OPTOELECTRONICS

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OPTOELECTRONICS

MODEL M1 OWNERS MANUAL

CE 95

PATENT NO. 5471402

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HANDICOUNTER® MODEL M1 FEATURES

The Optoelectronics Model M1 HandiCounter® is a full range, 10Hz to over 2.4GHz, pocket sized instrument that represents a substantial leap forward in features and capabilities. The Model M1 uses an imbedded microprocessor along with the powerful OE10 counter IC to provide advanced features such as Digital Filtering, Digital Auto Capture (auto hold), Data Storage, and Serial Data Output.

FEATURES

- Digital filter mode (pat pend) prevents display of random noise and oscillation
- Digital auto capture (pat pend) locks counter display on first reading to pass the filter.
- ARM/STORE button stores and recalls frequencies from a three register stack.
- Low Power Consumption 5 hours battery operation.
- Digital communications port permits data logging on a PC with Model CX12 RS232C converter and OptoLog software.
- 10 Digit LCD with available EL back light for optimum viewing under all lighting conditions.
- High Speed 250MHz direct count with 1Hz per second resolution.
- 10 gate times from 100 microseconds to 10 seconds with 13 milliseconds between measurements.
- High impedance and 50 ohm amplifiers for full range 10Hz to 2.4GHz coverage.
- Ultra sensitive 16 segment RF signal strength bargraph operates independently of counter.

APPLICATIONS

The Model M1 excels as a very high performance hand held instrument that can be used for general purpose frequency measurement. The Model M1 has much greater sensitivity than ordinary frequency counters especially at RF frequencies. This makes the Model M1 ideal for measuring radio signals off the air at the maximum possible distances using an optional antenna. For in circuit measurement of frequencies from oscillators or test points, the 1Meg input impedance amplifier can be used with a scope probe for direct connection.

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FEATURES CONTINUED

THE MICROPROCESSOR — OE10 ADVANTAGE

The internal microprocessor digitally filters the RF signal frequencies and reduces spurious counting. All of this is done without relying on the signal strength to exceed some arbitrary level, ensuring reliable performance in today's dense signal environments. Proprietary software monitors the incoming RF for stable coherent signals, and only when these conditions are satisfied will the count be presented to the user.

Internal memory allows the Model M1 to store the last three filtered frequencies for later examination. This feature allows totally unattended operation - the Model M1 can be turned on and will silently record the frequency of any nearby radio traffic. At any time later, the Model M1's memories can be recalled to check the results of an extended monitoring period.

DIGITAL COMMUNICATIONS PORT

The Optoelectronics' Model M1 hand held frequency counter is equipped with a TTL asynchronous serial interface which allows the units to be connected to a personal computer for the purpose of reading frequency information. The three-wire interface is accessible via a 1/8th inch stereo phone jack, and consists of Receive Data (TIP), Transmit Data (RING), and Signal Ground (SHIELD). An external RS-232C interface converter (Model CX12) is required to convert the TTL signal levels to RS-232C levels compatible with most personal computers.

An accessory RS232C converter, Model CX12, permits interfacing the Model M1 directly to the serial port of a PC. The CX12 comes with a PC compatible data logging program. Check with the factory for price and availability.

SPECIFICATIONS

Amplifier:	1Meg Ohm	50 Ohm
Impedance:	1Meg Ohm, 30 pF	50 Ohm VSWR <2:1
Range:	10Hz-50MHz	10MHz-2.4GHz (2.8GHz typ)
Sensitivity:	<10mV 10Hz - 10MHz, <20mV 10MHz - 50MHz	<5 mV @ 10MHz <300 uV @ 150MHz <3mV @ 800MHz <10mV @ 1GHz <50 mV @ 2.4GHz
Maximum Input:	100 V RMS	15dBm, 50 milliwatts

Frequency Display Resolution

Least significant digit displayed (LSD) as a function of Gate Time and Range

Range	Gate Time	LSD	Sample Display
200MHz	100 microseconds	10KHz	250.00MHz
	.001 second	1KHz	250.000MHz
	.01 second	100Hz	250.000 0MHz
	.1 second	10Hz	250.000 00MHz
	1 second	1Hz	250.000 000MHz
	10 seconds	.1Hz	250.000 000 0MHz
2.4GHz	.0064 second	10KHz	2400.00MHz
	.064 second	1KHz	2400.000MHz
	.64 second	100Hz	2400.000 0MHz
	6.4 seconds	10Hz	2400.000 00MHz

Time Between Measurements: 13 milliseconds, all Ranges and Gate Times.

Display: 10 Digit (120 segment) Liquid Crystal Display. Decimal at MHz position.

Size: 4.9" high x 2.8" wide x 1.4" Deep.

Cabinet: Extruded aluminum, black paint finish.

Power: 9VDC, 250 MA using model AC90 wall plug adapter.
5+ Hours operation from internal 4 cell NiCad Pack. 16 hour recharge from AC adapter charger. 13.8V automotive source must be reduced to <10V to prevent overcharge and overheating of the Model M1.

RF Signal Strength Bargraph

16, 3dB Segments, active when 50 OHm amplifier is selected

Frequency	1st Segment	Full Scale
27 MHz	300 microvolts	10 millivolts
150 MHz	400 microvolts	12 millivolts
450 MHz	1 millivolt	20 millivolts
850 MHz	1 millivolt	20 millivolts

Options

TCXO30: Precision +/- 2ppm 20-40°C temperature stability time base. Factory installed.

CX12: RS232 converter, permits interfacing the Model M1 directly to the serial port of a PC. The CX12 comes with the OptoLog data logging program.

CONTROLS

PWR ON/OFF This slide switch turns on power to the Model M1 HandiCounter®. The Model M1 can operate either from an internal NiCad battery pack, or from the model AC90 wall adapter/charger. When operating from the AC90 adapter/charger, the battery pack will be automatically charged when the power switch is in either the ON or OFF position. Turning on the power to the Model M1 initiates a 1.0 second test of all LCD segments.

AMP 1 M OHM/50 OHM This switch selects either the 1 Meg Ohm high impedance amplifiers, or the 50 Ohm amplifiers and prescalers. When this switch is in the 50 OHM position, the two RANGE switches labeled 200MHz and 800MHz/3GHz become active, and the INPUT A/B and FUNCTION push buttons are disabled. When the switch is in the 1 M OHM position, the INPUT A/B and FUNCTION push buttons are enabled, and the RANGE switches are disabled.

RANGE 200MHz When the 50 Ohm amplifiers are selected, the RANGE switch is active. When in the 200MHz position, frequencies between 10MHz and 250MHz can be counted. This is the direct count (not prescaled) 50 Ohm range.

RANGE 2.4GHz When the RANGE 200MHz switch is in the 2.4GHz position, a divide by 64 prescaler (divides the input frequency by a factor of 64 prior to counting) extends the range of the counter to over 2.4GHz. The counting time and resolution is adjusted as shown in the specifications.

ARM/STORE When either the CAPTURE or RECALL mode is selected, this push button is active.

GATE The GATE push button selects either the gate time or the number of averages, depending on the function currently selected. The GATE push button is disabled when the RECALL mode is selected.

DIGITAL AUTO CAPTURE™

Filter Mode Turn on the FILTER switch to reduce random counting, noise, and false signals. A unique digital filtering algorithm permits only meaningful measurements to be displayed. This makes using the Model M1 much easier and makes frequency finding much more powerful, because distant or short duration frequencies can be picked out of the background clutter. In the FILTER mode, the GATE LED blinks each time a measurement passes the filter. To make the filter even more effective at eliminating false counting, a higher level of filtering can be selected at power up by holding down the GATE push button until the display test appears. In this mode, the digital filter algorithm is more selective. Turning the Model M1 on without holding down the GATE push button selects the normal filter algorithm.

Capture Mode When the FILTER switch and CAPTURE switch are both turned on, the Model M1 is in the powerful DIGITAL AUTO CAPTURE mode. In this mode, the ARM/STORE push button switch is active. When the ARM/STORE push button is depressed, the next measurement to pass the filter will be displayed and stored in memory. While armed, the FREQUENCY annunciator flashes. When a measurement passes the filter, the FREQUENCY annunciator stops flashing, and the GATE LED blinks once. Each time the ARM/STORE push button is depressed, the next measurement to pass the filter is displayed and stored in memory. Three internal memory registers (Register X, Register A, and Register B) allow the most recent three measurements which pass the filter to be remembered and recalled.

Recall Mode RECALL mode is selected by turning off the FILTER switch and leaving the CAPTURE switch on. In this mode, the frequencies stored in the three memory registers can be displayed. When neither the A nor B display annunciator is on, Register X is being displayed. Depressing the ARM/STORE push button displays Register A. Depressing the ARM/STORE push button a second time displays Register B. Depressing the ARM/STORE push button a third time displays Register X again, and so on. Register X contains the most recent measurement; Register A contains the second most recent measurement; and Register B contains the third most recent measurement. No measurements can be made when the RECALL mode is active.

BACKLIGHT INSTRUCTIONS

Backlight ON You must hold the ARM/STORE button as you turn power on the Model M1. This must be done each time the Model M1 is turned off or loses power.

Backlight OFF The backlight is turned off by turning off the power of the Model M1

ABO *Automatic Backlight OFF*
The Model M1 features an *Automatic Backlight OFF* feature that allows for extended battery life while the Backlight is on. This feature will turn off the backlight ten (10) seconds after the last function change has been made. The backlight will only come on with a function change.

Standard Mode Filter and Capture feature are turned off.
The Model M1 features an *Automatic Backlight OFF* feature that allows for extended battery life while the Backlight is on. This feature will turn off the backlight ten (10) seconds after the last function change has been made. The backlight will only come on with a function change.

Filter Mode Filter function is on and Capture is turned off
The *ABO* feature will turn off the backlight ten (10) seconds after the last function change has been made, or any frequency activity.

Capture Mode Filter function is on and Capture is turned on
The *ABO* feature will turn off the back light ten (10) seconds after the capture feature has been armed. The backlight will only come on when a function change, rearming capture mode, or a frequency has been captured.

Captured Frequencies Viewing Mode Filter function is off and Capture is turned on
The *ABO* feature will turn off the backlight ten (10) seconds after the changing of the memory locations. The backlight will only come on with a function change.

NOTE: When the backlight inverter is powered on there may be a low level audible tone.

DATA INTERFACE

GENERAL

The Model M1 HandiCounter® is equipped with a TTL asynchronous serial interface which allows the unit to be connected to a personal computer for the purpose of reading frequency information. The three-wire interface is accessible via a miniature stereo phone jack, and consists of Receive Data (TIP), Transmit Data (RING), and Signal Ground (SHIELD). An external RS-232C Interface Converter (Model CX12) is required to convert the TTL signal levels to RS-232C levels compatible with most personal computers.

ELECTRICAL SPECIFICATIONS

The following electrical parameters are specified relative to Signal Ground (SHIELD).

Receive Data (TIP)
LOGIC "0": 0 - 0.7 Vdc (50 uA max. load current)
LOGIC "1": 2.0 - 5.0 VDC (50 uA max. load current)
Transmit Data (RING)
LOGIC "0": 0 - 0.45 Vdc (1.6 mA max. sink current)
LOGIC "1": 2.4 - 5.0 VDC (60 uA max. source current)

COMMUNICATIONS PARAMETERS

The following communications parameters are used for both Receive Data (TIP) and Transmit Data (RING).

Data Rate: 4800 bps (+/- 2%) Start Bits: 1
Data Bits: 8 Parity: NONE
Stop Bits: 1

DATA PROTOCOL SPECIFICATIONS

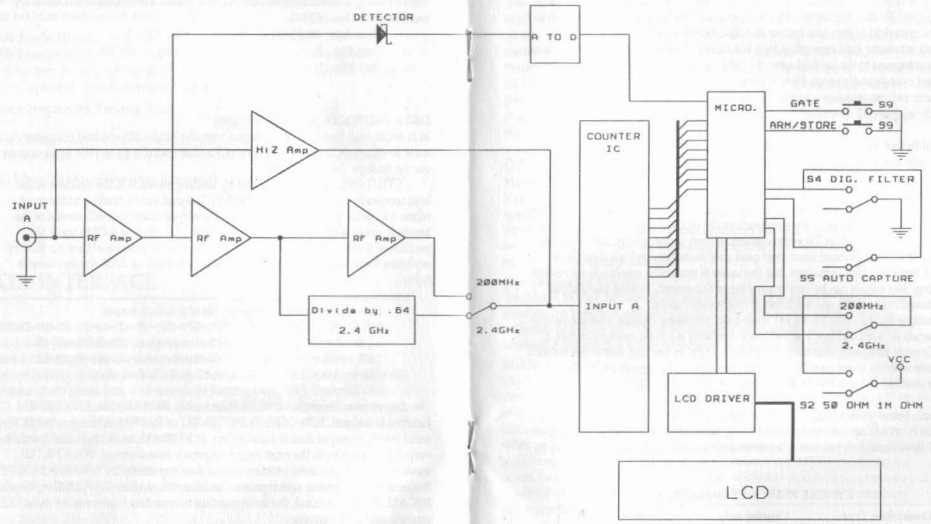
In order to read frequency information from the Model M1, the host computer must send an ASCII Carriage Return <CR> character (ODH, or 13D) to the counter via the Receive Data (TIP) signal.

The counter will then respond by sending eleven ASCII characters to the host computer via the Transmit Data (RING) signal, corresponding to the most recent successful counter measurement. The eleven characters will consist of the ten-digit count, plus an ASCII Period <.> character (2EH, or 46D) to mark the position of the decimal point. Leading zeroes of the counter resuH are blanked by replacing them with ASCII Space <SP, characters (20H, or 32D). *See the examples below.*

Gate time	Measured frequency	Serial interface output
0.01 S	52.500 MHz	<SP><SP><SP><5><2><.><5><0><0><0>
0.1 S	146.750 MHz	<SP><1><4><6><.><7><5><0><0><0>
1.0 S	908.32595 MHz	<9><0><8><.><3><2><5><9><5><0>
10.0 S	444.975 MHz	<4,<4,<4,<.,<9,<7,<5,<0,<0,<0,<0,

The data received from the serial interface is only valid when the FREQUENCY function is selected. If the PERIOD, INTERVAL, or RATIO function is selected, the serial interface output data is meaningless. In NORMAL mode, the serial interface output data represents the most recent frequency measurement. When FILTER mode is selected, the serial interface output data represents the most recent frequency measurement which passed the filter. When either CAPTURE mode or RECALL mode is selected, the serial interface output data represents the most recently captured frequency.

BLOCK DIAGRAM



USING THE COUNTER

HandiCounters® are unique in their ability to find RF transmission frequencies quickly. Immediate response to frequencies that are 10 to 16 dB greater than the background RF floor is possible. This is simply done by moving the HandiCounter® into the near field of the radio transmitter. The near field is the area close to the antenna where the field strength is high but falling off rapidly as distance increases. This is compared to the far field were the field strength is low but remains fairly constant over great distances. HandiCounters® work well at relatively close distances and can measure a transmission frequency rapidly without having to tune through the RF spectrum.

Several factors may prevent a stable frequency counter reading even when there is a bargraph response. Among these are:

- The signal is simply too small. While the Model M1 is very sensitive it can not work with extremely weak signals.
- Amplitude modulation (AM). Since the counter is measuring the zero crossings of the signal, it is sensitive to the amplitude of the received signal. Amplitude modulated signals such as TV video carriers, aircraft radios, garage door openers, etc. can be difficult to count since their peak amplitude may be high enough to cause a large bargraph indication, but the valley is too low in amplitude for reliable counting. AM signals can be very frustrating in this regard, looking like a signal that should easily count and yet never giving a stable count.
- Multiple signals - The Model M1 wide-band frequency counter may not be able to separate adjacent carriers. The FM broadcast band is a good example of this, a 20MHz wide band with channels on 200kHz centers. In any city, numerous stations will exist within a given area. It is possible that none of the signals are 10-15dB higher than the rest and this makes accurate counting difficult.

The table below gives actual test data showing the distances that various transmitters can be picked up with and without using the Model M1, in a typical metropolitan RF environment. If you live in a particularly quiet location your results may be better.

TYPICAL RF PICK UP DISTANCES

Transmitter Type	Counter only	Counter/APS104
Cordless Phone	1 foot	120 feet
CB Radio	25 feet	500 feet
VHF Two Way Radio	80 feet	1/4 mile

ANTENNA SELECTION

The ultimate performance of the counter will be compromised if the best possible antenna is not used. If only a single type of antenna is available, it should be of the telescoping whip UHF/VHF type. For maximum pick up distances, the antenna used should be tuned for the frequency band of interest. For example, with cellular frequencies, a cellular type of antenna with male BNC connector is essential for best results. The model RD800 rubber duck or model GP800 ground plane antenna will give good results. The GP800 is more expensive but will give the maximum possible performance (pick up distance). Check the Optoelectronics Catalog for available antenna packages.

OPERATIONAL CHARACTERISTICS

Multiple Transmissions

If two transmitters are operating at the same time within the pass band and they appear to have the same signal strength, then the bargraph will display a strong signal indication but the counter display will not stabilize. To compensate you must move physically closer to the transmitter of interest until the counter sees its signal as 10 to 15 dB greater in strength.

Over driving the Counter

The Model M1 can be over driven in the presence of a strong RF signal. In this situation the bargraph will also display a strong signal indication. It may be necessary to reduce signal level by moving away from the source or removing/shortening the antenna before the counter begins to count properly.

Multipath cancellation

The distance at which the signal can be detected may be much greater than the distance at which it can be counted. At 850MHz the wave length is about 35 cm and multipath cancellations can repeat at very close intervals. As you decrease the distance the problem goes away. If you are in a vehicle, best results can be obtained when you come to a complete stop and the transmitter also stops motion, providing a stable signal without multipath dropouts. Always operate the counter on the fastest measurement interval possible. Use the display hold switch as necessary. It is helpful to know the available frequencies in the area to assist in determining when you have an accurate reading.

USE WITH APS104

All broadband counters are subject to two fundamental limitations in their sensitivity. The first is the noise of the electrons moving though the circuitry of the counter input circuitry. For a typical 3GHz bandwidth front end, this results in input noise floor of about -70dBm. Since any desired signal to be counted must exceed this level by 10-15dB so the counter can reliably count zero crossings, the limiting sensitivity is -44 to -60dBm. This figure is approached by Optoelectronics' counters when operated in a laboratory environment, but there is another, more limiting factor when attempting to count radiated signals using an antenna.

Unless you find yourself on a deserted Pacific island, the signal you intend to measure is not the only one reaching the counter. Once an antenna is attached to the counter, every RF signal besides the one of interest becomes a source of interference and the second sensitivity limitation. The level of these incidental signals can be quite large, in fact, and usually is the limiting factor in frequency counter low level performance. Local AM, FM and TV transmitters broadcast with hundreds of kilowatts and yield an RF background that obscures all measurements. Again, since the desired signal must exceed all others by 10-15 dB, this difference in level can only be achieved by getting the counter much closer to the desired source than to the interference.

The most effective way to increase range is to use the Optoelectronics' Active Preselector. This unit addresses both of the limitations described above by implementing a narrow bandpass filter tunable over an extremely wide frequency range. When inserted in the signal path between the antenna and counter, this has two effects:

- The narrow 4MHz bandwidth passband removes most interfering signals, allowing only signals at the center tuned frequency to pass through to the counter. The apparent increase in sensitivity can be 40dB or more depending on the level of the interfering signal.
- Since the bandwidth of the measurement system is reduced, the 3GHz bandwidth noise floor limitation is also reduced. Gain in the Active Preselector correspondingly boosts signal level to take full advantage of the bandwidth reduction.

The 4MHz bandwidth of the filter was carefully chosen as the best compromise between sensitivity improvement and frequency agility. As covered above, the reduction in bandwidth eliminates interfering signals and broadband electrical noise. Therefore, narrowing the bandwidth generally results in greater sensitivity (this concept, carried to an extreme, is what makes typical communications receivers very sensitive - with bandwidths of 15kHz or so). Unfortunately, if this narrowing is carried too far, the signal can be extremely difficult to find unless you already know what frequency it is. This of course defeats the purpose of using the frequency counter altogether. The 4MHz bandwidth of the APS104 represents a good balance of sensitivity improvement and ease of use.

RECHARGEABLE BATTERY OPERATION

The counter can operate several hours from fully charged internal NiCad batteries when the "PWR" switch is in the "BATT" or "ON" position. The batteries are charged when the unit is powered by the AC-Charger/Adapter and the "PWR" switch is in the "AC-CHG" position. Full recharge will occur in 12 to 16 hours. The battery packs will also charge at a reduced charge rate while the counter is being operated from the AC- Charger/Adapter. If the optional NiCad 30 battery pack is installed the recharge time will be the same as both battery packs are charged in parallel. The counter may be operated over prolonged periods by AC Adapter operation with no harm to batteries as the charge current is regulated. The batteries should be deep cycled occasionally by allowing them to completely discharge and fully charge several times to maintain maximum battery capacity.

CAUTION

The NiCad batteries should last several years, however, it is recommended that the counter be checked inside after the first year of operation for any sign of battery leakage or corrosion. Replace all batteries if any visible damage is observed.

To inspect the NiCad battery packs it is necessary to open the cabinet. This is accomplished by removing two machine screws from each end of the cabinet and removing the top cover. Take care not to pinch any of the battery wires. Excessive currents could flow damaging the batteries.

CAUTION

110V AC and External DC Operation

A 110V AC, 60Hz TO 9V DC, 300-500mA, Center-Positive, AC-Charger/Adapter is specified for use and is supplied with the counter. This is a nominal specification and the adapter supplied with the counter will match the counter's requirement exactly. When using external power supplies make sure that the voltage under load does not exceed 12 VDC. When operating from an automotive electrical system, some means of reducing the voltage to the counter must be employed. Automotive voltages in excess of 13.8VDC are common and may damage the NiCad batteries. If the counter becomes excessively hot to the touch then remove it from the power supply immediately.

CALIBRATION

A calibration adjustment opening in the instrument top cover is labeled "CAL". This opening permits access to the trimmer capacitor which provides about a 10 parts per million adjustment range of the time base oscillator. Use the slow Gate Time for maximum resolution and read a stable signal of known frequency adjusting the trimmer for correct frequency display. Calibrate at 10 MHz or higher. The higher the calibration frequency, the more accurately the instrument can be calibrated.

If this adjustment is ever unable to bring the oscillator into calibration then there is a second adjustment inside referred to as C2. The C2 adjustment is a coarse adjust trimmer and can be used to bring the fine adjust trimmer (C1) into range. Remove the instrument top cover to access C2.

Accuracy:

Frequency mode: = ± Time Base Inaccuracy ± 1 count

Period mode: = ± Time Base Inaccuracy ± 1 count ±trigger error.

Trigger Error: is < .3% per period for sine waves of 40 dB signal to noise ratio and amplitude equal to sensitivity of counter. For any waveshape, trigger error is less than ± .0025 microseconds divided by the signal slope in volts per microsecond for signal to noise ratio of 40 dB.

FACTORY CALIBRATION SERVICE

OPTOELECTRONICS' Service Department provides a calibration service at the factory. Counters may be shipped for this service using the Factory Service & Return Policy explained on the last page of this manual. The current charge is $40.00 ($35.00 + $5.00 Return Shipping). This price is subject to change without notice. Consult factory for current pricing at time this service is requested. *OPTOELECTRONICS* will provide a Certificate of Calibration at time of calibration service, upon request.

PRODUCT WARRANTY

OPTOELECTRONICS, INC. warrants all products and accessories for one (1) year against defects in materials and workmanship to the original purchaser. Products returned for warranty service will be repaired or replaced at *OPTOELECTRONICS'* option.

Specifically excluded are any products returned under this warranty that, upon examination, have been modified, had unauthorized repairs attempted, have suffered damage to the input circuitry from the application of an excessive input signal, have suffered damage to the charging circuitry or internal batteries from application of excessive voltage or show other evidence of misuse or abuse. *OPTOELECTRONICS* reserves sole right to make this determination.

No other warranties are expressed or implied, including but not limited to, the implied warranties of merchantability and fitness for a particular purpose. ***OPTOELECTRONICS, INC.*** is not liable for consequential damages.

FACTORY SERVICE & RETURN POLICY

FACTORY SERVICE

Warranty: Products under warranty must be returned, transportation prepaid, to *OPTOELECTRONICS'* Ft. Lauderdale Service Center. All parts replaced and labor performed under warranty is at no charge to the customer.

Non-Warranty: Products not under warranty must be returned, transportation prepaid, to *OPTOELECTRONICS'* Fort Lauderdale Service Center. Factory service will be performed on a time and materials basis at the service rate in effect at the time of repair. A repair estimate prior to commencement of service may be requested. Return shipping will be added to the service invoice and is to be paid by customer.

RETURN POLICY

The *OPTOELECTRONICS* Service Department will provide rapid turnaround of your repair. No return authorization is required. Do not cause delays. Enclose complete information as follows:

1. Copy of sales receipt if under warranty.
2. Detailed description of problem(s).
3. Complete return address and phone number (UPS Street address for USA)
4. Proper packaging (insurance recommended). Note: Carriers will not pay for damage if items are improperly packaged.
5. Proper remittance including return shipping, if applicable (VISA, MasterCard number with expiration date, Money Order, Company P.O., etc.)

Address all items to:

OPTOELECTRONICS, INC.
SERVICE DEPARTMENT
5821 N.E. 14TH AVENUE
FT. LAUDERDALE, FL 33334

If in question, contact the factory for assistance:
Service Department (954) 771-2050.