TLM-2 TOWER LIGHT MONITOR

INSTALLATION and OPERATING INSTRUCTIONS

SYSTEM OVERVIEW

The TLM-2 Tower Light Monitor is a microprocessor-based system designed to monitor the status of incandescent and LED tower lighting systems. Alarm outputs include single bulb failure, LED fixture failure, flasher failure or out-of-tolerance condition and photocell failure. Status outputs are provided for beacon on/off and tower lights on/off. All outputs are opto-isolated for lightning protection when connected to external remote site monitoring equipment.

The monitor is designed to be installed at the electrical circuit breaker panel even if the flasher and/or photocell is located on or near the tower and is fed by a single 120- or 240-volt circuit. The current feeding the tower circuit is sampled by a current transformer located at the circuit breaker and is fed to the monitor circuit board where it is processed. With all lights operating on the tower, the monitor automatically calibrates.

SPECIFICATIONS

Lighting type:	FAA Style A incandescent or LED obstruction lighting standard using type L-864 beacons and type L-810 obstruction (marker) lights Note: All LED beacons must be the same type and wattage and all LED markers must be of the same type and wattage. Note: Beacon levels must flash together (not compatible with alternating or sequenced flashing)
Capacity:	Up to eight 620-watt bulbs (four beacons) or six 700-watt beacon bulbs (three beacons) and eight 116-watt marker bulbs; up to nine LED beacons and sixteen LED markers (120-volt operating voltage)
Sample method:	Current transformer; microprocessor controlled monitoring
Timing accuracy:	Referenced to 60 Hz line frequency (not compatible with 50 Hz)
Alarm outputs:	Photocell failure Flasher failure (alarms for continuous on or off, duty cycle tolerance and flash rate tolerance) Bulb failure or LED fixture failure (separate alarm outputs for beacon and marker failures)
Status outputs:	Tower lights on/off and beacon lights on/off (Alarm and status outputs are opto-isolated and are rated at 20 mA and 30 V maximum)
Power Requirement:	9 - 12 volts AC/DC at 100 mA (120-volt wall adapter included)
Size:	6" L x 3.2" H x 2" D clear plastic enclosure

INSTALLATION

Important! Installation requires access to the tower light circuit breaker and potentially lethal voltages. A qualified electrician should be employed to make any changes to the electrical system. All applicable electrical codes must be followed.

Locate the circuit breaker for the tower lights and turn it off. For 120-volt systems, remove the wire from the breaker and pass it through the current transformer hole (direction is not important). For 240-volt systems, remove the wires from the breaker and pass them through the current transformer *in the opposite direction*. Do not pass the neutral or ground wire through the current transformer. Reconnect the wire(s) to the circuit breaker (do not reset the circuit breaker at this time).

Mount the monitor enclosure near the circuit breaker panel and connect the current transformer to the monitor using the cable supplied ("CT OUT" terminals on the current transformer to the "CT IN" terminals on the monitor board - polarity is not important). After the current transformer and monitor are connected, the tower light circuit breaker can be reset. Tower lights should not be operated without the current transformer connected to the monitor.

Connect the wires from the AC adapter to the "AC/DC IN" terminal on the monitor board (polarity is not important). Plug the AC adapter into a 120 VAC receptacle.

Note! It is recommended that a 120 VAC receptacle be wired to the tower light circuit to supply the monitor. This method will cause the monitor to alarm the remote monitor system if the breaker should trip during daylight when the tower lights are normally off. If the monitor is supplied from a separate circuit, a daytime trip of the tower light circuit breaker will not cause an alarm until the photocell timer has expired (up to 20 hours).

Connect the remote monitoring system to the tower light monitor. As long as power is applied, the monitor provides a continuous closure between the "COMMON" terminal and each of the alarm terminals ("PHOTOCELL, FLASHER, BEACON, MARKER and ALARM") under a no-alarm condition. An alarm condition causes an open circuit on that alarm terminal (active high). If dipswitch no. 4 is set to "ON", the "PHOTOCELL, FLASHER, BEACON and MARKER" alarms are changed to active low. This mode allows these alarms to be paralleled with other units where multiple towers are monitored (such as directional arrays) to save on status inputs on the remote monitoring equipment. If this mode is used, the "ALARM" output from each unit should be wired to the remote monitoring system as a failsafe and to indicate which tower is causing the specific alarm. The "LIGHTS STATUS" and "BEACON STATUS" terminals provide a closure when the tower lights and beacons are on, respectively. These outputs act like dry contacts - the remote monitoring equipment must provide pull-up resistance if necessary. Note: polarity is important if the unit is fitted with the four-channel open-collector opto-isolators – the alarm terminals must be positive with respect to the "COMMON" terminal. If the unit is fitted with the two-channel FET opto-isolators, polarity is not important. A remote alarm reset can be accomplished by providing a closure from the remote monitoring system to the "GROUND" and "RESET" terminals (opto-isolated).

OPERATING DIPSWITCH SETTINGS

Note! Switch to the right is "ON", top switch is No. 1.

Switch No. 1: If there is a marker light used in the Antenna Tuning Unit (AM stations) for humidity control that is on continuously (located before the tower flasher/photocell unit in the circuit), then set this switch to "ON". This setting will cause the monitor to ignore this bulb and give correct a correct tower lights on/off status. This bulb must be a 116-watt marker lamp.

Note! ATU bulb cannot be used on LED lighting systems and switch no. 1 has no effect if unit is set up for LED mode.

Switch No. 2: If this switch is set to "OFF", the photocell timer is set to 20 hours. If the monitor does not detect the tower lights status change during this time span, a "PHOTOCELL" alarm will occur.

If this switch is set to "ON", the photocell timer is inhibited. Use this setting if tower lights are always operating (photocell not used).

Switch No. 3: If this switch is set to "OFF", the "PHOTOCELL, FLASHER, BEACON or MARKER" alarms will be cleared after the alarm condition is corrected (the "ALARM" output must be cleared by pressing the reset button).

If this switch is set to "ON", the "PHOTOCELL, FLASHER, BEACON or MARKER" alarms can be cleared by pressing the reset button twice; however, these alarms will reoccur if the alarm condition persists. Use this setting for holding the alarms until manually reset.

Switch No. 4: If this switch is set to "OFF", the "PHOTOCELL, FLASHER, BEACON and MARKER" alarms are active high; if the switch is set to "ON" these alarms are active low. Using active low alarms allows for paralleling of multiple units to save on status requirements of the remote monitoring system when used with directional arrays.

Note! Using the active low alarm mode compromises the failsafe feature of the unit unless the "ALARM" output is also used (this output is always active high).

INITIAL SETUP OPTION DIPSWITCH SETTINGS

Use this procedure to setup the TLM-2 to match the type of lighting (incandescent or LED) on the tower and to combine the beacon alarm with the flasher alarm to save a status input on the site monitoring equipment.

Unplug the power supply. Set the dipswitches as described below:

Note! Switch to the right is "ON", top switch is No. 1.

Switch No. 1: To combine the beacon and flasher alarms to a single BEACON alarm, set this switch to "ON". In this mode a beacon lamp failure will cause a BEACON alarm and a flasher failure will cause both a BEACON and FLASHER alarm. This mode is provided to eliminate a status input if necessary. For independent FLASHER and BEACON alarms, set this switch to "OFF" (default).

Switch No. 2: For towers with incandescent lighting, set this switch to "OFF" (default). For towers with LED lighting, set this switch to "ON".

While pressing the "CAL" button, power up the unit. The "RUN" light will flash at a 1 Hz rate confirming the unit is in the setup mode. Now release the "CAL" button; this will set up the unit for the desired operating mode(s). Next, power-cycle the unit; the "RUN" light will return to the 10 Hz flash rate indicating normal operation. These modes will be used until another initial setup is performed and they are retained if the unit loses power or is calibrated. Return the dipswitches to the previous settings used for normal operation. The unit is now ready for calibration.

CALIBRATION

To see how this procedure operates, press the "CAL" button.

In this mode, the "RESET" button is used to enter the number of incandescent bulbs or LED fixtures on the tower. Pressing this button will cause the lights on the TLM-2 to sequence from zero bulbs or LED fixtures (no lights lit) to the maximum number of lights permitted for the type of lighting. For more than eight LED fixtures, the lights will flash indicating a number between nine and sixteen. Additional presses will cause the lights to rotate through the permitted number of bulbs or LED fixtures. Press the "RESET" button repeatedly to cycle through the light sequence to familiarize yourself with this procedure. When finished, power-cycle the unit to return to normal operation and proceed with the calibration.

Incandescent lighting (switch no. 2 "OFF" in setup mode) (default):

All tower lights should be on and flashing normally before calibrating the monitor. When this is confirmed, press the "CAL" button. The lights on the TLM-2 now indicate the currently configured number of incandescent beacon bulbs (two for each beacon). This number can range from no lights lit to all lights lit on the TLM-2. To change this number, press the "RESET" button repeatedly to select the number of lights lit on the TLM-2 that match the total number of incandescent beacon bulbs on the tower. If the tower has no flashing beacons (markers only), select no lights lit. Press the "CAL" button again. The lights on the TLM-2 now indicate the currently configured number of incandescent marker bulbs on the tower. This number can range from no lights lit to all lights lit on the TLM-2. To change this number, press the "RESET" button repeatedly to select the number of lights lit on the TLM-2 that match the total number of incandescent marker bulbs on the tower. If the tower has no markers (flashing beacons only), select no lights lit. Press the "CAL" button again. The TLM-2 will now go into the survey and calibrate mode as indicated by the lights sequencing. This mode may take up to a minute after which time the unit will return to normal operation. Any changes to the number of bulbs on the tower will require a calibration.

LED lighting (switch no. 2 "ON" in setup mode):

All tower lights should be on and flashing normally before calibrating the monitor. When this is confirmed, press the "CAL" button. The lights on the TLM-2 now indicate the currently configured number of LED beacon fixtures. This number can range from no lights lit to all lights lit either steady or flashing on the TLM-2. To change this number, press the "RESET" button repeatedly to select the number of lights lit on the TLM-2 that match the total number of LED beacon fixtures on the tower. If the tower has no flashing beacons (markers only), select no lights lit. The maximum number of LED beacon fixtures that can be entered is nine as indicated by the "RUN" light flashing with no other lights lit. Press the "CAL" button again. The lights on the TLM-2 now indicate the currently configured number of LED marker fixtures on the tower. This number can range from no lights lit to all lights lit either steady or flashing on the TLM-2. To change this number, press the "RESET" button repeatedly to select the number of lights lit on the TLM-2 that match the total number of LED marker fixtures on the tower. If the tower has no markers (flashing beacons only), select no lights lit. The maximum number of LED marker fixtures that can be entered is sixteen as indicated by all lights flashing. Press the "CAL" button again. The TLM-2 will now go into the survey and calibrate mode as indicated by the lights sequencing. This mode may take up to a minute after which time the unit will return to normal operation. Any changes to the number of LED fixtures on the tower will require a calibration.

Note! The "RUN" light normally flashes at a 10 Hz rate to indicate the microprocessor is operating.

Note! It is important that the correct number of incandescent bulbs or LED fixtures on the tower matches the number of each type (beacon or marker) entered into the unit during the calibration procedure. An incorrect number may result in false alarms or no alarms if a failure occurs.

OPERATION

Daytime: All lights on the monitor should be on except for the "L/S" and B/S" (Lights status and Beacon status).

Nighttime: All lights on the monitor should be on and the "B/S" (Beacon status) light should be flashing in cadence with the beacon lights.

Note! If dipswitch no. 4 is set to "ON", the "PHOTOCELL, FLASHER, BEACON and MARKER" lights should be off

Note! It may take up to thirty seconds for the "BEACON and MARKER" alarms and up to four minutes for the "FLASHER" alarm to be activated after an alarm condition has occurred. After an alarm condition is corrected, it may take a few minutes for the alarm to be cleared (the "ALARM" output can only be cleared by the reset button).

ALARM and STATUS CONDITIONS

ALARMS:

PHOTOCELL: Monitor has not detected a change in the "lights status" condition in 20 hours (dipswitch no. 2 setting "OFF").

FLASHER: There are three types of flasher failures that will cause a flasher alarm: flasher continuously on or off, flasher rate out of tolerance and flasher on/off ratio out of tolerance. When a flasher alarm occurs, the "RUN" light will flash in the following manner to indicate which failure type caused the alarm:

One repeating flash: flasher continuously on or off
Two repeating flashes: flasher rate out of tolerance
(less than 20 or more than 40 flashes per minute)

Three repeating flashes: flasher on/off ratio out of tolerance
(less than 36 or more than 69 percent ON period of the total ON and OFF period)

Simultaneous failure types are indicated by a sequence of each type of flash. When the alarm is cleared, the "RUN" light will return to the normal 10 Hz flash rate.

This alarm can be cleared by pressing the reset button twice; however, it will reoccur if flasher problem is not corrected.

BEACON (BCN): Activates on a bulb failure, LED beacon failure or flasher continuously off.

Note! For marker-only operation, the beacon and flasher alarms are disabled. The "BCN" light is always off in the mode.

MARKER (MKR): Activates on a bulb failure or LED fixture failure.

Note! For beacon-only operation, the marker alarm is disabled. The "MKR" light is always off in the mode.

ALARM (ALM): Activates with any of the above alarms. This alarm can be cleared by pressing the reset button once. If this alarm is reset after a bulb failure, a second bulb failure will cause another alarm. If the alarm is reset again, the alarm will reoccur if the problem is not corrected.

STATUS:

LIGHTS (L/S): Indicates if tower lights are on or off. Flashes with beacons if all marker lights are out.

BEACON (BCN): Indicates if beacons are on or off (flashes with beacons).

MULTIPLE ALARM and STATUS CONDITIONS:

Certain tower light system failures will cause an alarm and an abnormal status condition.

Here are some examples:

A flasher failure in the OFF state will result in Flasher and Beacon alarms in addition to the Beacon status light remaining off.

A flasher failure in the ON state will result in Flasher alarm in addition to the Beacon status light remaining on.

If all marker lights are out, the Lights status will flash along with the Beacon status (a marker alarm will result also).

If all alarm and status lights are off, the monitor has lost power.

RESET and CALIBRATE BUTTONS

RESET: The first press will reset the "ALARM" output, the second press will reset the "PHOTOCELL, FLASHER, BEACON and MARKER" alarm outputs. Pressing the reset button for five seconds will start the current sample readout sequence described below.

Note! If dipswitch 3 is "ON", RESET must be pressed twice to clear the "PHOTOCELL, FLASHER, BEACON and MARKER" alarm outputs.

CAL: Pressing this button performs a monitor calibration. Any changes to the number of bulbs or LED fixtures in the system requires a calibration. It is also recommended that a calibrations be performed after a tower re-lamping or LED fixture replacement.

RETRIEVING STORED AND REAL-TIME CURRENT SAMPLES

When the TLM-2 is calibrated, it stores a current sample for the markers and a sample for the beacons. These samples are compared to the real-time samples taken after calibration to determine if there is a lamp failure. Each sample consists of a four-digit number that is scaled to the current for that sample (it is not the actual amperes). There are four samples: stored marker current, stored beacon current, real-time marker current and real-time beacon current. Both the stored calibration samples and the real-time samples can be retrieved by the following procedure (tower lights must be operating):

Press and hold the RESET button for five seconds. The unit will sequence through each sample and display it in 8-4-2-1 BCD format using the MKR, BCN, FLS and P/C lights in that order. The RUN, B/S, L/S and ALM lights will cycle for each number in the sample. Here is a sample sequence showing a BCD count from zero to nine:

	MKR	BCN	FLS	P/C		VALUE
RUN on	off	off	off	off	1st stored marker sample digit = 0	
B/S on	off	off	off	on	2nd stored marker sample digit = 1	0123
L/S on	off	off	on	off	3rd stored marker sample digit = 2	
ALM on	off	off	on	on	4th stored marker sample digit = 3	
RUN on	off	on	off	off	1st stored beacon sample digit = 4	
B/S on	off	on	off	on	2nd stored beacon sample digit = 5	4567
L/S on	off	on	on	off	3rd stored beacon sample digit = 6	
ALM on	off	on	on	on	4th stored beacon sample digit = 7	
RUN on	on	off	off	off	1st real-time marker sample digit = 8	
B/S on	on	off	off	on	2nd real-time marker sample digit = 9	8901
L/S on	off	off	off	off	3rd real-time marker sample digit = 0	
ALM on	off	off	off	on	4th real-time marker sample digit = 1	
RUN on	off	off	on	off	1st real-time beacon sample digit = 2	
B/S on	off	off	on	on	2nd real-time beacon sample digit = 3	2345
L/S on	off	on	off	off	3rd real-time beacon sample digit = 4	
ALM on	off	on	off	on	4th real-time beacon sample digit = 5	

After the sequence is complete, the unit returns to normal operation. The real-time samples will vary slightly with voltage fluctuations but should remain close to the stored samples that were taken during calibration. These samples are for reference only and are used for troubleshooting purposes. It is a good idea to log a set of these samples initially for comparison in case of problems later on.

CHECKING QUALITY of the CURRENT SAMPLE

The TLM-2 provides a way to check the amount of noise present on the current sample present on the input to the unit. To activate this mode power down the unit and press both the "CAL" and "RESET" buttons while powering up the unit. The "P/C", "FLS", "BCN" and "MKR" lights are now a signal-to-noise (S/N) indicator. If all lights are on, the S/N is good if the "P/C" light is off, the S/N is lower and so on. The "BCN" light indicates the S/N present when the beacons are on (light on) and for the markers (light off). Lower S/N readings indicate a higher deviation from the bulb constants that were stored during calibration and may be caused excessive RF on the sample. The unit should operate reliably with only the "MKR" light on; however any rearrangement or shielding of the wiring that results in the most lights on will improve reliability.

After two minutes, the TLM-2 will revert to normal operation.

FCC and FAA Requirements:

The FCC requires notice to the FAA of any beacon bulb failure, flasher failure (beacons continuously on), or dark tower within thirty minutes of discovery of the problem. The FAA will request the tower registration number and issue a NOTAM (Notice to Airmen) of the tower problem. The FAA will give the tower owner 15 days to correct the problem; however, the problem should be corrected as soon as possible and the FAA contacted when the tower is returned to compliance so the NOTAM can canceled. Failure to follow this procedure can result in hefty fines from the FCC.

FCC rules regarding tower lighting can be found at www.fcc.gov .

See FAA Advisory Circular AC 70/7460-1K "Obstruction Marking and Lighting" for lighting standards (specifically Red Obstruction Lighting Standards - FAA Style A).

See FAA Advisory Circular AC 150/5345-43F "Specifications for Obstruction Lighting Equipment" for flash characteristics (specifically Table 4 - Flash Characteristics for Obstruction Lights, Type L-864).

Warranty and Service:

FM Services warrants this product to be free of defects for one year after purchase. If you experience a problem or have a question about installation or operation, please call (336) 667-7091 or email at info@towermonitor.com

FCC Part 15 and Industry Canada ICES-003 Verification Notice

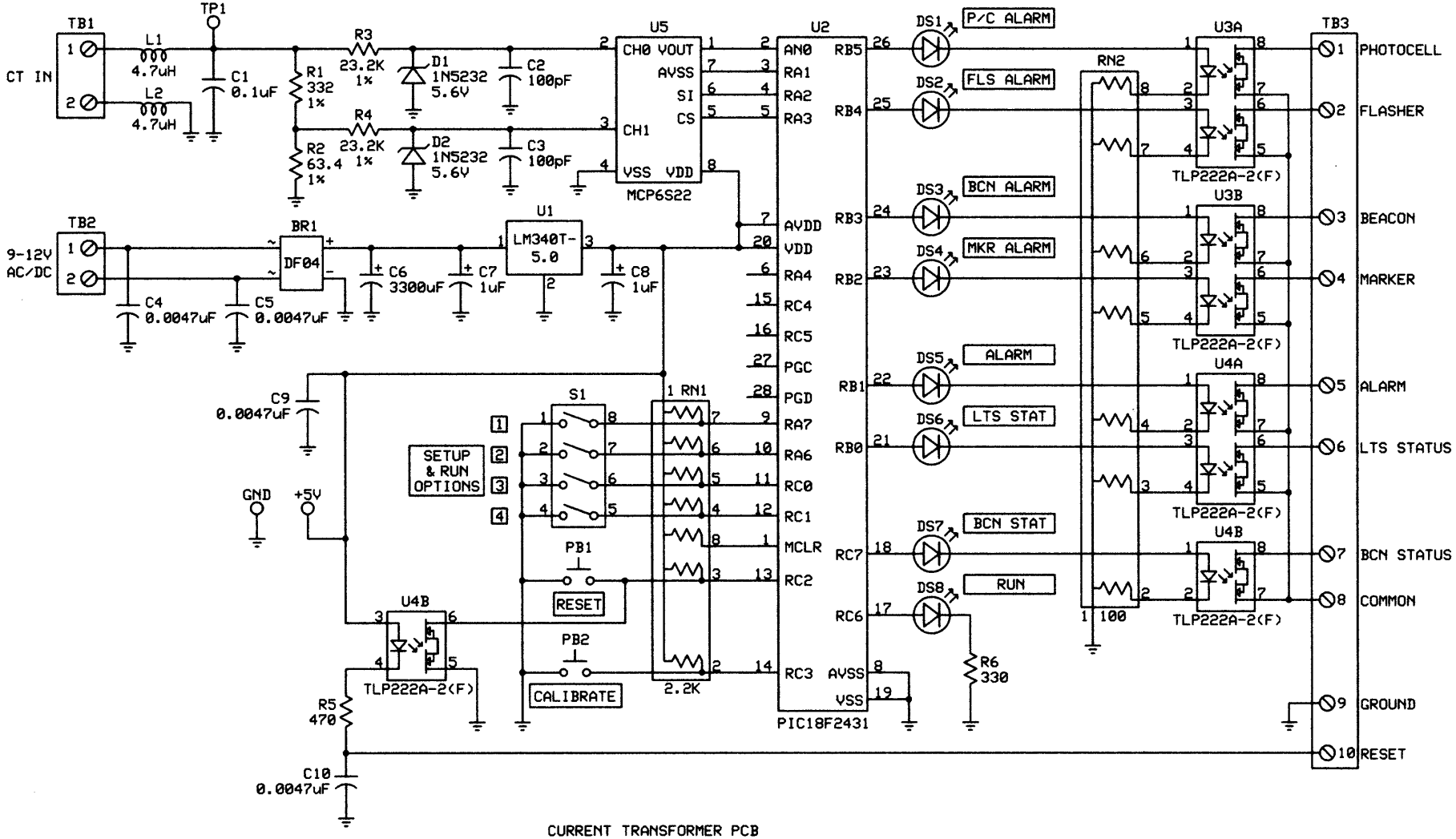
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at their expense.

This Class A digital apparatus complies with Canadian ICES-003.

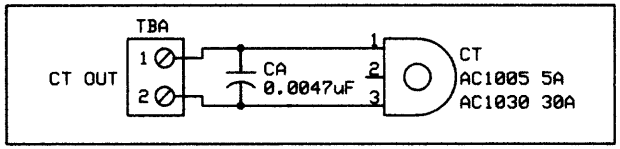
Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

TLM-2 TOWER LIGHT MONITOR PARTS LIST

PART	MFG. PART NO.	DIGI-KEY PART NO.	MOUSER PART NO.
+5V	201-RC		151-201-RC
BR1	DF04	DF04MDI	
C1	ECQ-V1104JM	P4725	
C2	D101K20Y5PH63L6R	1441PH	
C3	D101K20Y5PH63L6R	1441PH	
C4	D472K33Y5PH63L6R	1449PH	
C5	D472K33Y5PH63L6R	1449PH	
C6	ECA-1EHG332	P5546	
C7	TAP105K035SCS	478-1835	
C8	TAP105K035SCS	478-1835	
C9	D472K33Y5PH63L6R	1449PH	
C10	D472K33Y5PH63L6R	1449PH	
CA	D472K33Y5PH63L6R	1449PH	
CT	AC1005 / AC1030	1295-1101 / 1295-1098	
D1	1N5232	1N5232BDICT	
D2	1N5232	1N5232BDICT	
DS1	SSL-LX3044GD	67-1060	
DS2	SSL-LX3044GD	67-1060	
DS3	SSL-LX3044GD	67-1060	
DS4	SSL-LX3044GD	67-1060	
DS5	SSL-LX3044GD	67-1060	
DS6	SSL-LX3044GD	67-1060	
DS7	SSL-LX3044GD	67-1060	
DS8	SSL-LX3044GD	67-1060	
GND	201-RC		151-201-RC
L1	9230-36-RC	M8653	
L2	9230-36-RC	M8653	
PB1	B3F-1000	SW400	
PB2	B3F-1000	SW400	
R1	MFR-25FBF-332R	332XBK	
R2	MFR-25FBF-63R4	63.4XBK	
R3	MFR-25FBF-23K2	23.2KXBK	
R4	MFR-25FBF-23K2	23.2KXBK	
R5	470 5%	470QBK	
R6	330 5%	330QBK	
RN1	2.2K	4608X-1-222	
RN2	100	4608X-1-101	
S1	206-4	CT2064	
TB1	1716020000	281-1435	
TB2	1716020000	281-1435	
TB3	999398	281-1440	
TBA	1716020000	281-1435	
TP1	201-RC		151-201-RC
U1	LM340T-5.0	LM340T-5.0/NOPB	
U2	PIC18F2431	FM SERVICES PART	
U5	MCP6S22	MCP6S22-I/P	
U3A	TLP222A-2(F)		757-TLP222A-2(F)
U3B	TLP222A-2(F)		757-TLP222A-2(F)
U4A	TLP222A-2(F)		757-TLP222A-2(F)
U4B	TLP222A-2(F)		757-TLP222A-2(F)



CURRENT TRANSFORMER PCB

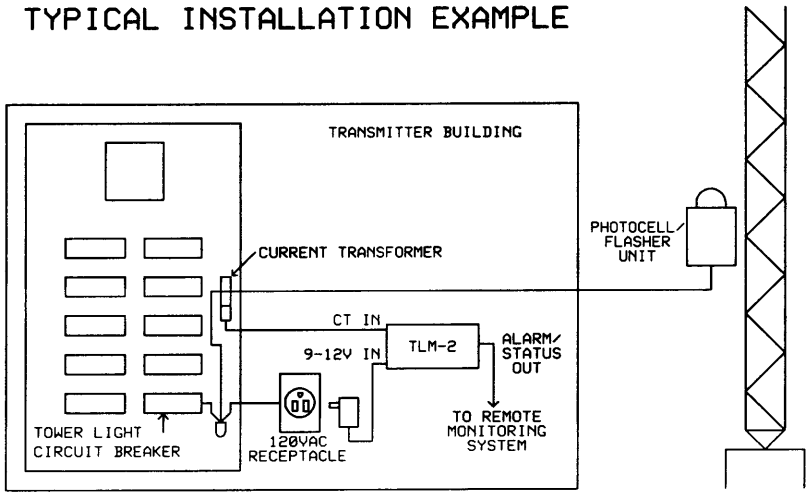


TLM-2 TOWER LIGHT MONITOR

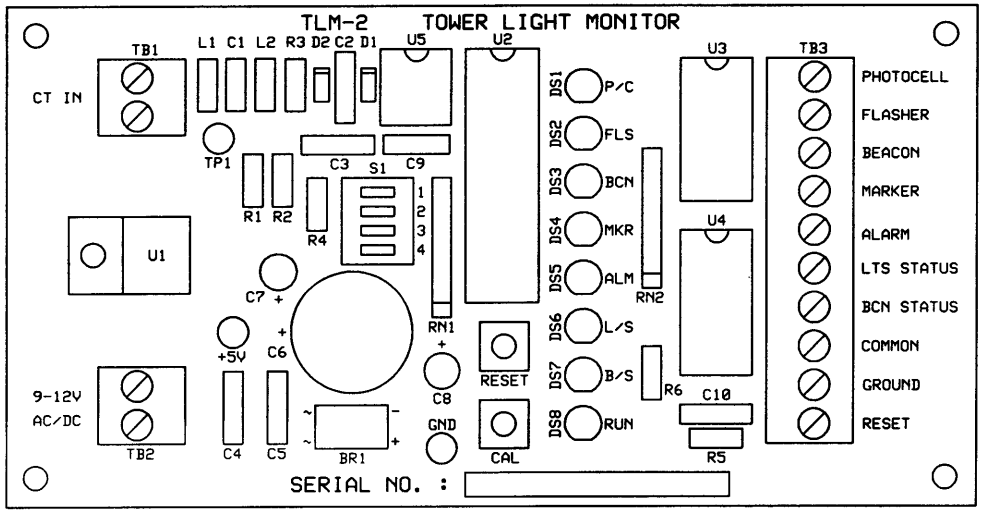
FM SERVICES WILKESBORO, NC

DWG: W. S. OWEN	DWG ID: TLM2A.SCH	TOWERMONITOR.COM
ENG: J. S. KELLY	DATE: 15 FEB 18	

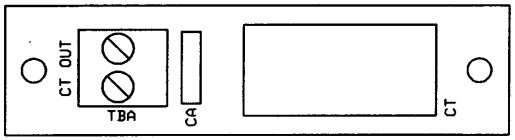
TYPICAL INSTALLATION EXAMPLE



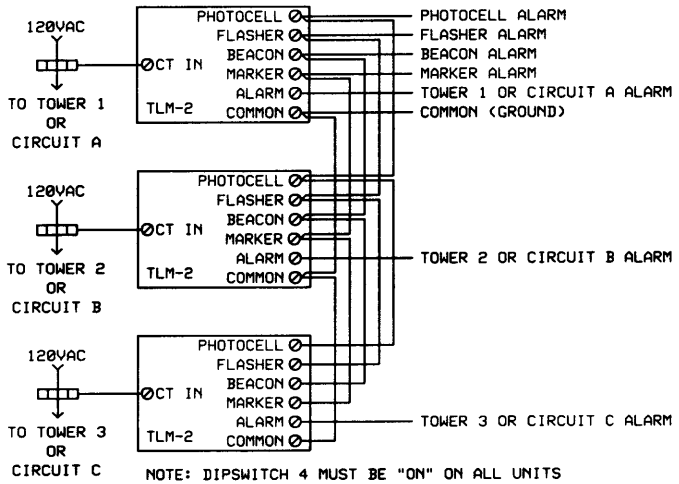
TLM-2 TOWER LIGHT MONITOR



CIRCUIT BOARD LAYOUTS

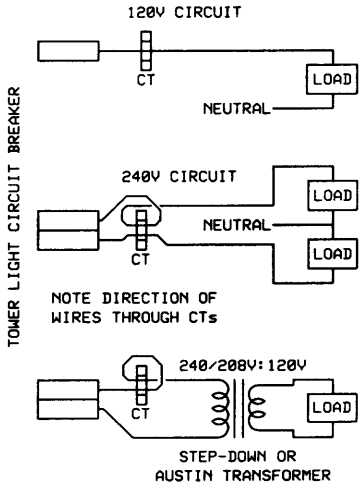


MULTIPLE TOWER MONITORING OR MULTIPLE CIRCUIT MONITORING

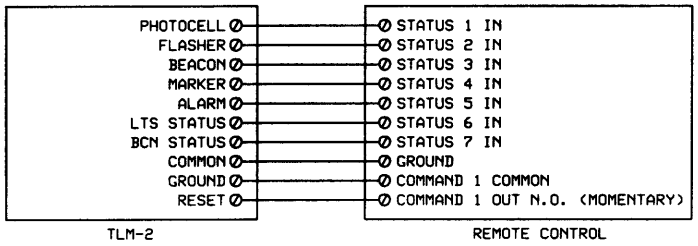


NOTE: DIPSWITCH 4 MUST BE "ON" ON ALL UNITS

CT WIRING EXAMPLES



TYPICAL REMOTE CONTROL WIRING EXAMPLE



TLM-2 TOWER LIGHT MONITOR

INSTALLATION EXAMPLES

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