniature four-channel remote amplifier/transmitter that connects directly to the TEL100D-C via a lightweight coaxial transmission cable. The TEL100M-C does the work of four 100C series amplifiers and includes filtering, offset and gain control for each of its four channels.

All BIOPAC SS series transducers and electrodes will function directly with the TEL100M-C. Excitation voltages are available on each channel input to provide power for *Simple Sensor* transducer assemblies (such as RSP, GSR, PPG and SKT).

The TEL100M-C requires one 9 V alkaline battery for operation. A low battery indicator light will flash when the battery requires replacing. Expected battery life is approximately 12 hours of continuous operation.

The TEL100C module set is a modulation/demodulation system.

- The modulation process occurs in the TEL100M-C.
- The demodulation process occurs in the TEL100D-C.

The TEL100M-C amplifies and filters the four input channels. After amplification the channel signals are time division multiplexed (TDM) into a single transmission channel and are sent through the CBL117 (coaxial cable) to the TEL100D-C. The TDM process intrinsically samples the four input channels at a rate of 2000 Hz / per channel. This sampling process occurs in the TEL100M-C module and is independent of the MP System.

Prior to the TDM process, the four input channels are low-pass filtered to 500 Hz. The TDM process always samples at 2000 Hz for each channel and each channel's maximum bandwidth is 500 Hz. Accordingly, the sampling process does not affect the user or the rate at which the MP160/150 samples data. The TEL100M-C transmits an analog signal.

The TEL100D-C demodulates the transmission from the TEL100M-C and incorporates user-selectable 35 Hz LPN or 500 Hz LP **filters** for removing noise and/or 50/60 Hz interference from any of the four input channels. Filters (35 Hz LPN or 500 Hz LP) can be independently assigned **on** or **off** for each channel.

- Use of the 35 Hz LPN filter automatically engages the notch filter (50 Hz or 60 Hz).
- Use of the 500 Hz LP filter disables the notch filter.

The TEL100D-C produces a ± 10 volt range analog output for each channel, and then these analog outputs are sampled by the MP160/150.

- Analog outputs are also available via the front panel of the UIM100C to direct the outputs to an alternate recording system in conjunction with the MP System.

The TEL100C module set has an upper frequency limit of 500 Hz for each channel. The TEL100C is not recommended for physiological measurements requiring higher frequency measurements (e.g. certain evoked response applications). However, a wide range of physiological activity can be monitored with the TEL100C, including ECG, EOG, EEG, GSR, SKT, PPG, RSP and surface EMG.

- Specialized signal processing of physiologic variables (like RMS filtered EMG, or QRS detection) are performed on the computer via calculation channels.

Up to four TEL100C module sets can be connected to a single MP System, providing a maximum of 16 transmitted channels. The TEL100C module set behaves the same as four alternate 100 series modules.

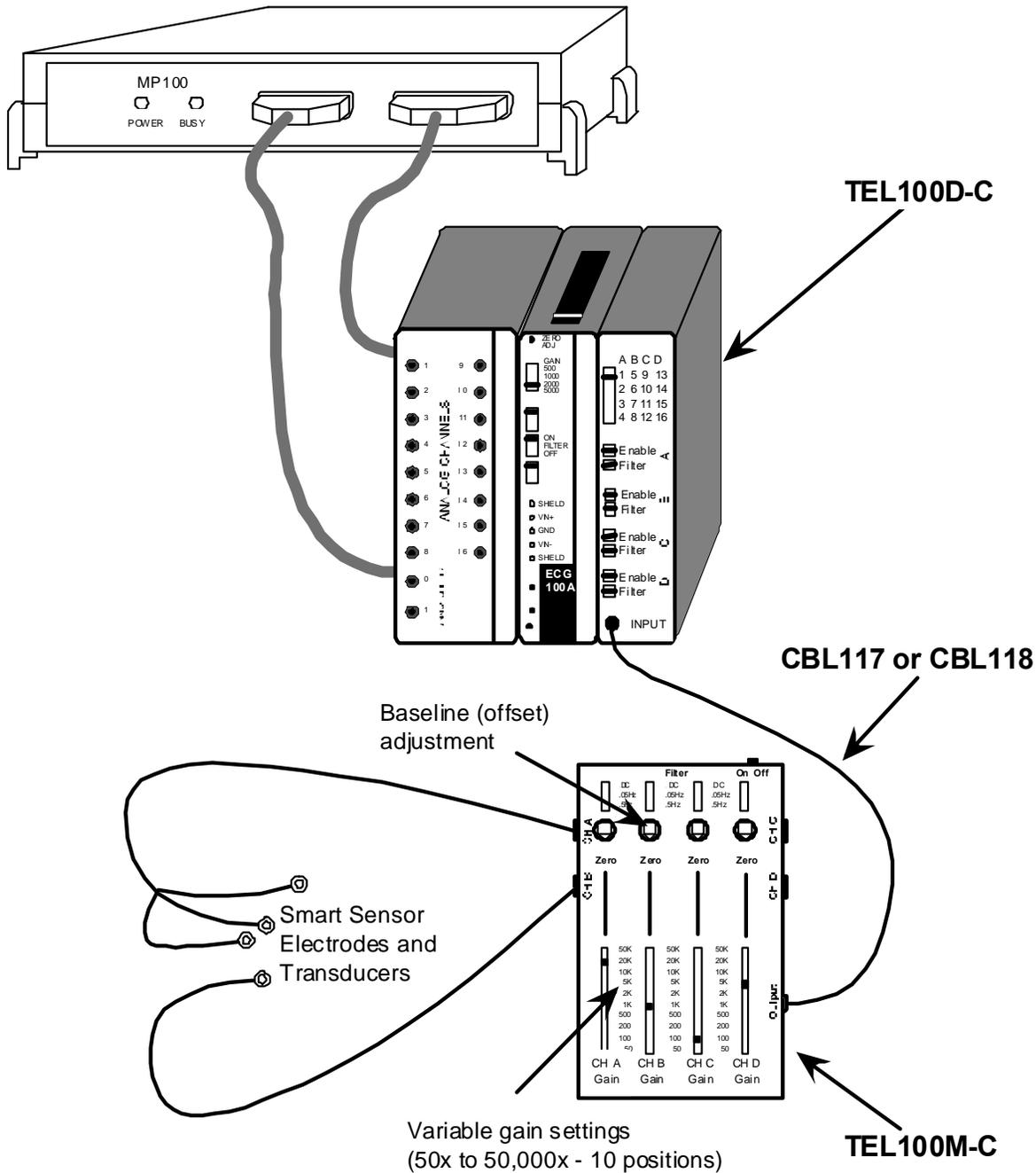
The 2000 Hz sampling rate of the TEL100C module set is independent of the MP System sampling rate.

- If a TEL100C channel is low-pass filtered at 35 Hz LPN, it would be appropriate for the MP System to sample that channel at 100 Hz or greater.

The TEL100C module set can be used independently from the MP System and, instead, with a different data acquisition system. The recommended configuration requires the IPS100C in addition to the TEL100C. Up to four TEL100C units can be used with a single IPS100C. The TEL100C channel outputs are then accessed via the front panel of the IPS100C using CBL102 3.5 mm phone plug to BNC male cables.

For studies that employ surface electrodes (e.g., ECG, EMG), gain settings from 500 to 5000 are typically appropriate. Similar settings are also appropriate for measurements with the RSP and PPG Simple Sensors. Moreover, non-electrode measurements (temperature, pulse, respiration and so forth) are typically performed with the **hipass** switch on the TEL100M-C set to DC (or 0.05 Hz to remove baseline drift), and the **filter** switch on the TEL100D-C in the ON position.

No special software is required to use the TEL100C module set. The TEL100C operates on the same *AcqKnowledge* software platform as the MP160/150. The TEL100C module set behaves equivalently to any four 100 series modules. All the surface electrode measurements (ECG, EEG, EMG and EOG) terminate in an SS2 Simple Sensor shielded electrode lead assembly. See the section on Simple Sensors for information about the termination of other physiological variables.



TEL100C—MP System setup

- CBL117** This 10-meter cable connects the TEL100D-C receiver to the TEL100M-C transmitter and is included in the TEL100C remote monitoring module set. The lightweight coaxial cable minimizes hindrance caused by multiple heavy cables. For increased operating distance, use CBL118.
- CBL118** This 60-meter cable connects the TEL100D-C receiver to the TEL100M-C transmitter and is designed as an extension option for the TEL100C remote monitoring module set. The lightweight coaxial cable minimizes hindrance caused by multiple heavy cables.

TEL100C CALIBRATION

To begin using the TEL100C system:

1. Plug the TEL100D-C into the side of the UIM100C
2. Select a bank to assign the channels to (A, B, C and D). Make sure no other 100C series amplifiers are assigned to those same channels. If certain channels in a particular bank are already being used (and cannot be moved), then turn the telemetry channel off, via the "Enable" switch on the front panel of the TEL100D-C.
3. Plug the CBL117 into the TEL100M-C and the TEL100D-C.
4. When recording in *AcqKnowledge*, turn on the TEL100M-C, by flipping the power switch from right to left. The LED on the TEL100M-C should blink once then stay off. If the LED continues to blink, the 9 V battery needs to be replaced (use 9 Volt alkaline batteries).
5. If bank 1 is selected on the TEL100D-C, then TEL100 Channels A, B, C and D will be assigned to MP160/150 channels 1, 5, 9 and 13 respectively. When using *AcqKnowledge*, select these channels when viewing data assigned to bank 1. The following documentation assumes that bank 1 is the selected bank.
6. To determine correct operation, rotate the zero balance for channel A on the TEL100M-C. Channel 1 in *AcqKnowledge* should indicate a moving baseline that changes as the zero is adjusted. Set the zero balance for channels A, B, C and D, so that the *AcqKnowledge* screen trace is centered. Plug the desired Simple Sensor into the TEL100M-C.

For EDA/GSR measurements, the following **Gain** settings correspond to $\mu\text{mhos per Volt}$. Similarly, for temperature measurements, the **Gain** settings listed correspond to $^{\circ}\text{F per Volt}$. Using the **scaling** or **rescaling** features in *AcqKnowledge*, these settings can be used to calibrate the signal.

The equipment calibrations for TEL100C and EDA (GSR) are:

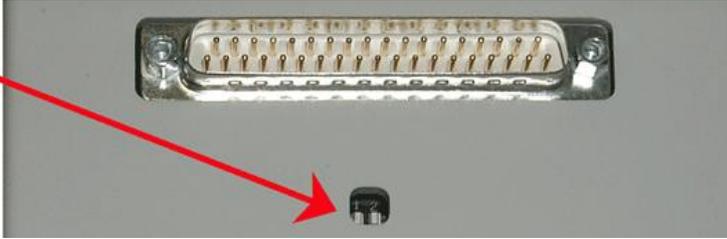
10 micro-mhos = 1 mV, so for a gain of 1000, this translates to 10 micro-mhos per 1 volt.
 A gain of 5000 on TEL100M would put the translation as 2 micro-mhos for 1 volt output.

Gain	EDA/GSR (SS3A) $\mu\text{mhos/V}$	SKT (SS6) $^{\circ}\text{F/V}$
50	200	100
100	100	50
200	50	25
500	20	10
1,000	10	5
2,000	5	2.5
5,000	2	1
10,000	1	0.5
20,000	.5	0.25
50,000	.2	0.1

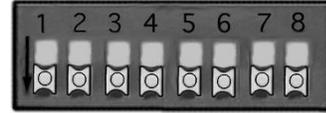
As with the SKT100C amplifier, temperature data collected with the TEL100C is centered around 90°F assuming the SKT100C is set to "DC". Supposing data was acquired using a gain setting of 500, a reading of 0 Volts would correspond to 90°F , whereas a signal of +2 Volts (read on the MP160/150) would correlate to a temperature of 110°F . These values could then be used to rescale the incoming signal from raw voltages to degrees Fahrenheit.

Modules can be set for 50 Hz or 60 Hz notch options to match the wall-power line frequency of the destination country. The proper setting reduces noise from interfering signals when the notch filter is engaged. Generally, wall-power line frequency is 60 Hz in the United States and 50 Hz in most of Europe; if necessary contact BIOPAC to determine the correct line frequency. To reset the line frequency setting, adjust the bank of switches on the left panel of the amplifier module.

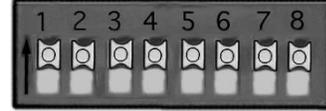
Line Frequency Switch bank is on the left panel of biopotential and transducer amplifiers



(The TEL100 has an 8-switch bank vs. 2-switch bank shown)



50 Hz =
All 8
switches
DOWN



60 Hz =
All 8
switches
UP

TEL100C SYSTEM SPECIFICATIONS

Number of Channels:	4
Sampling Rate:	2000 Hz (per channel) [Transparent to user]
Frequency response	(independent bandwidth settings per channel)
Low Pass Filters:	35 Hz LPN, 500 Hz LP
High Pass Filters:	DC, 0.05 Hz and 0.5 Hz
Channel Gain Control:	x50, x100, x200, x500, x1000, x2000, x5000, x10000, x20000, x50000
Output Range:	±9 V (analog)
Offset Control:	Yes
Input Signal Level:	Max: ±50 mV
Input Impedance:	2 MΩ (differential)
CMRR (1 kΩ source imbalance):	110 dB min (50/60 Hz); see Shield Drive Operation
CMII:	11 MΩ (DC), >1000 MΩ (50/60 Hz)
CMIV:	±7 V (referenced to amplifier ground) ±1500 VDC (referenced to mains ground)
Noise Voltage:	0.1µV rms (0.05-30 Hz)
Transducer Excitation:	±5 V (10 V pk) @ 20 ma (total max current from four channels)
Signal/Crosstalk Ratio:	(0.05-500 Hz) 65 dB min
Signal/Noise Ratio:	(0.05-30 Hz) 75 dB min, (0.05-500 Hz) 65dB min
Encoding:	TDM-DSB/LC
Signal transmission range:	≤ 60 meters via coaxial cable
TEL100M Power Source:	9 V alkaline battery (24 hrs nominal)
Dimensions	<u>Size</u> <u>Weight</u>
TEL100D-C:	4 cm x 11 cm x 19 cm 400 g
TEL100M-C:	9 cm x 15 cm x 3.3 cm 308 g
Pin-outs TEL100M-C:	Female DSUB 9 connector pin 1: Shield Drive pin 2: Vin+ pin 3: Ground pin 4: Vin- pin 5: Shield Drive pin 6: Vref+ (+5 V excitation at 5 mA nominal) pin 7: no connection pin 8: no connection pin 9: Vref- (-5 V excitation at 5 mA nominal)

NOTE: TEL100C-RF is discontinued. Contact BIOPAC for info/options.

SIMPLE SENSOR (SS) ELECTRODES AND TRANSDUCERS FOR THE TEL100C

Simple Sensor (SS) electrodes and transducers are explicitly designed to connect to the **TEL100M-C** transmitter, and most come with a 1.2 meter cable. SS assemblies include specific circuitry to adapt various physiological variables to the TEL100M-C.

Any SS electrode or transducer can be plugged into any TEL100M-C input. The õsmartö configuration of each electrode and transducer assembly communicates its specific signal type. Certain transducers (such as SS26 and SS27 Accelerometers) will reduce the overall recording life of the 9 V battery, but it is generally possible to record biopotentials and other signals for up to 12 hours.



Simple Sensors take the place of BIOPAC's traditional electrodes and transducers in that they are only compatible with the TEL100M-C amplifier. All the surface electrode measurements (ECG, EEG, EGG, EMG and EOG) terminate in an SS2 (Simple Sensor shielded electrode lead assembly).

The Simple Sensor connector varies from the transducer connector, but functionality is the same. The following physiological variables terminate as shown - see the corresponding transducer section for information about each Simple Sensor.

<u>SS #</u>	<u>Description</u>	<u>Corresponding Transducer</u>
SS1A	Unshielded 1.5 mm Touchproof Electrode Adapter (10 cm)	
SS2	Shielded Electrode Lead Assembly (1 meter)	
SS3A	Electrodermal Response Transducer	see TSD203
SS4A	Pulse Plethysmogram Transducer	see TSD200
SS5B	Respiratory Effort Transducer	see TSD201
SS6	Fast Response Temperature Probe	see TSD202A
SS7	Skin Surface Temperature Probe	see TSD202B
SS10	Hand Switch	see TSD116A
SS11LA	Airflow Transducer (medium)	see TSD117
SS17	Physiological Sounds Microphone	see TSD108
SS18	Skin Surface Temperature Probe	see TSD202D
SS20	Twin-Axis Goniometer (110 mm) · requires 2 channels	see TSD130A
SS21	Twin-Axis Goniometer (180 mm) · requires 2 channels	see TSD130B
SS22	Single Axis Torsiometer (110 mm)	see TSD130C
SS23	Single Axis Torsiometer (180 mm)	see TSD130D
SS24	Finger Goniometer (35 mm)	see TSD130E
SS25	Hand Dynamometer	see TSD121C
SS26LB	Tri-Axial Accelerometer (5 G) · requires 3 channels	see TSD109C
SS27L	Tri-Axial Accelerometer (50 G) · requires 3 channels	see TSD109F
SS28A	Heel/Toe Strike Transducer	see TSD111A
SS29	Multi-lead ECG Cable · requires 3 channels	see TSD155C

SIMPLE SENSOR CALIBRATION

Refer to the corresponding transducer section.